

**Government of the Czech Republic**

Department for Analysis and Coordination of Science,  
Research and Innovation



**National Research and Innovation  
Strategy for Smart Specialisation  
of the Czech Republic  
(National RIS3 Strategy)**

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## List of Abbreviations

AS CR	Academy of Sciences of the Czech Republic
AVO	Association of Research Organisations
BI	Balassa Index
CERIT	Centre for Education, Research and Innovation in ICT
CTT	Technology Transfer Office
CR	Czech Republic
CSO	Czech Statistical Office
EGAP	Export Guarantee and Insurance Corporation
EC	European Commission
ELI	Extreme Light Infrastructure (ESFRI project)
ERA	European Research Area
ESF	European Social Fund
ESFRI	European Strategy Forum on Research Infrastructures
ESIF	2014–2020 European Structural and Investment Funds
EPO	European Patent Office
EU	European Union
FTE	Full Time Employee Equivalent
GCI	Global Competitiveness Report
GEM	Global Entrepreneurship Monitor
GPTs	General Purpose Technologies
GDP	Gross domestic product
GVA	Gross value added
HW	Hardware
ICT	Information and Communication Technology
IROP	Integrated Regional Operational Programme
R&D IS	Research and Development and Innovation Information System
IT4I	IT4Innovations (National Supercomputing Centre – Ostrava)
KETs	Key Enabling Technologies
LTE	Long Term Evolution wireless broadband technology
MRD	Ministry for Regional Development
MIT	Ministry of Industry and Trade
SMEs	Small and medium-sized enterprises
MEYS	Ministry of Education, Youth and Sports
MI CR	Ministry of the Interior of the Czech Republic
MoA	Ministry of Agriculture
NACE	Statistical classification of economic activities
NATO	North Atlantic Treaty Organisation
NGA	Next-generation access
NIS	National Innovation System
MNCs	Multinational corporations
NPISH	Non-profit institutions serving households
NTF	National Training Fund
OECD	Organisation for Economic Co-operation and Development

OPEI	Operational Programme Enterprise and Innovation
OP EIC	Operational Programme Enterprise and Innovation for Competitiveness
OP PGP	Operational Programme Prague the Growth Pole of the Czech Republic
OP RDI	Operational Programme Research and Development for Innovation
ECOP	Education for Competitiveness Operational Programme
OP RDE	Operational Programme Research, Development, and Education
OP EMP	Operational Programme Employment
RES	Renewable Energy Sources
PCT	Patent Cooperation Treaty
pp	Percentage point
PIAAC	Programme for International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
FDI	Foreign direct investment
RIV	Information Register of R&D Results (data part of the R&D Information System, R&D IS)
RIS3	Research and Innovation Strategy for Smart Specialisation
RDIC	Research, Development and Innovation Council
SF	EU structural funds in the period 2007–2013
SITC	Standard International Trade Classification
SS	Secondary schools
SW	Software
TA CR	Technology Agency of the Czech Republic
TEP	Territorial Employment Pact
USPTO	US Patent and Trademark Office
v.v.i.	Public research institution
R&D	Research and development
R&D&I	Research, development and innovations
WEF	World Economic Forum
RO	Research organisations
STP	Science and Technology Park
HEI	Higher education institutions
PS	Primary schools

# 1. Introduction

## 1.1. The purpose and focus of the National Research and Innovation Strategy for Smart Specialisation of the CR (National RIS3 Strategy)

The purpose of the National Research and Innovation Strategy for Smart Specialisation of the CR (hereinafter the “Smart Specialisation Strategy of the CR” or the “National RIS3 Strategy”) is to effectively target funds – European, national, regional, and private – at activities that lead to strengthening the research and innovation capacity and at promising areas that have been singled out as priorities in order to fully utilise the knowledge potential at the national and regional level and at a combination of both and, in turn, to promote the reduction of unemployment and strengthen the competitiveness<sup>1</sup> of the economy.

As stated by the European Commissioner for Regional Policy Johannes Hahn:

*“To help Europe recover from the economic crisis, we need activities and investments that help countries and regions to release a new potential for growth and increase their role in innovation, improve productivity and competitiveness.*

...

*Rather than a ‘top-down’ approach, which comprises mainly public institutions and authorities, the new concept of investment in innovation requires a ‘bottom-up’ approach that is shaped in a joint process of ‘entrepreneurial discovery,’ which includes the private sector and the academic community and builds on internal strengths of each region, its entrepreneurship, and competitive advantages. Through this process, smart specialisation strategies can unlock economic transformation through modernisation, diversification and radical innovation in all regions of the European Union.”*

*Johannes Hahn, Smart Specialisation and Europe’s Growth Agenda*

The RIS3 strategy is to be understood in a wider context of European public policies. In this context, smart specialisation strategies are a precondition to the fulfilment of EU regional and cohesion policies and Europe 2020 objectives. These have been formulated in response to the economic crisis that hit Europe after 2007–8 and strive to restore European economic growth. However, it must be emphasised that this is economic growth that is based on new foundations so that it is consistent with other important social objectives. The Smart Specialisation Strategy is a strategy for growth that is based on the principles of intelligent solutions (“smartness”), sustainability and inclusiveness. Within an outlined European strategy, key areas of intervention represent effective investments in education, research, development and innovation; a shift to a low-carbon economy; and an emphasis on job creation and poverty reduction.

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<sup>1</sup> Unless specified otherwise, the National RIS3 Strategy uses the term competitiveness to refer to *economic* competitiveness.



The existence of a sophisticated RIS3 strategy also represents a precondition for implementing European Union regional policy interventions (EU structural and investment funds, ESIF) in the area of support for research, development and innovation. According to the General Regulation (Regulation (EU) No 1303/2013 of the European Parliament and of the Council), the obligation to prepare and submit to the European Commission a strategy for smart specialisation applies to those Member States or regions wishing to invest EFIS resources in the following thematic objectives:

1. **Strengthening research, technological development and innovation**
2. **Improving access to information and communication technologies (ICT), usage and quality of ICT**

In that sense, the Smart Specialisation Strategy is not only a precondition to interventions financed by ESIF within the given thematic objectives and investment priorities, but also the coordination mechanism for interventions that are to be implemented within the given area, regardless of the source of financing. The primary purpose of RIS3 is not to distribute ESIF resources, but **to support economic growth and transformation towards a knowledge economy, taking into account the societal challenges and conditions existing in member states and their regions**. A special and important feature in designing and implementing the RIS3 strategy is an emphasis on the “entrepreneurial discovery process” that includes – besides public administration – the participation of entrepreneurs, researchers and other socio-economic groups, including civil society in the role of an innovation user (the “quadruple helix”). This process applies not only to defining the strategy’s objectives, but it must take place throughout the implementation of the strategy in order to bring not only feedback and verification of implemented interventions but also new suggestions and recommendations for targeting upcoming interventions and refining the proposed areas of specialisation at which interventions will be oriented.

The main objective and purpose of RIS3 is to ensure economic growth and competitiveness that are based on the utilisation of knowledge and innovations (as opposed to competitiveness that is based mainly on efficiency). The “smart or intelligent” use and development of specialisation, combining economic specialisation and knowledge specialisation, is an instrument to promote economic growth. In this sense, RIS3 is a partial economic strategy. **Despite that, RIS3 cannot be limited to a narrow economic dimension, even if it constitutes its main purpose.** This is for several reasons: (i) responding to societal challenges and problems (e.g. environmental sustainability, social cohesion, in the narrow sense e.g. a low-carbon economy and technologies leading to greenhouse gas reduction) and finding ways to address them often also has direct economic effects and, of course, mediated and indirect effects, which is why the Smart Specialisation Strategy focuses on them; (ii) the conditions in society strongly influence business, research, education and its quality; the functioning of institutions is an important precondition for the trust of companies, and the Smart Specialisation Strategy therefore also focuses on these conditions, which are not directly related to business or research and development but rather serve as a framework for the effective implementation of activities that constitute the core of RIS3.

## 1.2. The links of RIS3 to other conceptual and strategic documents

The Smart Specialisation Strategy formulates, among others, interventions and proposals designed to improve the application of primarily public research and development. It is in no way a strategic document, the purpose of which would be to affect the entire research and development policy in

the CR. There are other strategic and conceptual documents serving this purpose, for example the National Research, Development and Innovation Policy 2009–2015 and its updates, and others.

Interventions in the field of education are also formulated in the Smart Specialisation Strategy. This is because education is considered the most important cross-cutting factor for developing specialisation domains and, more broadly, for developing innovative business and improving quality and research and development<sup>2</sup>.

### **An overview of strategic and policy documents of the CR, which are explicitly listed in the National RIS3**

<b>Document title</b>	<b>Date of preparation</b>	<b>Prepared by</b>
Analysis of the State of Research, Development and Innovation in the Czech Republic and their Comparison with Foreign Countries in 2012	2012	Office of the Government of the CR (OG CR) – RDIC
The Updated National Policy for Research, Development and Innovation of the Czech Republic for 2009 to 2015 with a view to 2020	2012	OG CR
Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic	2011	MEYS
Digital Czech Republic v2.0 – The Road to the Digital Economy	2013	MIT
Export Strategy of the Czech Republic for the period 2012-2020	2012	MIT
International Audit of Research, Development & Innovation in the Czech Republic	2011	MEYS
National Innovation Strategy of the Czech Republic	2011	MIT
National Research, Development and Innovation Policy of the Czech Republic for 2009–2015	2009	OG CR
National Priorities of Oriented Research, Experimental Development and Innovations	2012	OG CR – RDIC
National Reform Programme of the Czech Republic 2014	2014	OG CR
Economic Growth Strategy of the Czech Republic	2005	OG CR – RDIC
International Competitiveness Strategy of the Czech Republic for 2012–2020	2012	MIT
Human Resources Development Strategy for the Czech Republic		
Education Policy Strategy of the Czech Republic up to 2020	2014	MEYS
The working draft of the main conclusions of the analytical foundation for establishing the research specialisation of the Czech Republic	2014	RIS3 Facilitator
Priorities of the MIT for industrial research, development and innovation – working version	2014	MIT

### **1.3. The creation of the Smart Specialisation Strategy in the CR**

The preparation of the National RIS3 Strategy and its regional annexes began in May 2013 with analytical work in the regions. This work was accompanied by establishing partnerships in the regions for the purposes of regional RIS3, often with the use of existing structures, e.g. for regional

<sup>2</sup> Interventions in education are governed by the Education Policy Strategy of the Czech Republic up to 2020 and the Long-Term Plan for the Development of Higher Education, which is an ex-ante conditionality for higher education. However, it should be emphasised that RIS3 does not constitute a precondition for the area of education.

innovation strategies. The outputs of the work and discussions that have gradually emerged in the regions since May have been one of the sources for the proposal of the National RIS3 document, to which regional documents are annexed.

However, the National RIS3 is a separate document, it is not a summary or an excerpt of the regional annexes. The National RIS3 is the defining national document and the regional annexes specify and clarify its focus, especially in the case of the proposed specialisations, and – in some cases – they also add proposals for specific interventions that reflect the specific conditions existing in each region.

The regional annexes and their contents were coordinated with the National RIS3 and, throughout the process of document preparation at both levels, there was intensive discussion within the implementing teams.

The work on the national document was launched in November 2013 after the work of the RIS3 facilitator had started. The National RIS3 was prepared in connection with existing strategic documents of the CR, including mainly the following:

- National Innovation Strategy of the Czech Republic
- International Competitiveness Strategy of the Czech Republic for 2012–2020
- Update of the National Research, Development and Innovation Policy of the Czech Republic for the period 2009–2015 with an outlook to 2020
- National Priorities of Oriented Research, Experimental Development and Innovations
- National Reform Programme of the Czech Republic 2014
- and others

In addition to the above documents, partial analytical works that had been previously prepared by different entities were also used, including specific regional strategies and also analyses prepared at the regional, national and international levels, as well as other documents.

In order to propose selected domains, within which the CR has a strong potential for smart specialisation, separate analyses have been prepared to provide the framework for more accurate targeting of interventions. Data and analyses were updated as of 31 July 2014. Subsequent updates will be carried out throughout the implementation of RIS3. The sources for the proposal of specialisation domains also included underlying documents that were prepared for that purpose from June to September 2014:

- The working draft of the main conclusions of the analytical foundation for establishing the research specialisation of the Czech Republic, prepared by the Technology Centre of the AS CR for MEYS group III
- MIT priorities for the area of industrial R&D and innovation – working version, prepared by MIT

Proposals coming from both documents were taken into account within the relevant chapter of the specialisation proposal.

The areas of specialisation, as described analytically and proposed in a special chapter of the National RIS3, were refined in the regional annexes within on-going discussions with entrepreneurs, researchers and representatives of public administration that were started in the regions in the period from September 2013 to February 2014 (the “*entrepreneurial discovery process*” at the regional level). This process continued in the regions until July 2014 and it is envisaged to continue

further after the start of RIS3 implementation. ***The National RIS3 used the “entrepreneurial discovery process” in the regions to complement, or more specifically to specify the specialisation domains at the national level,*** as evident from the chapter on the research and economic specialisation of the Czech Republic.

In 2014, the National RIS3 strategy underwent a multi-cycle and multi-stage discussion and comment process, on the basis of which it was adjusted until the current version was refined: the document was discussed three times and approved by the National RIS3 coordination council (January, June and October 2014) and it was also discussed within the “entrepreneurial discovery process” in the form of a round-table meeting with representatives of leading companies and research organisations (January 2014) and the subsequent 4 innovative platforms (October 2014).

The **regional annexes** mentioned above are part of the National RIS3. The purpose of the regional annexes is to identify the peculiarities of regional innovation systems<sup>3</sup> in the different regions and explain their context, while taking account of and placing emphasis on the specific effects of existing or potential specialisation in the regions. Despite considerable homogeneity of the economy in the Czech Republic the regional innovation systems in the Czech regions vary considerably, not only in terms of the structure/nature of the individual parts of the innovation system, but also in terms of institutional development and grounding. Both of these reasons are strong arguments for proposing specific regional interventions that will reflect regional peculiarities and complement the extensive interventions implemented at the national level.

The regional RIS3 managers, who started their activities in May 2013, were tasked with preparing the RIS3 regional annexes. **The progress of the development of regional annexes** of the National RIS3 and the **progress of the establishment of regional partnerships** for the preparation and implementation of interventions for smart specialisation **is currently different in each region**. These differences primarily reflect the *institutional situation* in the different regions, namely the readiness of each player within the triple/quadruple<sup>4</sup> helix and the political leadership in the regions for this type of partnership. Some regions are better prepared than others from both perspectives because they have already developed and implemented their innovative strategies in the past. In some regions, it is more difficult to kick-start activities for the preparation of regional annexes because they have so far never prepared activities and interventions to support R&D&I (and smart specialisation) and have never dealt with them. The newly submitted RIS3 concept thus requires

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<sup>3</sup> According to Cooke (2002) or Etzkowitz and Leydesdorff (2000), the concept of innovation systems includes the knowledge-utilisation subsystem (the corporate sector, public administration) and the knowledge-production subsystem (research subsystem) that includes e.g. public research organisations, universities, private research organisations and businesses implementing research, etc. Where the National RIS3 mentions research, it is deemed to include both of the above subsystems.

<sup>4</sup> The concept of the triple helix (Etzkowitz, 1993, Etzkowitz and Leydesdorff, 2000) is an analytical tool suitable for analysing the organisational and institutional arrangement of key actors within the innovation system, which determines the competitiveness of regions (for more information see Blažek and Uhlíř, 2011). The term quadruple helix was introduced into scientific literature relatively recently, mainly in connection with the concept of smart specialisation. It is an extension of the original concept of triple helix to include the role of the non-profit sector, which may also play a significant role in some innovation systems (national or regional). See also Etzkowitz, H. and Leydesdorff, L. (2000): The dynamics of innovation: from national systems and “Mode 2” to a triple helix of university-industry-government relations. *Research Policy*, vol. 29, pp. 109–123) or Blažek, J. and Uhlíř, D. (2011): *Theory of regional development*. Karolinum, Prague.

often considerable changes in the attitude of these regions to promoting regional development and competitiveness.

**However, all 14 regional annexes were successfully approved by regional assemblies in June–September 2014.**

#### **1.4. The participation of entrepreneurs, researchers and partners from the triple/quadruple helix in the preparation and implementation of the Smart Specialisation Strategy**

##### **Entrepreneurial Discovery Process**

###### **The “entrepreneurial discovery process” in the period of RIS3 preparation in the regions**

In the regions, the preparation of RIS3 started in the first half of 2013. *The “entrepreneurial discovery process” started in September 2013*, i.e. a process engaging individual entrepreneurs, researchers and representatives of other entities of the triple/quadruple helix in RIS3 preparation at the regional level. The participation of entrepreneurs and researchers, representatives of public authorities, and the non-profit sector took place in different ways and at different levels:

- Business/innovation platforms represent groups, in which entrepreneurs prevail and in which researchers and other representatives of the triple/quadruple helix participate
- Regional councils for innovation, which represent the management structure of regional RIS3s, but these also generally include – among other members – the representatives of entrepreneurs
- Ad-hoc meetings and gatherings with entrepreneurs and researchers, which were organised by regional RIS3 managers in cooperation with regional governments
- Visits to companies and research institutions, discussions about the needs of and barriers to the innovation process in the region

More detailed information about the process of participation of entrepreneurs, researchers and other stakeholders in the regions during the preparation of regional annexes and the National RIS3 are always mentioned in the relevant regional annex.

The participation of entrepreneurs, researchers and other representatives of the triple/quadruple helix was organised in each region in a somewhat different manner that was adequate and that corresponded to the conditions existing in the given region. In addition, in some regions the effort to mobilise the representatives of the non-profit sector failed, which is why we refer to the triple/quadruple helix rather than just the quadruple helix.

The consultation and participation of entrepreneurs and researchers (and others) were organised in each region in different ways. In some regions, sectoral innovation platforms for the selected knowledge or economic domains of specialisation were established. In others, it concerned – at this stage – platforms that were organised thematically, e.g. platforms on human resources, entrepreneurship etc.

Representatives of entrepreneurs, researchers and other stakeholders in the regions were consulted and they participated in the RIS3 preparation in several rounds, continuously and repeatedly throughout the preparation of regional annexes until their approval by regional assemblies. **Overall,**

***in 14 regions, hundreds of stakeholders*** (both business and research, but also entities from the non-profit sector and public administration) ***participated in various forms in preparing the RIS3, prioritising and proposing measures and interventions and, in particular, in proposing the specialisation domains.***

In the regions, mainly the regional annexes were consulted, but the participants also had the opportunity to comment on the National RIS3 proposals. Their suggestions were consulted through RIS3 managers and they were adequately incorporated into the National RIS3, ***especially in the case of recommendations and proposals for the specification or further definition of (or addition to) the specialisation domains*** that were being proposed at the national level. ***The specialisation domains at the national level are thus the result of a combination of identifying the needs and specialisations at the national level and reflecting the needs, opinions and recommendations at the regional level.***

#### **The “Entrepreneurial Discovery Process” in the period of the RIS3 preparation at the national level**

The National RIS3 was discussed at a ***round-table meeting of entrepreneurs and researchers in January 2014***. This round-table meeting gave birth to innovation platforms at the national level.

***National innovation platforms*** were prepared and established from May to July 2014. Their first meeting took place on 6 and 7 October 2014. National innovation platforms were convened for the following specialisation domains, combining the knowledge and economic specialisations as identified in the RIS3 below:

- Engineering, electricity production and distribution, electrical engineering
- IT services and software, electronics, electrical engineering
- Production of means of transport
- Pharmaceuticals and medical technology

The innovation platforms focused on verifying and, above all, ***supplementing the National RIS3 proposals, with an emphasis on proposing priorities and recommendations from which the focus of the planned interventions will ensue.***

Innovation platforms at the national level discussed in particular the following:

- Analytical findings from the National RIS3; this discussion was preceded by a structured evaluation of the analytical findings by members of the innovation platforms through an online survey focusing on the members of the quadruple helix
- Recommendations for interventions that are the most important for addressing problems and causes of problems that were identified in the analytical part and verified by members of innovation platforms
- Preliminary specification of interventions according to the needs of each innovation platform’s specialisation domains

Innovation platforms confirmed the National RIS3 Strategy in the form in which it was proposed and discussed during 2014 at a round-table meeting (January 2014) and at meetings of the RIS3 National Coordination Council. Innovation platforms significantly promoted the National RIS3 concept that combines interventions aimed at completing the innovation system of the Czech Republic and its regions (i.e. horizontal interventions) and interventions aimed specifically at strengthening selected specialisation domains (i.e. vertical interventions). Innovation platforms stressed the importance of

human resources as one of the most important conditions for the further development and growth of the knowledge economy. At the same time, discussions at innovation platforms showed that horizontal interventions have certain sector-specific aspects that must be respected in preparing individual operations.

The focus of interventions aimed at strengthening the specialisation domains will be discussed at further meetings of innovation platforms in the first half of 2015 and beyond. Specifying interventions to take account of the needs of specialisation domains within discussions between entrepreneurs, researchers and representatives of public administration will be an important activity of innovation platforms from 2015 onwards.

The next meeting of national innovation platforms is planned for January/February 2015. In the first year, the national innovation platforms will meet more frequently than generally proposed in the chapter on implementation, i.e. with a frequency of approximately 3 to 4 months. In the subsequent years they will meet as needed, usually twice a year.

***The role of national innovation platforms and regional innovation platforms is described in detail in the chapter on implementation.*** The coherence of national and regional innovation platforms is ensured through the participation of some members of the regional innovation platforms in national platforms, as well as through the opportunity for representatives of the national level to participate in meetings of regional innovation platforms.

#### **The “entrepreneurial discovery process” during RIS3 implementation**

The process of participation of entrepreneurs and researchers, and other representatives of the quadruple helix in the search for opportunities to strengthen and develop specialisation will be ensured **mainly within innovation platforms at the national and regional levels**, and also within regional innovation councils. The key role of innovation platforms comprises specifying the proposed specialisation domains, discussing and proposing their profiles, identifying the needs in selected domains, ***identifying opportunities in selected specialisation domains and recommending interventions to strengthen the specialisation domains and their economic benefits***. In this sense, a process that engages mainly entrepreneurs and researchers through innovation platforms is absolutely crucial and irreplaceable for implementing RIS3, targeting interventions, and accomplishing the results of RIS3.

## 2. The starting point for the Smart Specialisation Strategy in the CR

### 2.1. The starting point for evaluating competitiveness

In the first period of transformation from about the mid-nineties until the first decade of the twenty first century, the Czech Republic drew competitive advantage from the resources based on the availability of skilled labour, which was (and is) more cost-effective than in western neighbours. The massive influx of foreign investment employed large numbers of people, while a gradual increase of management efficiency in foreign companies operating in the Czech Republic and a gradual shift towards more sophisticated activities led to an improvement in productivity and export performance. At that time, the Czech Republic had a unique position in the foreign direct investment market, mainly due to the technological advancement of the labour force, the well-managed Czechinvest agency, government incentives, the Czech Republic's accession to NATO and the EU, and its position in the centre of Europe near the main European markets. These conditions, working together, ensured that the CR had a leading position among the countries of the former Eastern Bloc.

The Czech economy has developed its position as a quality manufacturing base for the common European market, within the gap between the higher-cost countries of Western Europe and, at the same time, the more cost-competitive countries in Central and Eastern Europe and in emerging economies. Between 2002 and 2008, despite the on-going restructuring process, the Czech Republic maintained high employment in industry<sup>5</sup>, driven largely by production-type FDI (similarly to Poland, Slovakia and Hungary). This industrial specialisation within Europe was the main source of the country's high economic growth in that period. However, the gap between the cheaper and lower-quality countries and the higher-cost countries, which the Czech Republic occupies, has begun to narrow as the prices of inputs in the Czech Republic grow and, at the same time, as the ratio between quality and production cost improves in other Eastern European and Asian countries.

The fundamental starting point for the above development of the Czech economy is the changing character of the organisation of the world economy. It is increasingly connected not only through international trade, but also through global production networks<sup>6</sup>. These networks are arranged in such a way that, where possible, they are able to service the constantly changing worldwide consumption demand with increasing efficiency. The main organisational force behind these production networks are large multinational companies that use pricing, regulatory and other (e.g. the availability of specific knowledge or competence) differences between countries and regions to optimise the manner in which their own activities and their location are organised. Also, the above optimisation also includes deciding which activities are to be performed in-house and which are to be outsourced. The manner in which global production networks are organised affects the resulting geographic distribution of specific types of activities (sub-parts of the value chain). The growing degree of vertical disintegration of value chains has increased the importance of supplier-customer relationships and enabled domestic companies to participate in global production networks.

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<sup>5</sup> See table 10 in the annex for more information.

<sup>6</sup> The concept of a global production network or a global value chain includes not only production activities, but also an entire range of service activities of companies from the companies' perspective (financial services, consulting, logistics etc.).



However, from the viewpoint of the above developments, the Czech Republic has been paradoxically moving against the logical shift of the sources of competitive advantage<sup>7</sup>. There was often a downgrading – the restructuring of Czech industry and the inflow of manufacturing FDI enabled the Czech economy and the companies operating there to participate in global production networks, but only at low positions in the production of simple products with lower added value, using less-skilled labour. In some cases there was even a deskilling of the workforce due to the predominant use of less-skilled workers for routine tasks with minimal knowledge requirements.

Employment in large industrial enterprises controlled by foreign owners who use the best available workforce has narrowed the space for the establishment of new knowledge-based, high-growth Czech companies. This results in a situation where a class of talented people with the prerequisites for an entrepreneurial career are employed in middle and upper management of foreign companies rather than becoming entrepreneurs. In the long run, the added value of these people for the Czech economy does not have the same impact as if they established rapidly growing innovative companies focusing on the global market.

A high dependence on foreign companies, in the sense as described above, and the previous decades-long interruption of private enterprise (1939–1989) resulted in the virtual disappearance of entrepreneurship as a craft. The loss/non-development of experience in managing companies in the international competitive environment is a crucial starting point in terms of the development of the economy's innovation potential. In addition, entrepreneurs have a bad image in the Czech society (especially those who are successful) and the reputation of entrepreneurship is harmed by some of them. This further discourages successful and experienced individuals in employee positions from becoming entrepreneurs<sup>8</sup>.

In addition to the low intensity of the setting up of companies<sup>9</sup> and the stagnating rate of new business activities<sup>10</sup>, there has been inadequate development of entrepreneurial skills, the system for providing venture capital and the environment for the development of globally oriented companies with products and services intended for end customers. New, fast growing manufacturing companies are often formed around foreign enterprises and are connected directly or indirectly (through exporting their components or even complex modules to foreign manufacturers of end products) to foreign companies operating in the Czech Republic and abroad. This benefited the economy as a whole, as well as domestic companies. They gained access to know-how, experience and indirectly also to markets, although they often did not get direct access to the core knowledge of end customers/users and their needs, which is one of the main barriers to successfully anticipating innovative demand. Another important consequence for the present is the fact that it is difficult for Czech domestic companies to develop independently, or more precisely to compete (with well-

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<sup>7</sup> The Global Competitiveness Report (WEF) distinguishes globally three stages of development of economies, through which countries gradually go: 1) competitive advantage of economies based on the availability of factors; 2) competitive advantage based on improvement in resource-use efficiency; 3) competitive advantage based on innovation.

<sup>8</sup> For more information see the results of the Global Entrepreneurship Monitor 2011 for the Czech Republic.

<sup>9</sup> The number of newly established companies in the Czech Republic declined in the period 2000–2005, i.e. at the time of the main FDI influx (see Table 11 in the annex).

<sup>10</sup> According to the Global Entrepreneurship Monitor, new business activity includes individuals who carry out specific steps to establish a business or lead companies less than 42 month old – the rate of such activity in the group of people aged 18–64 years declined by 0.21% between 2006 and 2011.

established foreign companies) in demanding markets and enter new markets, in terms of both product and territory. The above situation has led to a deepening specialisation of the Czech processing industry, whose position is being attacked by countries with lower costs that gradually improve the price-quality ratio within industries that are crucial to the Czech Republic – automotive<sup>11</sup>, electronics, electrical engineering, mechanical engineering.

Especially in the past 10 years, there have been an increasing number of *endogenous champions*, i.e. rapidly growing companies established, owned and managed by Czech citizens. They base their growth on knowledge generated in the Czech Republic and on increasing its evaluation through innovation<sup>12</sup>, rather than borrowing know-how and using foreign entrepreneurship. Although the number and power of these companies has been gradually increasing, they have not achieved significance within the Czech economy comparable to that of foreign companies. It is a more robust and more powerful sector of endogenous companies that should form a fundamental pillar of sustainable economic growth in the Czech Republic.

At the same time, our previously lagging competitors (especially Poland) have been improving in the cultivation and presentation of their own institutional and business environment, while – *according to independent assessments – the quality of the Czech environment for entrepreneurship, in a broad sense, has been declining*. According to the Global Competitiveness Report<sup>13</sup>, the overall position of the Czech Republic has been consistently declining in comparison to other countries. In the general competitiveness index, the Czech Republic dropped from 29th place in 2006 to 46th place in the 2013–14 edition of the rankings (out of the total of 148 countries). A slight improvement in its position (37th place) in the latest WEF list (2014–2015) cannot yet be seen as a reversal in the trend<sup>14</sup>. Although the number of countries being compared has increased, the Czech Republic's overall competitiveness also declined in absolute terms over the same period (competitiveness index dropped from 4.7 to 4.4). We are most lagging behind innovation-driven economies in the area of institutions (by 1.4 points) and innovation (by 0.8 points). The worst-evaluated individual aspects of the institutional environment include, above all, public confidence in politics (146th place), the burden of government regulation (135th place), the effectiveness of the legal framework (126th place), favouritism-based decision-making of public administration (123rd place), the use of public funds (115th place), and ethics in the conduct of companies (109th place). Yet, a poor quality of the institutional environment is probably one of the major causes underlying the negative balance of talent mobility in the Czech Republic, even though talents are a key condition for the development of innovation-based competitiveness. At the same time, poor talent mobility also directly reduces the

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<sup>11</sup> The automotive industry is the branch of the economy dealing with the manufacture of motor vehicles and their accessories.

<sup>12</sup> Unless stated otherwise, the National RIS3 uses the term innovation to refer to economic innovation, i.e. in the narrower sense of a measurable economic benefit.

<sup>13</sup> The rankings published by the World Economic Forum compare the competitiveness of individual countries on the basis of the evaluation by managers from the most important companies in each country, which is accompanied by primary statistical data. The rankings are somewhat subjective – e.g. respondents from Western Europe may be more sensitive in evaluating the quality of the institutional environment than those from countries in the Middle East or post-Soviet republics. Despite that, the results are widely respected. Detailed values and rankings are listed in the annex, Table 15 and 16 and Chart 13.

<sup>14</sup> The improvement is primarily due to improvements in several indicators within the pillars: Institutions, Macroeconomic environment and Financial markets, within which there are indicators in which the Czech Republic moved about 50 places up the rankings. The improvement is probably associated with government austerity measures in recent years; the legal environment is also evaluated more favourably.

competitiveness of companies. In the area of innovation, low government demand for advanced technology solutions (124th) is seen as the biggest problem, and the availability of high-quality researchers and engineers (64th place) is also rapidly deteriorating, which is related to the negative balance of talent and the quality of the educational system (especially its outputs). This reduces the chances for companies operating in the Czech Republic to develop globally usable knowledge and apply it through innovation, and the country's attractiveness for R&D activities of MNCs<sup>15</sup>. Managers of companies most often mention corruption (17.2% of the responses) and inefficient government bureaucracy (12.6%) as the biggest barriers to business.

Between 2006 and 2013, the Czech Republic experienced the biggest drop in the overall evaluation of conditions for conducting business (the Ease of Doing Business Index<sup>16</sup>) in comparison to other countries in Central Europe. It fell from 41st place to 75th place (out of 189 countries evaluated), while the positions of surrounding countries and the Czech Republic's competitors either improved (Slovenia, Poland, Romania, Austria) or slightly declined (Hungary, Germany, Slovakia). In comparison to other countries, with respect to the individual conditions for doing business the worst situation in the Czech Republic concerns establishing a business (the processing of an application for electricity connection to a company takes an average of 279 days and requires 6 different permits; to establish and register a company, 9 procedures are required, taking an average of 19 days<sup>17</sup>). Other areas contributing most significantly to making doing business in the Czech Republic difficult, are the administrative burden involved in paying taxes and the problematic investment protection.

International rankings that monitor competitiveness and the business environment confirm that, in recent years, the Czech Republic has been losing ground to its main competitors in Central Europe and the rest of the world. Although these evaluations have their methodological pitfalls, the Czech Republic's decline in some of their aspects is so obvious that it must be taken into account.

At this time, some large and important investment projects (such as Hyundai) are still being completed and the technologically advanced workforce is distributed and engaged in global value chains. *However, the Czech Republic ceases to be as attractive a destination for manufacturing-type FDI as it was in the previous 10 years.* The reason is the above-mentioned deterioration of the environment for business (both absolutely and relatively with respect to its main competitors) and also the fact that the supply of cheap basic factors of production in the world markets continues to grow; the Czech Republic is thus exposed to increasing competition from developing countries. There is minimal foreign investment flowing into the Czech Republic for specific, globally applicable competencies and know-how. However, there has been a gradual increase in companies that place knowledge-intensive activities in the Czech Republic<sup>18</sup> that require the involvement of skilled workers (construction, development, design). The importance of the EU ESIF funds – which represent a tremendous opportunity to accelerate the commenced structural changes in the economy and strengthen the potential to build a competitive advantage driven by innovation – has been growing along with the onset of the global economic crisis, but a large portion of them is used in the construction sector (including those that were intended for promoting innovation).

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<sup>15</sup> MNCs = multinational corporations

<sup>16</sup> The Doing Business rankings compiled by the World Bank monitor the quality of the conditions for business from the perspective of the regulatory framework and the protection of property rights. Detailed data and rankings are listed in the annex.

<sup>17</sup> The Doing Business rankings.

<sup>18</sup> Whether new or replacing less knowledge-intensive manufacturing activities.

Research and consequently development represent one of the basic prerequisites for developing competitiveness and sustainable development. In the 2007–2013 programming period, 40 regional R&D centres and 8 European Centres of Excellence were built in the Czech Republic. These R&D centres are important for the further development of the Czech Republic's research base and have significant potential for enhancing the international competitiveness of the Czech Republic, provided that research results are successfully implemented in practice. Due to their sectoral focus and strategic location, the regional R&D centres can become important sources of the development of applied research in the Czech Republic's regions and they also represent potential for developing cooperation between the businesses and research organisations.

Although the problem-based orientation of research funded by public resources has gradually strengthened, there are still gaps in communication between research organisations and the business sector. It is necessary to enhance the dialogue between the two spheres, which would result in a better transfer of knowledge into practice and the establishment of genuine cooperation in research with an emphasis on strategic research, problem-oriented choice of topics, interdisciplinary scope and consistency with social challenges. In addition to developing cooperation and excellence in research, it is also necessary to develop an environment for high-quality research management and for transferring research results into practice in order to increase the benefits of research for both society and the economic sphere, as well as the conditions for disseminating the results of high-quality research and development through their popularisation.

At the beginning of 2014, the Czech Republic is thus in a situation where industrial specialisation is the main catalyst of the economy, to which a number of commercial services are linked. So far the least importance<sup>19</sup> within the domestic economy is attributed to knowledge-intensive services (KIS), where developed economies concentrate a significant part of innovations. Positive examples in the Czech Republic include IT and software services, where both their importance within the Czech economy and their export performance are increasing. Activities with the highest added value are most often implemented at the beginning (R&D) and at the end (marketing, sales, customer contact) of the production chain and it is exactly the establishment of these activities that needs to be encouraged or they need to be attracted to the Czech Republic and further developed. By contrast, the development of industry and technical skills of the workforce can become a strength in connection with the envisaged partial re-industrialisation of Europe<sup>20</sup>. The objective of the Smart Specialisation Strategy is to create such an environment and activities at the national and regional levels that will unlock opportunities for the development of Czech companies growing as a result of a rising global demand of end customers for locally generated innovations, which will increase the Czech Republic's ability to influence its own economic growth and reduce its dependence on the import of entrepreneurship and strategic management from abroad. Such a growth and its contribution to the Czech GDP are – in terms of both quality and longer-term sustainable competitive advantage – more important than a mere shift in the value added and the knowledge intensity of activities implemented in the Czech Republic by foreign companies, unless these companies utilise local knowledge. However, it is important to also focus on branches of foreign companies and their

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<sup>19</sup> In the EU, KIS account for an average of 40% of employment, while in the Czech Republic this is only 32% (2011). The convergence occurs very slowly.

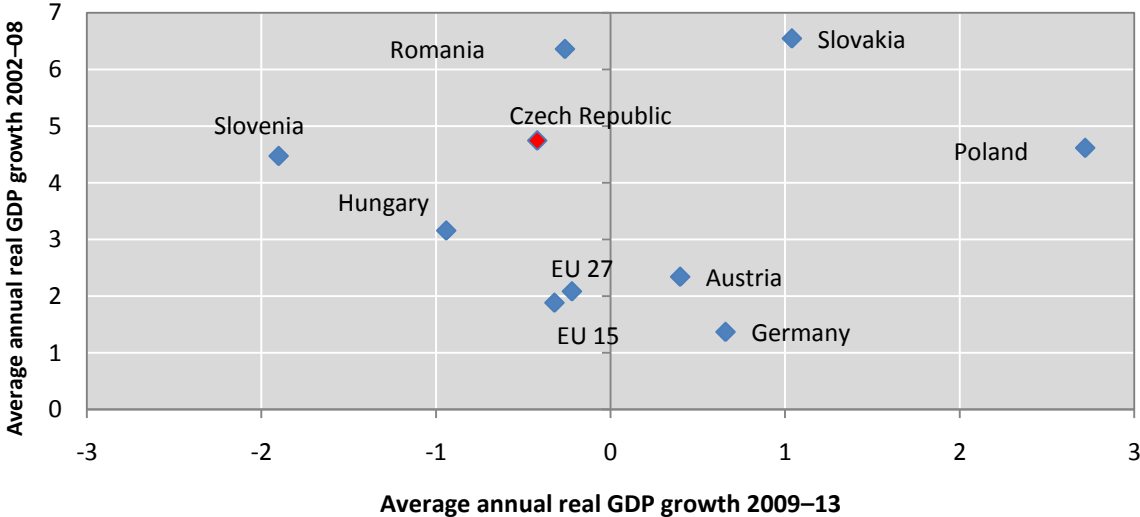
<sup>20</sup> The envisaged partial return of manufacturing activities to the EU is a response to rising costs in China and other rapidly growing primarily Asian economies, greater automation of production, the growing need for a more flexible response to the needs of customers in the EU, and tighter links between production and research and development.

upgrading<sup>21</sup> within value chains and on increasing the knowledge intensity of their activities, because they play a significant role in the Czech economy. In connection with certain global organisational trends, new opportunities and threats arise in this area for the Czech Republic<sup>22</sup>.

### 2.2. Macroeconomic framework

In macroeconomic terms, the period between 2002 and 2008 was one of the most successful in the Czech Republic’s history. Real annual GDP growth ranged between 2% and 7% and was among the highest in Europe. On the supply side, the main source of the Czech economy’s competitiveness and growth was an increase in labour productivity (per person employed), which contributed 3/4 of GDP growth in that period. The main cause was the massive influx of foreign direct investments<sup>23</sup> and the subsequent utilisation of their production capacities in the growth in global demand after 2004. Through their demand, foreign companies also indirectly influenced domestic companies. The fact that the inflow of FDI was a decisive factor in the growth of aggregate productivity has been shown by various on-going studies<sup>24</sup>. They presented a big difference in productivity and export performance between segments of foreign companies and companies without foreign capital.

Chart 1: Average annual real GDP growth in the period 2002–2008 and 2009–2013, selected EU countries



Source: Eurostat (Annual national accounts – Real GDP growth rates), own modifications

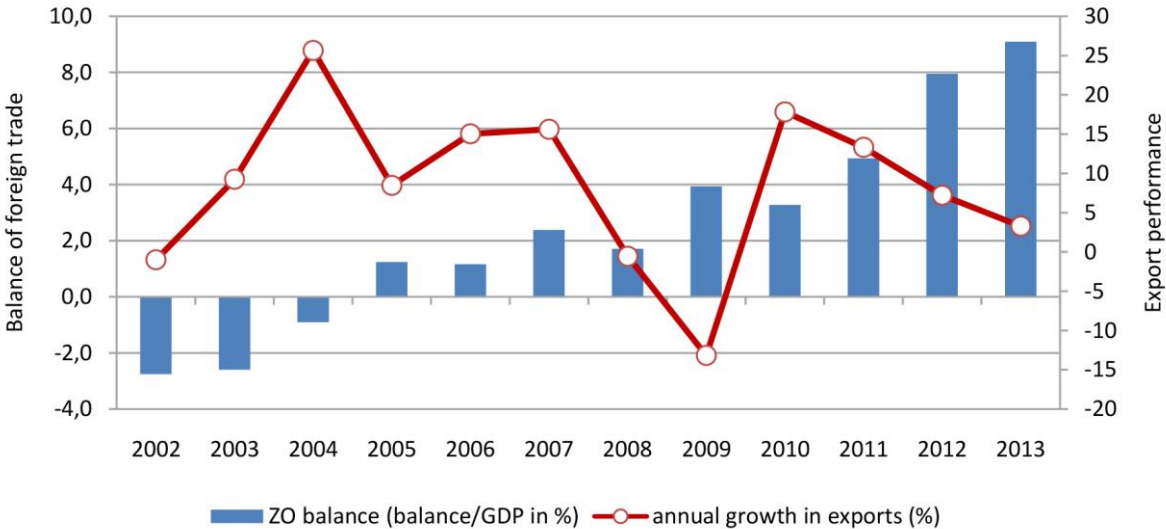
Nevertheless, labour productivity growth was lower in the Czech Republic compared to some other Eastern European countries. This is particularly evident in the period after 2008 when labour productivity in the Czech Republic stagnated (between 2009 and 2012 it even decreased, both in real terms and relative to the EU-27 average). By contrast, in Poland, Romania and (except for 2009) also in Slovakia labour productivity grew faster than the EU-27 average<sup>25</sup>.

<sup>21</sup> A movement up the hierarchy of value chains closer to end markets/customers.  
<sup>22</sup> Described in more detail in the section on global organisational trends.  
<sup>23</sup> The inflow of FDI was mainly supported by the on-going transformation of the Czech economy and the government’s policy of attracting FDI, but also the Czech Republic’s accession to the EU.  
<sup>24</sup> For example CSO (2012) – Companies with foreign equity participation in the Czech Republic’s economy: decline or further strengthening?  
<sup>25</sup> The trends in labour productivity are shown in Chart 8 in the annex.

On the expenditure side of the economy, the main source of economic growth were net exports, which contributed more than 45% of GDP growth in the past 10 years. The above-average impact of foreign trade on the Czech economy is evidenced by the comparison with the EU 27, where – in the same period – net exports contributed only 21% of GDP growth. The positive impact of exports also continued in the period after 2008, with an overall trend of increasing trade surpluses (the growth of exports outpaces that of imports). This indirectly suggests that the production of relatively complex components with a higher added value and of final products has been gradually increasing within the manufacturing and assembly activities of MNCs in the Czech processing industry, while a significant portion of simple parts is imported. A gradual shift in activities with a higher added value at MNC branches is still mainly driven by cost efficiency<sup>26</sup>, rather than access to unique and globally applicable know-how and knowledge. Paradoxically, the model of “hired labour” thus persists, with only a gradual shift in qualifications, namely from the use of assembly workers to engineers employed in design and development activities. Although there are exceptions (and their number is growing), most development activities of MNC branches in the Czech Republic are located at the lower end of the value chain (more complex design tasks, adaptation of products to local markets etc.); those are not key corporate R&D capacities.

The main driver of the Czech Republic’s high export performance was foreign demand for products from the Czech Republic that was satisfied by branches of production-type MNCs, which also benefited domestic companies through subcontracts. To a lesser degree, the increasing competitiveness and export performance of endogenous companies also contributed.

**Chart 2: Trends in the Czech Republic’s foreign trade, 2002–2013**



Source: CSO – foreign trade (cross-border concept), CSO – national accounts (GDP, production method)

The EU remains the main target export market where more than 80% of the export value is going. Over time, its share has been slightly declining, mainly due to economic stagnation of EU countries and their lower demand for products produced in the Czech Republic. The highly active balance of foreign trade with most EU countries is due to the location of production capacities of foreign (mainly European) companies in the Czech Republic, where the ability to occupy these challenging

<sup>26</sup> A very good ratio between technical competence and the cost of labour force is one of the main reasons for the placement of functions such as development, construction and design that are more sophisticated and more important within the corporate hierarchy .

foreign markets lies in activities that are located abroad; in most cases these activities are not managed from the Czech Republic and they do not use local abilities to occupy these markets. In recent years, however, there has been a gradual reduction in the Czech Republic's previously highly passive balance with other advanced economies, which may indicate the increasing ability of local businesses to occupy demanding foreign markets outside the EU as well. Still, the volume of foreign trade with other developed economies outside the EU remains low relative to their size. In a global perspective, rapidly growing Asian markets are not yet successfully occupied by Czech companies on any larger scale. It is likely that some Czech outputs are implemented in these markets through re-export where foreign companies supply products to these markets, for which Czech companies supply intermediate products. However, Czech companies themselves do not have opportunities in Asian markets under control and, in turn, cannot take full advantage of them.

The cost competitiveness of the Czech economy has gradually been depleted. Real unit labour costs<sup>27</sup> increased by 3.4% in the Czech Republic between 2003 and 2012, which is the fifth highest rate within the EU 27 and, after Estonia and Slovenia, the third highest value among the new member states (see Chart 12 in the annex). Labour in relation to the value of the manufactured product has become more expensive in the Czech Republic. The Czech Republic's growth rate of unit labour costs is much higher than in Poland, Slovakia, Hungary and Romania, but also higher than in most Western European countries. The absolute cost of employment is still much lower in the Czech Republic than in Western European countries, but it is higher than in its direct competitors, i.e. in Poland, Slovakia, Hungary and Romania, and the difference between the Czech Republic and these countries is increasing. The attractiveness of the Czech Republic as a destination for production-type FDI is declining and this is also reflected in the declining value of FDI and their structure (reinvested profit prevails over investments in equity with the construction of new production capacities).

### **2.3. World trends**

The Czech economy and its competitiveness are influenced by many global trends that have a character of opportunities or threats and, in many cases, act in a contradictory manner. The trends can be broken down into changes in the organisational structure of the world economy and, on the other hand, into megatrends, which mainly affect the global society and global demand. Neither of these two groups can be ignored when preparing the Smart Specialisation Strategy, since these trends have the potential to significantly strengthen or weaken the chances of success and the positive effects of our efforts and investments. Organisational trends are important because the core of Czech economic activities for growth is a part of global value chains. Global consumer megatrends are important because the value chains are mostly controlled by companies or groups of companies that are in direct contact with global demand dictated by end customers. The list of trends is not exhaustive and their force and the way in which they will affect the competitiveness of the Czech economy is different and mutually interdependent.

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<sup>27</sup> Real unit costs compare the costs for labour (costs per employee at current prices) and productivity (GDP at current prices for employment).

### 2.3.1. Organisational trends

The phenomenon of **globalisation** has been fully apparent in the Czech Republic in the past 20 years. The main driving force behind economic globalisation was the disintegration of value chains that, thanks to decreasing trade barriers, enabled strong MNCs that control global production networks to place/outsourcing their activities in different parts of the world as needed and to optimise the way in which their own activities are organised. The new form of globalisation translates into a situation where MNCs are currently not only looking for cheap factors of production around the world, but they are also increasingly searching for sources of knowledge and unique know-how and especially for key experts and talents. This increases the global fluctuation of talents and key experts that is not controlled only by MNCs, but by the talents themselves. This increases the pressure on individual countries (even the Czech Republic) to be able to keep/improve their position in the market niches in which they can be globally competitive and provide their key knowledge sources (R&D organisations, universities, and key talents, experts) and, at the same time, become attractive for the influx of outside sources of knowledge.

This is related to the **transformation of the organisation of the MNCs' R&D activities where one of the two main trends is the concentration of own R&D to only a few places around the world** in which the above combination of knowledge sources is available. The aim is not only to improve cost-effectiveness, but also the process of creating knowledge and innovations. Networks of cooperating research organisations and other entities are used for cooperating and to obtain external (from the company's viewpoint) knowledge from other important "hot spots". For the Czech Republic, this process can be an opportunity with regard to MNCs that have been operating there for a long time and in the fields where the Czech Republic has a globally competitive research capacity. In contrast, for MNCs that are less rooted in the Czech Republic and that operate in fields where key research capacity is lacking, this trend may lead to the continuation of less knowledge-intensive production with obsolete technologies, where there is a high risk of such production being relocated to countries with lower input costs or to the proximity of MNCs' corporate research and development centres.

The intensive global movement of talents carries a risk for the Czech Republic, namely the drain of talent<sup>28</sup> that is not sufficiently offset by talent coming from abroad. The availability of talent is a critical prerequisite for innovation-based economy, and changes in the organisation of global production networks increase the importance of competition for talent and its special competence. Unless we find a way to succeed in this competition, our economic position in the world will continue to weaken.

**Another current trend in companies' R&D activities is open innovation, which takes place in parallel to the concentration of MNCs' core R&D activities<sup>29</sup>.** The main objective of the open innovation process is to use networks and new sources of knowledge to identify new opportunities

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<sup>28</sup> The Global Competitiveness Report (WEF) can serve as indirect evidence – in that report, the Czech Republic ranks below average in the brain drain indicator and its position is deteriorating rapidly (from 44th position in 2009 to 84th position in 2012).

<sup>29</sup> These two trends are often happening simultaneously within one company. The core R&D activities leading to higher-order innovations are implemented by the company internally (but can be carried out in collaboration with research organisations). At the same time, it delegates lower development activities or activities on the border of its current specialisation to cooperating entities and, thus, uses a distributed knowledge network. However, within these lower-order innovations there is also a demand for cooperation with research organisations, albeit not as strong.



outside the main sphere of companies' operation. The purpose is – in the world of distributed knowledge networks – to utilise not only internal sources, but also external sources and to also seek incentives for innovation outside the companies. Companies become more open about their needs and problems and work with external partners (companies, research organisations, suppliers/customers) to address them and create innovations, which allows them to find a way to new solutions and applications as well as to new areas of operation that they cannot identify by themselves. In particular, large MNCs often provide technology and a portion of their intellectual property to external partners and, thus, probe new areas of application. The concept also envisages that knowledge of companies/research organisations that is not or cannot be used effectively in the market should be provided to external entities via licensing/spin-offs/joint-ventures.

Open innovation can also benefit Czech companies and R&D institutions, provided that they are able to offer attractive and unique knowledge to global players and, conversely, provided that the Czech economy has companies that are able to absorb knowledge from the outside. In this respect, there are very heterogeneous companies operating in the Czech Republic – companies that build their competitiveness on knowledge and on creating and accepting knowledge (“endogenous champions”). On the other hand, there is a relatively large group of companies that base their competitiveness on the price advantage. The largest group consists of companies that are somewhere between the above-mentioned categories and for some of them the *open innovation* trend can mean the start a positive cycle of growth, which can place them among the “*endogenous champions*”.

**Distributed knowledge networks.** The trend complements the concept of open innovation and is, in a broad sense, based on a systemically interconnected set of knowledge across economic and social institutions, including individuals. It uses the openness of both the innovation process and interdisciplinary exchange of knowledge, which allows companies to gain a competitive advantage in the form of unique combined knowledge. Technological advances in IT may result in – among other things – an impetus for development in agriculture, namely through developing software that will for example improve harvest efficiency or allow harvest quality control. KETs<sup>30</sup> play a key role in knowledge-based networks. Knowledge in these technological areas has a high variability of use across economic sectors and its application (not only separate but especially the combination of individual KETs) enables the development of innovations in different production chains. KETs are a great opportunity for the Czech economy, as innovations created based on these knowledge domains can also be applied in fields that might, at a first glance, seem to require little knowledge or to be rather distant. The trend of distributed knowledge networks provides potential for Czech R&D teams having unique expertise in some specific knowledge domains that can be used by MNCs for their own innovative activities.

**“Endogenous champions”** (companies owned and controlled by Czech citizens showing rapid growth driven by global demand) – the identification of such companies, their integration into the global economy, and their shift to higher positions within global production networks. The ability of the economy to create/generate endogenous champions is very important for long-term competitiveness, the ability to respond to external shocks and adapt to them in a positive

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<sup>30</sup> KETs (Key Enabling Technologies) are key broad technological knowledge domains of a systemic nature, whose use in various economic fields makes it possible to generate product, production process and service innovations. These include nanotechnology, microelectronics, advanced materials, photonics, industrial biotechnology, and advanced manufacturing technology.

sense. Fields in which these champions operate can generally be described as engines of the economy, to which companies from driven sectors connect and which benefit from the prosperity of the champions. In the Czech Republic, this category is comprised of a small but growing number of companies that, however, have not had any major importance within the economy thus far. It is their development that should be one of the main pillars of the Czech Republic's future competitiveness. Endogenous champions also have a vital role in creating a positive image of business and the development of the entrepreneurial environment. However, supporting and educating such companies is a long-term process that requires a systemic approach and long-term fieldwork that is necessary for identifying these companies and gaining their trust.

### 2.3.2. Global consumer megatrends

Below is a description of the most important global consumer megatrends that will increasingly affect global demand and, in turn, the Czech economy. Each of those trends will be indirectly reflected in the Czech Republic, with a different intensity and in a structured manner within various economic fields. The influence of megatrends on individual companies and entities in the Czech Republic will be individual and its intensity cannot be precisely predicted in advance because it depends on many factors and microeconomic aspects of each company. Companies will be forced to follow these trends, anticipate their possible impacts and adjust to them proactively.

**Resources tension on the planet.** The growth of the population and its demand on a global scale increases the pressure on basic resources (water, food, land) and traditional energy sources. This increases the pressure on nature and, along with climate change, biodiversity declines and the frequency of extreme weather events increases, which worsens the availability and quality of basic resources. The growing number of people without access to safe drinking water and basic food poses a threat to socio-political stability. The main challenges include long-term sustainable use of resources, elimination of poverty, and improvement of the quality of life. Global growth of demand for innovative solutions in these areas will lead to the growth of business opportunities and jobs in the field of long-term sustainability (reducing the energy and material intensity of industry, ecological and efficient transportation, clean technologies, renewable energy resources, efficient and productive agriculture) all over the world, including the Czech Republic. At the same time, there will be a growing need to generate applicable results of research in this area. In the Czech Republic, there is an expert and research background and facilities in the energy sector, which can be used for the development of technologies that use traditional energy sources and alternative sources in an innovative way. The Czech Republic can offer similar capacities and expertise in the field of agriculture and material research.

**Growth to the east of us.** Asia has not only taken competitive advantage of the increasing use of resources and productivity growth, but it also generates and concentrates wealth, experiences population growth, and is gradually becoming an increasingly important player in the field of research, technology and innovation and a centre of global production and consumption (at the expense of the "Global Triad" of North America, the EU and Japan, which is also losing ground geopolitically). A massive increase in the standard of living and, in turn, in consumption in Asian countries, is an opportunity (not only) for cooperation between European and Asian countries and an opportunity for applying specialised knowledge of Czech companies and becoming successful in those markets. The increasing standard of living also massively increases the cost of production in Asian countries. In combination with the persisting lack of technical skills of the local workforce,

some companies will be relocating their capacities back to Europe, which also has other benefits for them (flexibility of supplies, proximity to key R&D departments of companies and leading RO that represent key sources of knowledge, and proximity to the still significant and rich markets within the EU). Growth in Asia will thus very likely lead to the partial and selective re-industrialisation of Europe, which can benefit the Czech Republic due to its industrial tradition and the continuing favourable ratio of production costs and labour force skills relative to Western Europe.

**Urbanisation of the world.** The number and proportion of the population living in cities in developed and, even more so, in less developed countries has been increasing over the long term. At present, the global proportion of people living in cities has exceeded 50%. High economic activity and a high number of people will be concentrated within limited areas. People living in these cities will demand better services, better housing, better transport, better management, and a better living environment. There will be growing demand for innovative solutions, technologies and products intended for people living in cities, especially in the fastest growing cities in developing countries. The problems and risks that are caused by urbanisation in the area of mobility, the environment and social issues will present key challenges that will need to be addressed ever more often. In this regard, the concept of “smart cities” is important, as it focused on innovative solutions to urban problems and on improving the functioning of cities and offering new services. The need for key expertise and supplies in the area of transport systems, capital equipment and construction in rapidly growing cities within less-developed countries may be an opportunity for Czech companies (or those operating in the Czech Republic) that should not be missed.

**New ageing.** The number and proportion of elderly people have been increasing in developed countries and demographic ageing is gradually also affecting emerging economies. The main manifestations of demographic changes include the declining number of countries with young populations, accelerated cross-border migration, the growth of the global middle class and urbanisation. Globally, the structure of elderly people is also changing – their wealth, technological knowledge, activity and involvement are growing. This significantly changes their requirements for an active life in elderly age, which creates new, rapidly growing demand for services, products and technologies tailored to their needs, which is also the case of the Czech Republic. The unsustainability of pension system funding, increasing demands on health and social care, tensions in society between the young and the elderly and problems with the employability of young people with no work experience (at the expense of older skilled workers) constitute the main threats to the public sector. These are the main challenges that accompany population ageing, which affects not only developed countries but it will also rapidly accelerate in developing countries.

**Technology for the future.** Growing digitalisation and automation and the development of new technologies will continue to change the organisation and productivity of traditional value chains. It will also result in lower use of non-specialised labour in production and distribution, which can be a threat to employment in this group of people. This will concern not only developed countries, but increasingly also developing countries. New technologies are changing the methods of consumption, work, business and production, methods of becoming successful in the markets, social relations and the way of life. Key technologies<sup>31</sup> act as broad knowledge domains and can be used in an extensive portfolio of fields and products even far beyond the original area of operation, with a high potential

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<sup>31</sup> In particular KETs (explained above), or the more generally conceived GPTs (General-purpose technologies), which have the character of radical technological innovations that affect the whole economy (for example the Internet or nanotechnology).

for innovation. Their combination with other knowledge represents one of the key capabilities of the world's economies to enable new applications and ways of fulfilling specific needs arising from new trends in global demand.

**The power of individuals.** Global economic growth, cross-border trade and the spread of political and social changes have contributed to the growth of the global middle class, which will eventually become the largest population group in most countries. The global competition for talent and the increasing importance of the human factor for competitiveness have increased the significance of the "global class of experts" who are the key bearers of knowledge and implementers of change, and even the Czech Republic is under increasing pressure to succeed in this competition. One of the consequences is also the gradual widening of the income gap and the increasing concentration of power and wealth in the hands of a limited number of individuals. Technologies eliminate information asymmetries, as individuals have information and tools of mass dissemination of information. The ability of individuals to create a mass wave of support or resistance has increased exponentially. At the same time, the possibilities of individuals and small groups to influence global demand and to further personalise it are increasing. Fragmented demand increases the importance of market niches and it will be important for companies to analyse and service these trends.

## 3. Analytical section

### 3.1. Business and innovation

#### 3.1.1. Introduction

Over the past two decades, innovation has become the centrepiece of corporate strategies. As a result, it has also become part of professional discussions concerning the nature of competitive advantage and, by extension, the economic growth of countries and individual regions. Innovation is a complex phenomenon that takes many forms – this complicates its perception, measurement and, in turn, the design of innovation support by the public sector.

For the purposes of this section<sup>32</sup> of the RIS3, we define innovation as a ***change that brings value to customers, for which they are willing to pay*** (e.g. Christensen, 1997; Tidd et al., 2005). From the perspective of economic policy objectives (especially employment targets) the key aspect of innovation is its reception in the market. That alone ultimately decides on the effectiveness of innovation policy<sup>33</sup>. Many misunderstandings arise from the fact that technical solutions (e.g. a prototype) produced by research organisations are sometimes referred to as innovations, without being sufficiently verified in terms of the specific needs of the market and without having a chance of being received by customers. This perception of innovation as technical solutions often leads to concentrating attention on research, development and cooperation between the business and the academic sectors. However, it also leads to underestimating the role of an overall corporate strategy, non-technical innovation (including marketing, organisational innovation) and other in-house processes that have a significant impact on the ability of companies to grow and innovate.

Most innovations thus arise in the markets and are implemented by companies. Research organisations are also an important subject of innovative processes of companies, especially in the case of higher-order technical innovations of various types. This is especially true in areas where there is creative interaction between research organisations, companies and markets. The National RIS3 pays specific attention to promoting innovation that provides the most room for using research results. At the same time, account is also taken of the structure of the local economy with a high proportion of traditional industries and the importance of non-technical innovation for obtaining/maintaining competitive advantage of companies. In addition to innovations generated by companies, attention is also focused on innovation in the public and the non-profit sectors.

The structuring of both the problem areas and the proposal part largely reflects the following starting points. The innovation performance of companies and, in turn, of entire economies depends primarily on (i) entrepreneurship, (ii) new knowledge, and (iii) a favourable regulatory framework for business. Within the RIS3, entrepreneurship is understood as an “active force that interconnects the resources needed for successful innovation” (Fagerberg, 2005). As the bearers of this force,

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<sup>32</sup> Innovation can also be understood in a broader sense, i.e. as a change that brings value to users (e.g. innovation in public administration or innovation that reduces negative externalities). In other parts of the text, innovation is understood in that broader sense – adequately to the context – but always with the condition that there must be manifested/acquired value to the user.

<sup>33</sup> Investments in research that are carried out in order to promote innovation are seen as a tool of innovation policy. However, research policy also has objectives other than to promote innovation and economic growth.

entrepreneurs and managers seek to interconnect markets, knowledge and specific technical solutions within the innovation process. The innovation process comprises the following:

- (i) Identifying new customer needs;
- (ii) Finding technical solutions to satisfy them;
- (iii) Searching for, acquiring and coordinating the management of necessary resources (including research results, if needed) and competences;
- (iv) Launching the innovation onto the market so that it is well received by customers and so that the launch takes place ahead of the competition.

The above indicates that ambitions and goals of entrepreneurs and managers are an important aspect of entrepreneurship (and, by extension, of innovation). To a large extent, these reflect local (not only business) culture, the overall atmosphere in the society, and the functioning of the regulatory framework for business. Innovation is essentially a very demanding investment with a very uncertain return. The cost of the investment, the uncertainty of its return and its delay in time increase proportionately to the increasing order of the innovation. Entrepreneurship and cultural environment within the society significantly affect which opportunities entrepreneurs and corporate managers do or do not want to use in the context of the costs and risks associated with using them.

With respect to new knowledge as a specific input into the innovation process, innovations that are successful in the market require a purpose-based interconnection of the various forms of such knowledge. New knowledge that is necessary for innovation (including technical innovation) usually has the character of “a new combination of already existing knowledge or information” (Jensen et al., 2007). The novelty lies in the actual combination (targeted application) of available knowledge. Research and development for innovation is thus highly targeted and is very different from research that focuses on pushing the boundaries of knowledge of the society. New knowledge in the form of strategic information about the situation and trends in the markets (the needs and behaviour of customers, the possibilities of suppliers, the steps taken by competitors etc.) are of crucial importance, even within the company itself.

At the level of the entire economy, especially in the longer run, innovation relies on new knowledge that expands the overall level of knowledge and thus the potentially achievable technological possibilities of the society (see the chapter on research and development). Knowledge gained through industrial research and development leads to technological solutions to specific needs and problems during the innovation process. New knowledge gained from the markets through interaction with customers, suppliers, competitors etc. as well as knowledge about the functioning of the in-company environment makes it possible to identify new opportunities and to find effective ways of using such opportunities for innovation and building the company’s competitive advantage and market position. The specific combination and importance of the above kinds of new knowledge for successful innovation vary from case to case. There is no simple, direct link between the technical demands of innovation and its economic benefits for the subject carrying out the innovation (Hirsch-Kreinsen et al., 2008).

The regulatory framework for business includes both general rules for business (e.g. for setting up or winding up a business) and legislatively set conditions affecting its profitability (e.g. the level and form of taxation). Industry-specific regulation is also very important (e.g. rules on GMOs or industry standards of quality). The regulatory framework has an important impact on the entrepreneurial initiative of individual citizens and on companies’ investment decisions. This makes it an important

part of the innovation environment. It is mainly the stability and predictability of the regulatory framework that has a substantial impact, because frequent changes disrupt expectations of economic actors and make the environment difficult to predict and, by extension, affect personal motivation and investment decisions.

Based on analyses, research and discussions with stakeholders (key actors) the following main problem areas have been identified:

- Low level of entrepreneurship and inadequate performance of the endogenous entrepreneurial sector
- High dependence of the Czech Republic's economic development on the activities of foreign-owned companies<sup>34</sup> that only use the Czech Republic as a manufacturing base
- The instability of the regulatory framework and the administrative burden associated with complying with the regulatory rules.

### **3.1.2. Problem area 1: Inadequate endogenous entrepreneurial sector and entrepreneurship**

#### **Manifestations and subproblems**

- The endogenous<sup>35</sup> business segment has undergone dynamic development over the past decade. Despite that, only a small (though growing) portion of companies are able to keep up with global market leaders, both commercially and technologically (Berman Group, 2010). In terms of real economic and financial strength, the endogenous business sector consists mainly of companies that are small on a European or global scale, even though some of them have over 250 employees. There are very few truly large companies with many thousands of employees within the endogenous business sector. A lot of mature companies are still dealing with the heritage of huge internal debt that was incurred back in the period of a centrally planned economy. The majority of them have undergone very complicated privatisation. Some of them have only recently been acquired by owners who are interested in the long-term development of the company rather than in restructuring it in order to sell off its liquid assets. Both the internal debt and the complicated search for a strategic owner have negatively affected the current innovation capacity within this business segment. In terms of generally available data, these problems are documented e.g. by the significant difference in value added per employee or the notable lagging-behind in business R&D investments in comparison to foreign controlled companies.
- There are a number of dynamically growing companies within the endogenous business sector. Some have gradually become important players in their respective markets (usually in special niches of markets otherwise occupied by large multinational companies). This dynamic sub-

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<sup>34</sup> There are significant differences among foreign-controlled enterprises operating in the Czech Republic and many of them constitute technological leaders of the Czech economy. At the same time, however, there is a significant group of companies (known popularly as "assembly plants") that contribute significantly to the Czech Republic's exports but are characterised by activities that are not very sophisticated and have low added value. The above problem area addresses both types of foreign-controlled enterprises as specified, knowing that even small businesses with unsophisticated manufacturing and service activities may, over time, strengthen their position within the parent company and bring activities with high added value to the Czech Republic.

<sup>35</sup> An endogenous company is understood as a company whose strategies and business are controlled from the Czech Republic.

segment mainly consists of small and medium-sized enterprises whose innovative capacity is limited by their size. Moreover, available statistical data are increasingly distorted by the growing number of successful local companies that have relocated their headquarters outside the Czech Republic (mainly the Netherlands, Cyprus, Luxembourg etc).

- The sales of a large portion of endogenous enterprises in the manufacturing industry<sup>36</sup> are strongly dependent on demand from branches of foreign companies that are based within or near the Czech Republic (with the dominant position of Germany as the main export destination). A large portion of endogenous companies have limited ability to penetrate demanding and/or distant markets on their own<sup>37</sup>. For some of them, this is due to lack of interest or the perception of too high risks and limited competences. For others, this is due to their size and development stage in which it has – thus far – been natural to primarily target the domestic and neighbouring markets as a relatively easier expansion method. The dependence of the endogenous business sector on foreign companies' demand through which their products usually penetrate into the European/global markets shows that the Czech Republic's economic growth is strongly dependent on "importing" entrepreneurship from abroad.
- At the same time, R&D expenditure of Czech small and medium-sized businesses has been growing rapidly over the past seven years, thus creating the conditions for the development of innovative, globally competitive production. Due to a high level of interconnection between the Czech and foreign economies, even Czech small and medium-sized businesses are increasingly engaged in international value chains.
- The innovation capacity of endogenous companies has also been affected significantly by relatively limited growth- and innovation-related ambitions of entrepreneurs and managers of such companies. Widespread characteristics of competitive and market strategies of endogenous companies include (Berman Group, 2010): (i) building competitive advantage based on low costs and the adoption of foreign technologies instead of innovations that are new to the market, (ii) relying on future demand of existing customers instead of looking for new markets, (iii) preferring maintaining the status quo to striving for further growth, (iv) relying on one's own competences only and distrusting the benefits of cooperation – limited ability to utilise the open-innovation concept, (v) perceiving problems as obstacles rather than opportunities. Due to the above facts, domestic companies have limited potential for growth that is based on knowledge-oriented activities.

### Causes

- The business sector as a whole entered the process of transition to a market economy in a condition when it was lagging significantly behind in technology, management, business strategies etc. Under such circumstances, it was just a matter of time until a major part of the corporate sector became part of multinational companies through acquisitions. Even today, companies with no foreign capital are still tackling the consequences of the above situation, although they have managed to eliminate them gradually.

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<sup>36</sup> At the level of economic sectors, the manufacturing industry constitutes the main driving force of economy in the Czech Republic.

<sup>37</sup> The World Economic Forum (WEF) carried out a comparison of 144 countries based on managers' answers to the question "To what extent are international distribution and marketing from your country owned and controlled by domestic companies?". The Czech Republic ranked 112th. There were 159 managers representing the Czech Republic in the survey.



- Preceded by the world war, four decades of central planning virtually destroyed the “craft” of entrepreneurship and the specific knowledge and skills associated with it. Globally, enterprise and management underwent dynamic development over that period. Unfortunately, the Czech Republic was not part of that development. As a result, it lacked any experience with strategic corporate management, especially with managing dynamic growth, the transition from a small family business to a large international company, and innovation. Even more than two decades after the demise of the centrally planned economy, entrepreneurial and management experience is still relatively limited. Due to massive growth of the demand for components on the part of foreign companies, local entrepreneurs have long profited from focusing mainly on developing technical competence in production and technical development<sup>38</sup>, which has further slowed down the spontaneous development of enterprise, i.e. the ability to find and utilise new business opportunities independently<sup>39</sup>.
- As opposed to the trends common in established market economies, a specific culture of employment-based society has developed that can currently be observed e.g. in the fact that the most successful university graduates strive *en masse* to find a job in a branch of a world-renowned foreign company or even in the public sector instead of trying to establish their own business. This sets the local entrepreneurial culture notably apart from the entrepreneurial culture in the countries that occupy the top ranks in international competitiveness or innovation performance rankings. Insufficient motivation of people to establish new businesses is apparent mainly in technology-intensive fields. The conditions for developing a business in technology-intensive fields are perceived as problematic (GEM, 2011). Limited self-confidence of the majority of the population and very low knowledge and experience required for starting a new business significantly affect the process of setting up new businesses, especially in cases where the technology-intensity of such a business significantly increases the business risk. Nevertheless, the establishment of new companies, mainly knowledge-intensive ones, is the key ingredient for the long-term strengthening of the endogenous business sector.
- Another notable cause of the weakness of the endogenous business segment is limited motivation of local entrepreneurs to further expand their companies (Pavlínek, Ženka, 2011; Berman Group, 2010). There are multiple causes for the limited motivation for further expansion and it is difficult to generalise. Besides the absence of successors to whom the growing companies could be handed over, this lack of motivation also reflects the local culture. The majority of the population still perceives entrepreneurship as a means of obtaining material wealth (often not entirely ethical) and not as a resource enabling the development of the society, technologies and overall welfare. This motivation for enterprise along with a high risk aversion among the Czech population (Bosma et al., 2012) (the “a bird in the hand is worth two in the bush” approach) reduce the overall effort of economic actors to further grow and look for new business opportunities. Another problem is the general image of successful entrepreneurs. The

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<sup>38</sup> Many owners of SMEs confirmed that between 2003 and 2007 it was not necessary to look for new customers. The demand from branches of foreign companies in the Czech Republic and surrounding countries or their direct suppliers was so high that the only thing required for business success was to meet their technical requirements.

<sup>39</sup> See footnote 8. Another example is the fact that the Czech Republic ranks as low as 57th out of 144 countries in terms of how much significance companies attach to customer care and customer requirements – see WEF: Global competitiveness report 2012/2013.

perception of their success and their social role is the second worst of all 54 countries that were assessed in the latest round of the Global Entrepreneurship Monitor survey (Bosma et al., 2012).

### Consequences

- One consequence of the weak endogenous business sector is the specific innovation demand of companies. The very low number of endogenous companies that are able to push the technological boundaries in their respective fields in combination with the fact that the top foreign companies operating in the Czech Republic have their research and strategic facilities located mostly outside the Czech Republic (see below) cause low innovation demand in the segment of higher-order innovations. These innovations usually require significant inputs in the form of new knowledge obtained through research and development. Low demand in the higher-order innovation segment means that companies have limited need for cooperation with research organisations. From the perspective of the academic sector, this reduces the potential for commercialising the results of their research, as the majority of cases of successful commercialisation of public research results are driven by demand from the application sector.
- Another consequence is the fact that the development of the technical competences of companies (technical development, organisation of production etc.) is way ahead in comparison to non-technical competences (strategic management, marketing, innovation management) that are at least equally important for the successful development of companies and innovations. The prevailing character of the participation of the endogenous business sector in value chains<sup>40</sup> widened the gap between the level of the development of technical and non-technical competences even further. Excellent technical competences and the ability to also address complex technical issues are a prerequisite for participation in supply chains. However, business and managerial competences are necessary in order to penetrate into end-consumer markets and move higher in the value chains. Therefore, inadequately developed non-technical competencies (i.e. limited experience with their practical use) significantly reduce the potential of most members of the domestic business sector to capitalise on their highly developed technical competencies in foreign markets. While this problem mainly concerns SMEs, as they usually cannot delegate individual functions to specialised teams, it is not limited to SMEs only.
- The endogenous entrepreneurial sector is not yet strong enough to offset the declining contribution of FDI to growth and employment. This fact, too, is one of the reasons why it is necessary (especially in the long term) to support the development of endogenous companies, especially those that are able to expand their presence (through exports and foreign direct investments) on foreign markets. In the long term, the scope and quality of the endogenous business sector will affect both the growth potential of the Czech Republic's economy and its vulnerability to cyclical fluctuations and structural problems, the frequency and intensity of which are increasing in connection with globalisation.
- The weakness of the endogenous business sector is connected with the dependent position within global production networks as well as with a limited ability to penetrate into demanding end-consumers markets. The ability to move up global production networks and penetrate

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<sup>40</sup> The prevailing position of an endogenous company is that of the supplier of components (less often complex modules), where the customer defines the product (service) parameters in very specific terms. The customer also very often defines the manufacturing technology and the materials used. If the company is dependent on this type of customer, its room for innovation is greatly narrowed, namely to innovation the purpose of which is to reduce unit costs.

demanding markets is associated with the widely-conceived entrepreneurship of local businesses. This includes both entrepreneurship meaning the ambitions of existing companies to grow and innovate, as well as entrepreneurship meaning the setting up of new companies with high growth potential that is usually associated with developing or applying<sup>41</sup> new technologies..

### **3.1.3. Problem area 2: High dependence of the Czech Republic's economic development on the activities of foreign companies**

#### **Manifestations and subproblems**

- Foreign companies as a segment are the main driver of the economy in the Czech Republic, both directly through their performance and through creating extensive demand for the production of companies within the endogenous segment. These companies are the main actors through which the Czech Republic participates in the European and, by extension, the global economy. Branches of foreign companies as a whole achieve significantly higher productivity and export growth rates than the endogenous business sector. At the same time, they are the main source of the transfer of advanced technologies, management methods and other proven practices (trade, innovation management etc.) to the Czech Republic, thus greatly contributing to the growth of productivity of the local economy.
- The high dependence of the domestic economy on foreign companies' activities is evidenced by the trends in the balance and structure of the current account of the balance of payments. While in 1996 the balance of trade deficit equalled 9.2% of GDP, within a mere 10 years the balance of trade reached a surplus that currently amounts to 5% of GDP. This significant and quick change in export performance is unique within the global economy, especially as regards economies with industrial tradition whose exports are not driven by raw materials. The rate and scope of the change in the balance of trade are clearly indicative of external causes (Pavlínek, Ženka, 2011)<sup>42</sup>.
- The expansion of foreign companies' activities has led to increased job creation, including the endogenous business segment. In terms of the Smart Specialisation Strategy, there are two significant problems that are linked to the above economic trends. First, the strategic decisions of a large portion of companies concerning their further orientation (including investment, innovation etc.) are made outside the Czech Republic. While these companies differ in terms of autonomous decision making, most of them are limited with respect to issues relating to their strategic response to new business opportunities and risks. Second, most foreign companies in the Czech Republic only fulfil some corporate functions. Most often these include organising production, assembly and logistics between the manufacturing plant and warehouses located both in the Czech Republic and abroad, these being the activities with the lowest share in the overall added value of products and services on the market. Although development and other design and engineering activities are gradually being developed in many manufacturing plants, most strategic activities at the base of value chains and business activities at the end of value chains are implemented outside the Czech Republic. It is these activities that concentrate most of

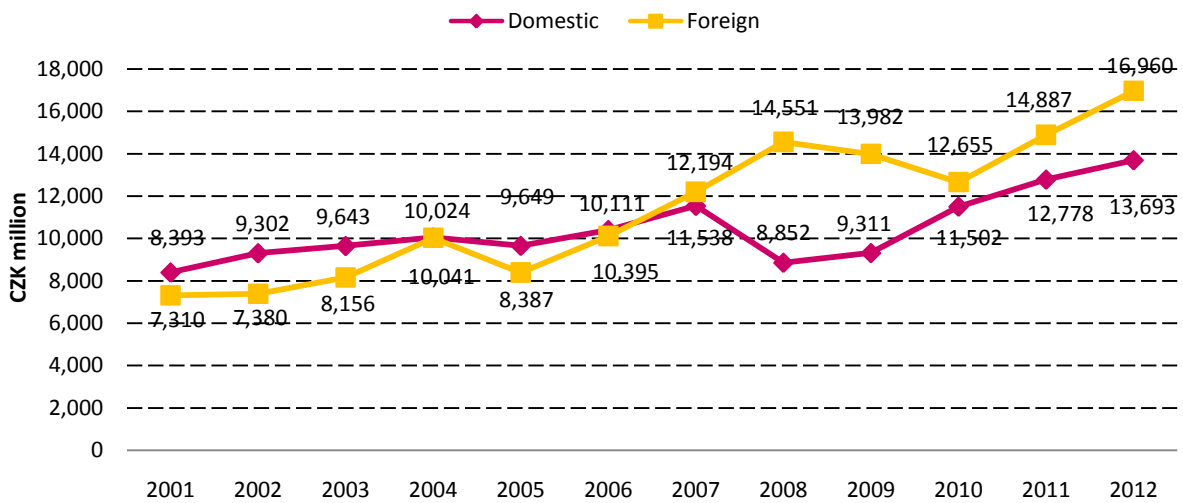
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<sup>41</sup> The application of new technologies in traditional fields provides significant room for innovation. A large portion of medium-sized and large companies within the endogenous business sector operate in traditional fields.

<sup>42</sup> A special analysis carried out by CSO in 2003 showed that productivity and export performance in foreign-controlled companies notably exceed the level of both of these indicators in companies within the endogenous segment.

the added value of the products and services, and strategic decisions of the companies concerned on the direction of the innovative process are linked to them.

**Chart 3: Comparison of trends in R&D expenditure – domestic and foreign companies in the Czech Republic**



Source: Research and development, CSO. Note: The values in the chart show non-capital R&D expenditure that better illustrates the trends in corporate R&D intensity over time.

- The scope of these problems is evidenced by the following statistics. In 2012, out of 281 private companies with more than 1000 employees, 62.8% were foreign-owned and, with an increasing headcount, the proportion of foreign companies rapidly increases. The proportion of foreign companies is even higher in the manufacturing industry, which is the main driving force of the domestic economy. As regards the increase of the knowledge intensity of enterprise, dependence on foreign companies can be illustrated by the trends in the structure of business R&D expenditure (see **Ошибка! Источник ссылки не найден.**). The foreign business segment has been consistently increasing its share in R&D expenditure of the entire business sector. While in 2012 their share was 55.3%, 10 years ago it was 46.6%.
- Despite the above problems, the increase in foreign companies' R&D capacities constitutes a significant opportunity for the future. This trend signals the attractiveness of the Czech Republic as a destination for developing activities with higher added value that require high quality engineers and facilities for technical development. Some global technology leaders are developing these activities in the Czech Republic and rely on the Czech Republic as the centre of their further development<sup>43</sup>. In this respect, the opportunity lies in the presence of successful manufacturing plants of numerous foreign companies, where targeted support can be used to intensify expansion of more demanding activities with higher added values in the Czech Republic. Another important trend in the development of global value chains is the concentration of corporate R&D activities and their location near successful manufacturing plants, where there are favourable conditions for the expansion of such activities. The risks that might result in a failure to use this opportunity include growing instability of the entrepreneurial environment in combination with a high administrative burden on companies (see problem area 3 below) and the declining level of education (see the problem area education).

<sup>43</sup> For example Siemens, Honeywell, ABB etc.

## Causes

- The original causes of the current condition of the economy and, in turn, of the business sector lie in a four-decade-long (1948–1989) interruption of private enterprise. Along with that, the causes include the historically specific combination of internal factors and external conditions in the early 1990s when the Czech economy started to integrate into the market-based global economy. The internal factors mainly included (i) a favourable ratio between labour price and qualification, (ii) strong industrial tradition and relative technological advancement, (iii) high-quality infrastructure compared to other Central European countries, and (iv) a weak domestic sector capable of very limited competition. The external conditions further enhanced the importance of the Czech economy's attractiveness for the expansion of foreign companies' activities – they mainly included (v) closeness to developed European markets, later with the prospect of accession to the EU, and (vi) changes in the organisation and, by extension, the territorial configuration of transnational production systems<sup>44</sup>.
- In 1997–2003, the Czech Republic was the main FDI haven (per capita) within the transitive economies of Central and Eastern Europe. Investments of foreign companies took the form of both greenfield investments and acquisitions of local (mainly) large businesses. Strong growth of the global economy after 2003 then led to full utilisation of such newly-created (and other new) capacities of foreign companies, which is evidenced by the reversal of the Czech Republic's balance of trade over a very short period between 2003 and 2005. Further evidence is the rapid growth of the passive factor income balance, which includes the repatriation of foreign companies' earnings to their owners. External causes<sup>45</sup> are also documented by the fact that this reversal occurred despite the trend of the long-term strengthening of the Czech crown.
- There was a large inflow of foreign investments (FDI) into the Czech Republic and subsequent growth of foreign companies' demand for Czech subcontractors, which significantly benefited endogenous businesses. These are now often directly or indirectly (through their exports of components – often complex ones – to foreign manufacturers of final products) linked to foreign companies operating in the Czech Republic and the neighbouring countries. This benefited both the economy as a whole and domestic companies, as they gained access to know-how, experience etc., and – albeit indirectly – to global markets. This resulted in the extraordinarily strong growth of the Czech economy in 2004–2008<sup>46</sup>. On the other hand, the development of such dependence on foreign companies created or reinforced some barriers to the development of endogenous companies (see problem area 1).

## Consequences

- The Czech economy is now at a stage where it is gradually losing the advantage of price competitiveness, especially in the manufacturing industry, which has been caused by the domestic growth in the cost of labour, energy and services and amplified by the increasing attractiveness of the conditions for locating certain types of activities in developing countries. Thus far, the loss of competitiveness only concerns some types of activities and fields, but it is

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<sup>44</sup> Dominant managerial procedures leading to the focus on brand and key activities and thus extensive outsourcing and delocalisation of production (see e.g. Stiglitz, 2002; Dicken, 2011).

<sup>45</sup> The gradual development of the Czech Republic's functional specialisation within the global production networks as a manufacturing base for European markets (see footnote 9).

<sup>46</sup> See CSO (2009), Statistical Yearbook of the Czech Republic; CES, NTF (2011) The Competitiveness of the Czech Republic 2010–2011.

likely to further expand. Given the continuing decline in the conditions for enterprise (deepening political instability that makes tax and other conditions difficult to predict, high administrative burden, demographic ageing, declining quality of school graduates etc.), the sector of foreign companies is very likely to experience the outflow of investments and a change in the structure (and volume) of incoming investments. Trends in the volume and structure of FDI show that the Czech Republic is gradually entering a new stage in the development of its economy. The intensity of FDI inflow has been decreasing significantly<sup>47</sup>.

- As a result, the Czech Republic's economic growth – both potential and real – has slowed down considerably and the above factors may also have a negative impact on economic growth in the future. The endogenous sector is currently too weak to offset the envisaged decline in the contribution of foreign companies and FDI inflows towards economic growth and job creation in the near future. Local companies' capacity, resources and potential to increase productivity through innovation and a generally greater emphasis on a knowledge-based economy are limited (see above). Further economic growth of the Czech Republic therefore depends on its future attractiveness for activities of foreign companies. With respect to gradual loss of ability of the Czech Republic to compete through the price of local production inputs, the importance of non-price competition factors increases significantly. In some of these factors (education attainment and the education system, institutional environment, public research quality etc.), the Czech Republic is ahead of its current competitors among transition and developing economies. However, it is considerably lagging behind in comparison to established market economies. This is a problem, because if the Czech Republic is to grow and create jobs in the long term, it must compete with developed economies rather than transition and developing economies.
- Given the expected decrease in the rate of FDI inflows, potential growth of disinvestments of foreign companies and the Czech Republic's limited success in competing for higher-quality FDI, there is a risk of long-term stagnation and a considerable worsening of the situation in the labour market. These impacts may be especially strong if the above three phenomena occur at the same time, which cannot be ruled out. The trends as described above point to the necessity of strengthening the endogenous business sector, even though it cannot replace the effect of FDI in the short or medium term. The economy's high dependence on foreign companies also has specific consequences for the area of cooperation between the corporate and academic sectors. A decisive amount of knowledge-intensive and also strategic activities of local branches of foreign companies (such as trade, marketing or communication with customers) takes place outside the Czech Republic. As a result, these branches – including their local suppliers – have very limited room for innovation, which is often limited to process and technological sub-innovations in production and assembly. Where local branches are included in syndicate R&D, this inclusion usually involves providing fragmentary information from the manufacturing process or implementing final customer solutions, yet it does not involve participation in main R&D capacities. The above situation limits the scope of companies' demand for cooperation with research organisations in the Czech Republic. On the other hand, foreign companies that carry out R&D in the Czech Republic (e.g. Honeywell, Siemens etc.) provide an extraordinary

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<sup>47</sup> Although the decline in the inflow of foreign investments is partially attributable to the economic crisis in recent years, the decline is striking, especially in terms of building new production capacity. Nevertheless, even the ratio between reinvested profits and dividends is changing in favour of dividends.

opportunity for local research organisations in terms of cooperation with the application sphere, including the potential to secure significant income from the private sector.

### **3.1.4. Problem area 3: Complexity, instability and subsequent high administrative demands of the regulatory framework for enterprise, limited effectiveness of strategies and tools to support enterprise**

#### **Manifestations and subproblems**

- The instability of the tax and regulatory framework for enterprise poses a serious problem for the Czech Republic's entrepreneurial environment. Pursuant to a regular international survey by the World Economic Forum<sup>48</sup> local entrepreneurs and managers consider (i) corruption, (ii) administrative burden, (iii) tax rates and tax collection, and (iv) regulations relating to employment to be the main problems. With the exception of corruption, these problems are nothing exceptional, as the other three items dominate among the problems of the entrepreneurial environment in most OECD countries. However, a regular international survey by the World Bank<sup>49</sup> shows that the severity of these problems is considerably greater in the Czech Republic than in most OECD countries and, in some aspects, the conditions existing in the Czech Republic are significantly worse than in many developing economies.
- According to the latest summary index of regulatory conditions for enterprise, the Czech Republic<sup>50</sup> ranked 75th out of 189 countries assessed. In 2006 it ranked 41st, and in 2009 it ranked 66th. This drop is a signal that regulatory conditions for enterprise in the Czech Republic are getting relatively worse<sup>51</sup>. The reason is that, in many other countries, larger numbers of positive changes are implemented faster. The Czech Republic ranks worst in the following areas: setting up businesses and connecting businesses to electricity (both 146th), tax rates and tax collection (122nd) and investment protection (98th). By contrast, the situation is relatively better in the area of access to credit (55th)<sup>52</sup>.
- In the Czech Republic, there is a wide spectrum of tools to support enterprise and innovation, covering areas ranging from support for exports<sup>53</sup>, to access to loans for start-up entrepreneurs<sup>54</sup> to a range of subsidy programmes within the OPEI that are targeted at the absorption of new technologies, the use of IT, the implementation of innovation etc. The problem with all these tools is the inadequate assessment of their actual benefits. The evaluations that are performed are often formal, while the implementing entities have no adequate "policy – learning" cycle in

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<sup>48</sup> WEF (2013): World Competitiveness Report 2013-14.

<sup>49</sup> World Bank (2013): Doing Business 2014.

<sup>50</sup> World Bank (2013): Doing Business 2014.

<sup>51</sup> To some degree, this assessment may be affected by subjective factors (some of the indicators assessed are based on subjective assessment by respondents from the business sector), while the current political situation may also cloud partial successes (e.g. the gradual simplification of legislation on enterprise, or the digitisation of Czech public administration).

<sup>52</sup> In certain thematic areas, studies by WEF (see note 45) and WB (see note 46) are partly based on subjective assessment by the respondents, whose opinions may thus be affected by differences in their socio-cultural environment and their different perception of problems in certain areas. Nevertheless, the Czech Republic's declining position in these rankings cannot be disregarded.

<sup>53</sup> Services of the Czech Export Bank, the EGAP insurance company and support for participation in trade fairs within the Operational Programme Enterprise and Innovation for 2007–2013 (hereinafter the OPEI).

<sup>54</sup> The Start, Guarantee and Progress programmes under the OPEI.

place that would lead to a permanent improvement in the efficiency of the support tools. The overall strategic framework for activities focusing on support for enterprise and innovation is also inadequate. The parallel existence of a large number of strategies, many of which are implemented only temporarily and to a limited degree or not at all, creates a chaotic situation that makes it impossible to plan effective support and reduces confidence of target groups in the public administration's ability to set up and correctly implement these support tools.

- Positive examples of support may include tools for the tax deduction of R&D costs, which were further extended to include the purchase of external R&D services from research organisations at the beginning of 2014. Nevertheless, even here the deficiencies of the practical implementation of this support are experienced in cases where the unclear interpretation of the rules for deducting cost items results in lawsuits between companies and the state.

### Causes

- The absence or slow implementation of reforms to improve the regulatory framework for enterprise has been caused by high personnel turnover within the central authorities of state administration and in the management of organisations established by them. The persistence of this situation in conjunction with insufficient protection of top officials in relation to politicians has led to a gradual loss of expert experience and, by extension, the capacity to carry out public administration to a high standard.
- Political instability results in frequent partial changes in tax laws and other regulatory rules. Such changes are motivated by short-term objectives rather than by the country's long-term economic strategy. An extreme example of instability is the situation in 2012 when the VAT rate for the upcoming year was still uncertain 1 month before the end of the year. Other examples include the implementation and quick abandonment of the so-called Super Gross Salary or frequent changes of the VAT rate.
- Another notable cause is the absence of a shared long-term vision and strategy for the Czech Republic's economic development, which has been repeatedly pointed out by many public authorities in the media<sup>55</sup>. Within the confrontational style of Czech politics, the absence of a shared long-term strategy makes it easier to promote partial short-term solutions, regardless of their long-term impact or consistency with steps taken in other areas.
- A specific cause underlying the limited efficiency of tools to support enterprise and innovation is the approach to drawing funds from the EU Structural Funds. The emphasis on using up all allocated funds is understandable. Given the high turnover of human resources and the on-going loss of expert experience (see above), the emphasis on using up SF resources results in supporting some tools that are targeted or set up incorrectly. The volume of funds that have to be used by these tools leads to their figurative "inflation" and sometimes even discrediting among representatives of the target groups<sup>56</sup>.

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<sup>55</sup> For the latter, see prof. Lubomír Mlčoch in an interview for *Ekonom* magazine No. 50/2013.

<sup>56</sup> Examples may include clusters or business incubators. Besides successful and well-functioning clusters and incubators, there are others that have failed to deliver the originally declared benefits. However, successful examples show that the idea of establishing and supporting clusters and incubators – in itself – is correct for the Czech economy, provided that a system is set up to ensure greater competitiveness of entities.



## Consequences

- The unstable and complicated regulatory framework for enterprise in conjunction with the high level of perceived corruption create behavioural patterns that provide little support for innovation, the development of businesses and, by extension, the entire economy in general. A serious example is entrepreneurs' increased motivation to protect what they have already created<sup>57</sup>, which naturally reduces motivation for further growth of companies. The seriousness of this consequence stems from the fact that local entrepreneurial culture can be characterised by a higher risk aversion<sup>58</sup> than in other European countries that are better performers in terms of innovation.
- The instability and complicated predictability of taxation makes strategic planning of companies difficult, as it complicates the calculations of expected trends in return on investments, thus making the investments riskier.
- The relative drop in the Doing Business rankings signals a rigidity of the local regulatory framework for enterprise. The relative deterioration of the conditions may negatively impact on foreign companies' decisions regarding the location of their activities. One strength of the Czech Republic is the presence of successful manufacturing plants of multinational companies and the supply of high-quality engineers at a favourable price. The above trends jeopardise the opportunity lying in the development of R&D and related activities at local manufacturing plants. This is because activities with higher value added are more sensitive to the quality of the entrepreneurial environment.
- Poor conditions for setting up or winding up a business (144th according to Doing Business) are a significant barrier to increasing the amount of entrepreneurship in the society. However, fulfilling this objective has been one of the long-term prerequisites for higher dynamism and innovative performance of the endogenous business sector (see problem area 2).

### 3.1.5. Digital agenda and entrepreneurship

#### Problems

- In the Czech Republic, inadequate development of physical infrastructure for the spreading of high-speed and high-capacity Internet connection is an essential barrier to the development of a full-scale digital economy<sup>59</sup>. Due to very low investment activity of Internet providers, the availability of next generation networks (NGA, incl. LTE) is very limited and, as a result, only 20% of the population is connected to the proclaimed high-speed Internet (more than 30 Mbit/s)<sup>60</sup>. However, in reality the connection speed is even lower and only 3% of the population have access to the proclaimed speed of 30 Mbit/s<sup>61</sup>. Moreover, only one fifth of the population have

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<sup>57</sup> There are an increasing number of cases where the headquarters of Czech companies are registered abroad, in countries with more favourable regulation and better protection of investments – these are being justified as a response to the increasing instability of the local environment and the perceived risks for further development by owners of successful companies.

<sup>58</sup> See the Global Entrepreneurship Monitor 2011.

<sup>59</sup> National Policy in Electronic Communications – Digital Czech Republic v2.0 – The Road to the Digital Economy, Ministry of Industry and Trade, 2013.

<sup>60</sup> The European Commission, Digital Agenda for Europe (<http://digital-agenda-data.eu/>).

<sup>61</sup> IHNEC.cz, The map of the Czech digital wasteland: Only 3 per cent of people have a truly fast internet connection (<http://byznys.ihned.cz/zpravodajstvi-cesko/c1-61402650-mapa-ceske-digitalni-pustiny-opravdu-rychly-internet-maji-jen-3-procenta-lidi>).

any hope of seeing their Internet connection speed increase<sup>62</sup>. In and of itself, the speed and distribution of quick Internet connection is not an explicit barrier to the development of enterprise in general, but given the advent of the digital economy, the importance of speed and coverage with high-speed Internet for economic activities increases. Even today, the development of specialised digital services and knowledge-intensive activities in various segments of the national economy are dependent on Internet speed and coverage.

- Low utilisation of electronic communication between business partners (both in sharing information within the supply chain, and in exchanging business documents) ranks the Czech Republic among the weakest EU countries in this comparison<sup>63</sup>, despite the fact that the digitisation of value chain management and supply chain relationships can be a source of significant savings, especially in terms of corporate fixed costs. The use of digital technologies for communication between business partners together with the digitisation of the entire production process can lead and, in many cases, has already led to the development of new knowledge domains within the economy.

### **Causes**

- Insufficient investments in the physical infrastructure for high-speed connection have led to the ageing of the infrastructure, especially in terms of its capacity. Internet connection providers have not been motivated to develop the infrastructure and, as a result, they used their available funds for other purposes.
- Until recently, the low demand for digital services was attributable to the high prices of Internet connection and end devices. However, this factor is now marginal and there is an opposite trend. Demand for end devices using digital services has been growing considerably. Along with the above trends, new room is created for economic activities with high added value and a potential for high profits.
- The unclear definition of powers at the central level led to low activity in the field of digital agenda. The departmentalism and strong vertical hierarchy of individual ministries poses a limitation to effectively addressing horizontal issues, incl. the digital agenda.
- The (lack of) confidence in the safety of using electronic communication is a key factor of the digital economy. Unless users of digital services and technologies have confidence in their security, it cannot be expected that either digitised supplier chain relations or the digital economy itself will develop.

### **Consequences**

- Maintaining the physical infrastructure for the provision of Internet connection in its current condition may finally lead to the exclusion of the Czech Republic and, in turn, the Czech business sector from the digital economy-based global markets. Investments in physical infrastructure thus have major influence on keeping the Czech Republic present in global markets and, at the same time, they can support domestic economic activity, i.e. not only in the segment of new technologies and digital services, but also in the construction segment focusing on the construction of the required infrastructure.

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<sup>62</sup> Czech Telecommunication Office, Mapping infrastructure for the provision of high-speed Internet access in the Czech Republic.

<sup>63</sup> The European Commission, Digital Agenda for Europe (<http://digital-agenda-data.eu/>).

- The growing demand for end devices and digital services leads to the emergence of new market segments and thus also the establishment of new business entities operating in these markets. Such new digital services are often knowledge-intensive, especially the creation of expert and entertainment SW. In combination with the existing economic structure, their development thus provides the basis for the emergence of new economic domains.

## 3.2. Research and development

### 3.2.1. Introduction

High-quality research is a key source of new knowledge that extends the scope of available technological possibilities that can be used for innovation. Within their activities, research organisations also significantly contribute to the professional training of a new generation of researchers and their further education. There is a direct link between research quality and the quality of tertiary education graduates (see the analysis for the area of human resources). Research and training of researchers ensure the ability of the society and the economy to adopt and utilise a growing volume of existing and already available knowledge that has been produced on a global scale. The ability to maintain a high level of knowledge in the economy constitutes an important source of innovations and a prerequisite for the business sector's ability to succeed in international competition (see the analysis for the area of enterprise).

The quality of research and its practical relevance (applicability) are not in contradiction, as proven by many analytical studies. If the research system is managed adequately and both basic and applied research and university education are anchored within research agendas focusing on long-term strategic challenges, it is possible to achieve mutual synergies that contribute to the quality of research and increase its benefits for the society and the economy<sup>64</sup>. As regards the practical relevance of research, it must be emphasised that this does not exclusively concern research in technological fields but also research and dissemination of knowledge in the field of social sciences that constitute key expertise necessary for non-technical innovations, including social innovations and innovations in services (i.e. knowledge necessary for identifying the changing needs of public and private sector demand, including marketing expertise, innovation management etc.).

The main strategic documents of the Czech Republic perceive suitable conditions for high-quality public research<sup>65</sup> as one of the fundamental prerequisites for competitiveness and – in the long term – consider it a key precondition for the innovative efficiency of the economy that creates stimuli for the development of new application directions<sup>66</sup>. Despite the existence of some top-ranking facilities and research teams, in most areas the overall quality of research in the Czech Republic lags

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<sup>64</sup> For an overview of studies focusing on detailed documentation of dependence between both, see Arnold, E. and Giarracca, F. (2012): *Getting the Balance Right: Basic Research, Missions and Governance for Horizon 2020*. EARTO. (<http://www.earto.eu/european-news/detail/article/technopolis-report-getting-the-balance-right-in-public-rd-investment.html>).

<sup>65</sup> Public research is understood as research that is implemented within the public sector, i.e. mainly in the government and university sectors.

<sup>66</sup> See e.g. the *National Innovation Strategy of the Czech Republic*, p.3, or the *International Competitiveness Strategy of the Czech Republic for 2012–2020*, p. 41.

significantly behind the most developed countries<sup>67</sup> due to a range of factors<sup>68</sup>. The limited number of high-quality research teams in the Czech Republic affects the limited attractiveness of Czech research organisations for top foreign research organisations, companies and even high-quality domestic and foreign researchers and talented young scientists. This further strengthens the lack of openness of Czech research and, as a result, the barriers that prevent improving the quality of Czech research to an internationally comparable level remain in place. The relatively weaker position of many Czech research organisations is also the reason for the insufficient participation of Czech teams in international research projects that require top-level facilities meeting, among other things, the European standards for research infrastructures. Although there has been an improvement in this respect, owing to investments in research infrastructures supported by the Structural Funds (namely from Operational Programme Research and Development for Innovation) in recent years, there are still some deficiencies in this area, both in the management of these infrastructures and in the increasing deficit of top-quality research infrastructures in the capital city of Prague.

While the area of R&D policy management has its specifics in every country, in the Czech Republic this area has long been plagued by many deficiencies and has been the subject of long-term criticism and political discussions. Launched in 2008, the reform of the research, development and innovation system brought many partial improvements, but there is still room for improvement in this respect, including putting into practice the recommendations drawn up within the project entitled International Audit of Research, Development & Innovation in the Czech Republic<sup>69</sup>.

The above characteristics of public research in the Czech Republic are further detailed and explained in a breakdown by problem area or theme:

- Inconsistent quality of public research
- Digital agenda and public research
- Low relevance and underdeveloped cooperation between public research and the application sector
- Low international openness of the Czech research environment
- Deficiencies in R&D policy management and governance

This breakdown is necessary, because only a detailed description of each problem area makes it possible to analyse the causes of the current situation, its consequences and possible development risks. However, at the same time it is necessary to be aware of the strong mutual conditionality of the problem areas, where the management system setting affects the quality and relevance of research and significantly influences the openness (or lack of openness) of the research environment. Similarly, the degree of the openness of the research environment is – to a large extent – both a cause and a consequence of the low quality and relevance of research and the problematic setting of R&D policy management.

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<sup>67</sup> *Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad in 2013.*

<sup>68</sup> Decades-long isolation of Czech science, small number of world-renowned scientists, non-existence of strong partners from the private sector, inadequate instruments and equipment, frequent “inbreeding”, i.e. lifelong career of scientists and teachers within one university etc. (see the results of the *International Audit of Research, Development & Innovation in the Czech Republic*, <http://audit-vav.reformy-msmt.cz>).

<sup>69</sup> *International Audit of Research, Development & Innovation in the Czech Republic*. Final report. Prepared for MEYS by Technopolis Group, Prague 2011 (<http://audit-vav.reformy-msmt.cz>). Hereinafter the International Audit.

### 3.2.2. Problem area 1: Inconsistent quality of public research

#### Manifestations and subproblems

- *The volume of research results* in the Czech Republic has shown *an increasing tendency* in recent years and, in terms of the number publications produced, it reached values that are comparable to or even exceed those of the most developed countries<sup>70</sup>. This is clearly a consequence of the long-term trend of increasing public investment in research and development that began at the beginning of the 21st century and, despite minor fluctuation in the crisis years 2008–2010, has maintained its growth dynamics – this trend ranks the Czech Republic among the fastest growing EU countries in the last decade.
- *The level of the Czech Republic's scientific production in terms of average quality* that is measured through the citation rate of publications<sup>71</sup> has been gradually improving since 2000, but it *still lags behind the EU-27 average*<sup>72</sup>.
- However, there already are *strong and top-quality research teams* in the Czech Republic that take part in developing scientific publications in collaboration with the best research teams abroad and that have the world's highest citation rates<sup>73</sup>. Due to that, the Czech Republic has maintained an overall solid position in international comparison.
- However, it can be generally concluded that the level of Czech research is varied, there are few internationally competitive teams and the dominant mass of research does not stand up to international comparison in terms of quality. *Overall*, the Czech Republic is thus characterised by an *average level* (despite the existence of some top-quality facilities) that is associated with low attractiveness for both Czech and foreign top-ranking scientists. The causes that must change for there to be any hope of a significant improvement in the quality of Czech research include the following:

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<sup>70</sup> Between 2000 and 2010, the Czech Republic's proportion in global production of publications increased from 0.52% to 0.74%. As regards the number of scientific publications per FTE of a person employed in research and development, the Czech Republic achieved values even greater than Germany or the USA (see the *Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad in 2012*).

<sup>71</sup> It needs to be emphasised that the significance of the citation rate indicator differs in various fields and comparison between different fields is very difficult.

<sup>72</sup> In terms of the citation rate of publications by Czech authors per FTE of persons employed in R&D, the Czech Republic lags behind developed EU countries and even some post-communist countries (see the *Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad in 2013*).

<sup>73</sup> In the period from January to October 2012, the share of publications by Czech authors in the top 1% of the most cited works reached a value of 1.32%, i.e. 32% more than what might correspond to the theoretical value. This indicator is one of the highest values overall. Van Norden, R. (2012): 2012 in Review. *Nature*, vol. 492, pp. 324-327. Although bibliometric methods cannot be viewed as the sole authoritative tool to determine quality in research, in 2003–2009 the Czech Republic showed above-average bibliometric values and, at the same time, generated a minimum volume of scientific production in the fields that have direct application relevance: instruments and instrumentation, nuclear physics and technology, aviation and engineering, computer science, mathematics, selected sub-disciplines of chemistry, electrical engineering and telecommunications, the environment, clinical medicine and biomedical sciences (see Vaněček, J. (2011): *Field-based and institutional analysis of R&D results in the Czech Republic* [www.vyzkum.cz/Priloha.aspx?idpriloha=645356](http://www.vyzkum.cz/Priloha.aspx?idpriloha=645356)). As regards participation in the 7th Framework Programme, the Czech Republic shows a higher rate of participation in the fields of nuclear research, transport (including aviation), nanoscience, material research and production technologies, bioeconomy (food, agriculture and fisheries, biotechnologies) and partially also in the environmental area.

- Czech research suffers from *a lack of critical mass and fragmentation* that undermines a number of other aspects that are important for research quality: limited opportunities for interdisciplinary research, limited capacity for addressing long-term strategic projects, and limited possibility to address grant projects and cooperate with the practical sector at the same time result in preference for the “more secure” grant resources<sup>74</sup>. The absence of a critical mass is further exacerbated by a lack of incentive mechanisms for networking and cooperation between facilities (the methodology of registering scores in the Information Register of R&D Results discourages the creation of joint R&D results).
- Generally, it can be concluded that – due to fragmentation – *Czech research lacks the formulation and subsequent implementation of long-term research agendas*<sup>75</sup>. There are no teams that would consistently address the research of crucial scientific and social challenges in the long term and could thus become the bearers of breakthrough findings.
- The financing system still fails to sufficiently differentiate between high quality and poor quality, thus failing to create favourable conditions for developing truly excellent research teams. These mainly require long-term stability of financing (see the previous bullet).
- The cases when Czech research teams achieve *international success*, are usually cases based on *personal ties with a strong foreign partner*, often based on the reintegration of Czech scientists who have worked in a prestigious institution abroad. However, these ties are often unstable as Czech research organisations scarcely create conditions or programmes that might make it possible to build – around such personal ties with a strategic foreign partner – a critical mass of a team able to develop the research theme and guarantee long-term financing for it.
- A positive example driven by an effort to concentrate resources and excellent research effort is the activity to support “*large infrastructures for research, experimental development and innovation*” (hereinafter “large RDI infrastructure”)<sup>76</sup>. This activity focuses on supporting completely unique research facilities with high financial and technological demands operating on the “open access” principle. The specific importance of large RDI infrastructures within the Czech Republic’s national research and innovation system is amplified by the fact that, pursuant to the Czech legislative framework of support, individual projects of large RDI infrastructures are approved by the Czech government. Large RDI infrastructures play an important integrating role in the currently fragmented system of support for research, development and innovation in the Czech Republic and, in turn, allow for concentrating a critical amount of capacities and resources for performing excellent research, development and innovation activities of extraordinary international overlap. As the majority of large RDI infrastructures are directly connected to foreign research infrastructures (e.g. ESFRI), they are a means of integrating the Czech Republic’s

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<sup>74</sup> The results of a survey carried out within the International RDI Audit prove that the size of the research group in the CR correlates positively with the intensity of cooperation with the application sector (Annex 5 to the Final Report: Science-Industry Linkages, p. 107).

<sup>75</sup> The International Audit identifies the following basic factors undermining the quality of Czech research: fragmentation, lock-ins, resistance to interdisciplinary and application-oriented research.

<sup>76</sup> A large infrastructure for research, experimental development and innovation is a “*unique scientific facility – including its purchase, associated investments and organisation of its activities – that is necessary for research and development activity as a whole having high financial and technological demands and that is approved by the government and established by one research organisation to be also used by other research organisations*”. The definition pursuant to the provisions of Section 2(2)(f) of Act No 130/2002 Coll., on support for research, experimental development and innovations from public funds and on the amendment to some related acts (Act on Support for Research, Experimental Development and Innovations), as amended.

national capacities into foreign research infrastructures of pan-European or global importance, which also positively impacts on stimulating excellence in Czech research. The activity to support large RDI infrastructures was launched in 2010 when the Czech Republic's continuously updated strategic document for the given field was adopted – the Roadmap for Large RDI Infrastructures in the Czech Republic<sup>77</sup>. In the coming period, the key challenge will still lie in securing a long-term framework for financing large infrastructures in order to ensure their stability, allow for their further development and, last but not least, allow for their connection to foreign research infrastructure (e.g. ESFRI).

- Other positive examples that are driven by the *effort to concentrate resources and research effort* include additional infrastructure investments implemented with support by the Structural Funds within the framework of the Operational Programme Research and Development for Innovation (“R&D Centres”<sup>78</sup> that include both centres of excellence and regional R&D centres) and also Centres of Competence in applied research<sup>79</sup> financed from national sources. In both cases, these are resources allocated on the basis of long-term financing of research through oriented research and, in the case of Centres of Competence and regional R&D centres, with a link to the needs of the application sector.
- In the case of *R&D Centres*, this also includes an effort to introduce long-term financing on the basis of performance contracts and, at the same time, to differentiate R&D centres depending on their mission and ambitions:
  - centres that may become a part of an international network for division of labour in research and a gateway to the international research community (a total of 8 *centres of excellence*), and
  - centres whose mission is to interconnect and provide findings in their fields of specialisation to users/the application sector within the Czech Republic and increase their absorption capacity via cooperation and contract research (40 *regional R&D centres*).<sup>80</sup>
- By concentrating resources, *R&D centres* have created the conditions for a long-term strategic direction in research. Crystallisation cores of scientific teams with solid material conditions have thus been created in selected research areas, making the Czech Republic attractive even to foreign researchers. The introduction of performance contracts contributed to a clearer orientation and measurability of research effort towards top-class scientific results, or towards closer links with the practical sector (possibly a combination of both metrics). Even though there are continuing concerns about the financial sustainability of supported centres, successful R&D centres and research infrastructures should undoubtedly become *key building blocks within the National RIS3*. At the same time, it will be necessary to create favourable conditions for their

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<sup>77</sup> Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic. MEYS, 2010, and its further updates. (<http://www.msmt.cz/vyzkum-a-vyvoj/ceska-roadmap>).

<sup>78</sup> See <http://www.opvavpi.cz/cs/siroka-verejnost/projekty.html>.

<sup>79</sup> <http://www.tacr.cz/index.php/cz/programy/centra-kompetence.html> It is a programme focusing on support for implementing long-term strategic research agendas in the partnership of research organisations and companies.

<sup>80</sup> This is analogous to differentiating between *general purpose technologies* that require a high concentration of resources to advance the boundaries of knowledge (to explain the fundamental principles of functioning) and the effort to utilise the findings obtained in the area of *general purpose technologies* in a wide range of possible applications that require a large amount of applied research and experimental development (see *The Role of Community Research Policy in the Knowledge-based Economy*, EC, 2010, chapter 1.4. and subsequent all-European discussion focusing on Key Enabling Technologies: [http://ec.europa.eu/enterprise/sectors/ict/key\\_technologies](http://ec.europa.eu/enterprise/sectors/ict/key_technologies)).



closer links with the needs of the application sector (Hebáková, Granger, 2013) and to ensure sufficient resources for the long-term development of the centres once they are established.

- Similarly, projects included in the Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic constitute key elements of the Czech Republic's research system, which require a specific approach within the national strategy, especially with respect to the need for stable long-term financing of operations, including necessary technological upgrading.
- The above investments have led to the improvement of the equipment of research facilities in the Czech Republic, which creates opportunities for concentrating high-quality research and innovation activities and also for closer links between Czech research and the European research area.
- It is clearly positive that – as part of an assessment using alternative methodology – the International Audit<sup>81</sup> concluded that despite the generally unsatisfactory situation in a number of areas as described above, at least one case of a good practice example has always been found. It already exists in the Czech institutional environment and can be used as a model to improve the quality of research throughout the entire system within other reform efforts<sup>82</sup>. The newly developed assessment methodology (2013) takes into account some proposed elements (taking account of area-specific aspects in assessing and introducing the element of international peer-review<sup>83</sup> during quality assessment, at least to a limited extent).
- A specific problem of the Czech research environment lies in the fact that the capital city of Prague is increasingly lagging behind in terms of research infrastructure availability (because it is impossible to use resources to support research within key operational programmes in 2007–2013 under the Convergence objective), even though more than half of public-sector research capacities are concentrated there. Prague-based research capacities provide a significant portion of their expert capacity to the application sector on a nationwide scale; in some cases these are unique research facilities whose expertise cannot be replaced from other sources on a national scale.

### Causes and evidence

- The causes underlying the poor quality and low attractiveness of Czech research in comparison to foreign countries lie both in the deficiencies of the regulatory framework, and in areas requiring interventions at the level of research organisations.

#### a) Regulatory framework

- In many respects, the current *quality assessment*<sup>84</sup> system and the related *system for the financing of research* in the Czech Republic have thus far acted contrary to the efforts to improve research quality. The assessment system was set to count outputs, i.e. the quantity rather than

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<sup>81</sup> The International Audit also included the pilot verification of alternative methodology using international peer review, which was applied on a sample of 18 high-quality research facilities of various types and orientations (see International Audit, Annex 3).

<sup>82</sup> International Audit, annex 3, p. 28.

<sup>83</sup> The process of reviewing scientific work, research or projects by others who are experts in the same field.

<sup>84</sup> This is the RIV (Information Register of R&D Results) and its methodology, on the basis of which institutional support is distributed through mechanical calculation (for more information see e.g. the *International RDI Audit in the Czech Republic*).



quality of the results achieved, which motivates the production of useless results. This fact was criticised, among others, in the International RDI Audit in the Czech Republic<sup>85</sup>. In 2013, assessment methodology was modified to newly include peer review elements and the assessment method was differentiated for research in various scientific disciplines. In the future, the specific effect and further development of the new methodology will require increased attention so that the assessment system consistently differentiates between high (international) quality and poor quality research and so that it takes increased account – besides excellence – of the application relevance of research, international participation and the assertion of the third role of research organisations<sup>86</sup>.

- The prevalence of special-purpose resources (taking the form of a large number of small grants) over institutional resources leads to the *short-term nature of research*, the *instability of financing*, and the *fragmentation of finances*. This is the consequence of a shift from the prevalence of institutional financing to special-purpose financing that is anchored in the objectives of the Reform of 2008<sup>87</sup>, which was criticised in the findings of the International RDI Audit in the Czech Republic (a proposal to increase the proportion of institutional resources to at least 50%).
- As a side effect, the large proportion of grant resources *generates excessive administration* (grants require reporting, submitting additional grant applications, which decreases the success rate and leads to considerable lost investments), which makes it impossible to formulate long-term, ambitious research agendas and to set up (and retain in the long-term) high-quality research staff.
- The standard practice in *project assessment* at the level of providers shows a number of deficiencies, including low openness to foreign assessors. The system supports aversion to risk (e.g. it does not acknowledge the possibility that research may be unsuccessful, results must be reported administratively for each grant, in some cases the number of planned results is assessed as the measure of quality) and discourages cooperation with other institutions (the need to share points in the Information Register of R&D Results), which reduces interest in interdisciplinary topics.

#### b) Research organisations

- Deficiencies in the strategic and operational *management of both research organisations and research activity itself* arise mainly from the absence of systematic education in this area and generally from the undervalued role of management in research<sup>88</sup>.
- In day-to-day activities, the negative consequences of inadequate operational management are reflected in the *low quality of supporting processes*, which concerns the area of HR management (inadequately developed processes for the recruitment and career growth of research staff), grant support (absence or low professional level of grant support), supporting activities for cooperation with the application sector (absence or insufficient experience of employees

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<sup>85</sup>The Final Report of the International Audit of Research, Development and Innovations in the Czech Republic. MEYS, Prague, 2012.

<sup>86</sup> Measures within the updated National RDI Policy for 2009 to 2015 with a view to 2020 have also been designed in this sense.

<sup>87</sup> See **R&D system reform in the Czech Republic** (<http://www.vyzkum.cz/FrontClanek.aspx?idsekce=495405>).

<sup>88</sup>International Audit, Annex 3.

responsible for commercialising results and establishing partnerships with the application sector), as well as general administrative processes (financial and technical support of research).

- Management deficiencies are also negatively reflected in the lack of strategic approach to *research activity planning* (lack of ambitious research objectives, inadequate analysis of competition in research planning, low interdisciplinary and inter-institutional cooperation) but also in *inadequate promotion of achievements* and limited room for career growth of talented individuals<sup>89</sup>, which substantially undermines the quality of research activities.
- *Material conditions* represent another cause of the low quality of research in the Czech Republic. In terms of available instruments and equipment, the situation has been gradually improving, mainly thanks to considerable investments by the Structural Funds in recent years (with the exception of Prague, which has been excluded from funding through Operational Programme Research and Development for Innovation owing to its high GDP level).
- There are still deficiencies in the area of *unique research infrastructures*, which are still not fully available, even though they may become the key motivating factor attracting researchers from abroad, provided that stable and long-term resources are secured for their operation and subsequent technological upgrade. Nonetheless, the Czech Republic has advanced significantly in this respect in recent years (e.g. by defining the Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic and providing a subsidy title to support their operation<sup>90</sup>). Although the consequences of these steps have not fully shown yet, it can be expected that, in the coming years, they will translate positively into the increased attractiveness of Czech research organisations. However, the future success of this effort will depend on the following factors:
  - Adequate setting of *infrastructure management*, including the provision of open access to users from both the academic and corporate sectors<sup>91</sup>.
  - Securing *stable long-term financing of infrastructures* (including technological upgrade) and information sources.
  - Motivating *remuneration and further education of key management personnel* and especially the new generation of future scientific management (middle management) as well as qualified *technical staff*.
  - Establishing adequate strategies to *strengthen their cooperation with the application sector*.
- In material terms, there are still deficiencies *in the area of researchers' salaries*<sup>92</sup>, especially in the case of younger researchers (where the salaries in the university and government sectors strongly depend on the length of work experience<sup>93</sup>) and doctoral students, which – in combination with unattractive career prospects and insufficient use of the achievement principle – discourages talented students from pursuing careers in science, i.e. prevents them from focusing fully on research work. However, there are also deficiencies in the ability to retain qualified technical personnel that are necessary for seamless operation.

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<sup>89</sup> *International Audit*, Annex 3.

<sup>90</sup> *Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic*. MEYS, 2010, and its further updates (<http://www.msmt.cz/vyzkum-a-vyvoj/ceska-roadmap>).

<sup>91</sup> For more information see the *National Innovation Strategy of the Czech Republic*.

<sup>92</sup> National Training Fund (2011): *Motivation of graduates for research work. Underlying materials for assessing the National RDI Policy: Area of human resources*.

<sup>93</sup> NTF (2011): Attractiveness of R&D jobs in salary terms. Background studies for the preparation of national RDI priorities (<http://www.vyzkum.cz/FrontClanek.aspx?idsekce=15138>).

- Within the context of the Czech Republic, a specific problem lies in the fact that key public research capacities that are required for implementing the Smart Specialisation Strategy in most areas are located in Prague, where the possibilities of financing by ESIF in the period 2014–2020 are very limited, as Prague is an economically developed region.

### **The specific position of the capital city of Prague in the Czech Republic's research and education system**

Prague is the educational centre of the entire Czech Republic with supraregional importance. For the most part, Prague-based universities *provide education to students living outside Prague*. About 70% of the students of Prague-based universities have their residence outside the territory of the capital city of Prague. The number of students from outside Prague illustrates the attractiveness of Prague's universities to students from all over the Czech Republic – they come to Prague to study disciplines that are unique and available only at Prague-based universities, but they are also attracted by the prestige of studying at universities that rank among the world's most successful ones.

Prague-based universities and research institutions also play a key role in *developing human resources for research and innovation in the Czech Republic*. Every year, Prague-based public universities produce over 36% of all master's degree graduates from the Czech Republic's public universities. For research, doctoral graduates are crucial. In this regard, Prague-based universities produce 40–50% (the figure varies each year) of all doctoral graduates in the Czech Republic.

The data clearly indicate that *Prague-based universities produce highly-qualified experts for the research, development and innovation sector throughout the country*.

Prague-based research organisations deal with similar problems as entities outside Prague. In addition, they are considerably underfinanced due to the limited availability of resources from the Structural Funds in the period 2007–2013 as compared to the rest of the Czech Republic. Nevertheless, the analysis of Prague-based capacities shows *the potential of Prague-based universities and research teams to achieve research excellence on an international scale*.

This can be illustrated for example by the concentration of key research organisations that provide *links between the Czech Republic and the European research area*. Prague-based research institutions are represented in European research infrastructures and their (in the context of the Czech Republic) high success rate within the 7th Framework Programme shows that *Prague-based research teams are the key drivers of high-quality research in the Czech Republic*.

From the analysis of national programmes of support for applied research, it can be inferred that *most projects within applied research programmes include Prague-based organisations and businesses that are based outside Prague*. Most results of supported project are subsequently implemented outside Prague. This is due to the structure of the economy where the business sector, i.e. the potential user of R&D results, is mainly based outside Prague.

***Prague-based research capacities provide a significant portion of their expert capacity to the application sector on a nationwide scale***; in some cases these are **unique** research facilities whose expertise cannot be replaced by other sources on a national scale. Nevertheless, these are fields that clearly contribute to competitiveness. Therefore, the involvement of Prague-based research teams will also be crucial in terms of implementing the priorities of the upcoming Smart Specialisation Strategy.

## Consequences

- The consequences of the above situation include *the continuing inability of Czech research to win more notable international recognition for its quality*, despite gradually increasing public investments in research and partial successes of a limited number of high-quality teams. Unless the building of a critical mass of high-quality research is reinforced at least in some research areas, the mission of research organisations is differentiated more clearly, and corresponding benchmarks and metrics of quality are defined, it is unrealistic to expect any significant improvement in the quality of research in the Czech Republic.
- The failure to address structural problems that affect the improvement in the quality of and the unsatisfactory framework conditions for Czech research will lead to *low social return on future investments in research*. As a result, Czech research would only have a limited ability to produce sufficient original results to make it attractive on an international scale. Its *ability to provide significant impulses for the application sector in the Czech Republic would be limited*, and it would not become a sought-after partner for important corporate clients abroad.
- Without a systematic effort to improve the framework conditions, it can be expected that a significant portion of already implemented investments (especially investments by the Structural Funds) will not bring the expected benefits for improving research quality. Without a clear perspective of further reform steps within the entire system, the *risk of brain drain*, which has been mitigated through recent investments<sup>94</sup>, may become acute again and it may also result in the loss of those high-quality researchers that have been attracted to the Czech Republic through investments in recent years.
- Prague-based research organisations contribute significantly to the training of human resources for research in the application sector in other regions within the Czech Republic and they represent natural partners for a major part of the Czech Republic's application sector. In the context of the Smart Specialisation Strategy, the inability to draw resources from ESIF in the period 2014–2020 constitutes a fundamental problem, especially in priority fields of smart specialisation (see the chapter on specialisation). The exclusion of Prague-based research organisations from support may negatively affect the availability of suitable research partners for companies, thus limiting their innovative capacity.

### 3.2.3. Problem area 2: Digital agenda and public research

#### Manifestations and subproblems

- In terms of research quality, *ICT infrastructures* are of special significance. Digital infrastructures are important to research activity in two respects: firstly, in terms of providing sufficient data storage, transfer and processing capacity; secondly, in terms of digital content and access to information and available findings and scientific results.
- Since 1996, the CESNET organisation has been providing *digital infrastructure for the needs of research organisations in the Czech Republic* – it provides transfer and data services for research organisations and, at the same time, it implements its own research activity in this area. In recent years, major investments in digital infrastructures have been implemented in the Czech Republic

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<sup>94</sup> 40% of key personnel of research organisations that were interviewed in the survey carried out by the International RDI Audit believe that the international mobility of researchers causes the Czech Republic to lose more necessary experts than it gains (Kostić, Pazour, Pokorný, 2012).

(including strengthening CESNET's core infrastructure); a part of these investments were implemented thanks to Structural Fund support: within priority axis 3 of the OP RDI, in part also thanks to the construction of centres of excellence under priority axis 1 and regional R&D centres under priority axis 2 in the IT field. These investments, too, allow the Czech Republic to maintain a long-term *solid level in the research area associated with e-infrastructures* (tools for high-speed networks, data transfer and network traffic monitoring, highly parallel computing, distributed computing, cybernetic safety etc.), i.e. even in the form of commercially successful results.

- Access to scientific information in digital form in *expert databases and electronic scientific periodicals* constitutes a key prerequisite for high-quality research. Without that, it is not possible to maintain contact with the top international scientists. In the area of digital content, the fundamental prerequisite for high-quality research lies in the availability of expert information sources (access to expert databases and electronic publications) where there are still serious deficiencies in the Czech Republic, especially in the case of field-specific sources of information.

### **Causes and evidence**

- The basic element (the communication portion) of e-infrastructures administered by CESNET is of top global quality in the Czech Republic, whereas the distributed computing and storage infrastructure (grid) is at a very good international level organisationally but its capacity is limited (Ministry of Education, Youth and Sports, 2011). The existing infrastructures still *lack sufficient storage capacity* and there are no *supercomputing resources* in the Czech Republic (although their construction is in the implementation phase – IT4I in Ostrava and CERIT in Brno).
- Within the Czech Republic, the IT area is among the research areas that have been generating *significant numbers of commercially applicable results* in the long-term, including the establishment of technological companies and subsequent investment of venture capital. Thanks to the presence of several important Czech IT companies with international reach (e.g. Seznam, AVG and others) and a growing number of foreign companies that locate their R&D capacities in the Czech Republic, there is a considerable opportunity for further reinforcing specialisation and creating of synergistic links between the high-quality facilities and entrepreneurial activities.

### **Consequences**

- Insufficient prioritisation of investments in e-infrastructures to serve the needs of research, their continuous upgrading and also in the development of specialised human resources that are required for the administration and operation of e-infrastructures may cause Czech research to lag behind and reduce public investment efficiency.
- In terms of smart specialisation, the area of digital agenda for research has consequences both for the need to further strengthen the existing specialisation in the area of e-infrastructures and associated research areas (including the issues of cybersecurity and protection of critical infrastructures, storage and processing of large volumes of data, and data mining), and for the need to make digital content and scientific information available to research organisations and the business sector.

### 3.2.4. Problem area 3: Low relevance and underdeveloped cooperation between public research and the application sector

#### Manifestations and subproblems

- *In the Czech Republic, the level of cooperation between research organisations and the application sector is low*, it mostly includes short-term limited-scope cooperation whose scope and contribution to innovations is very limited. This is evidenced, above all, by the low share of revenues of universities and public research institutions coming from corporate sources<sup>95</sup>. Another part of this problem is the existence of a rather extensive but difficult-to-quantify “grey zone” of cooperation that does not take place through official channels and is therefore not kept on record by research organisations (either due to the inadequate setting of the legislative conditions at national level, inadequate internal rules of research organisations, or the lack of high-quality support services within research organisations).
- Another measurable effect of the low level of cooperation between the corporate sector and public research is – besides the amount of resources – the *low proportion of researchers with experience of working in the private sector*. In this respect, the Czech Republic ranks among the countries with the lowest values in the EU<sup>96</sup>. The deficiencies in the application relevance of public research in the Czech Republic and, in part, also the inadequate awareness of intellectual property issues in research organisations are also documented by the low level of patent activity of research organisations in the Czech Republic, which lags far behind the EU average.<sup>97</sup>
- In about the past 10 years, the Czech Republic has experienced *partial improvements* in the linkage between academic research and the application sector, especially as a result of implementing the Reform of the RDI system in the Czech Republic in 2008. Due to financial appraisal of applied results defined pursuant to the Information Register of R&D Results, there has been an increase in the attention on the application relevance and the number of applied R&D results. As regards R&D centres financed by the Operational Programme Research and Development for Innovation, there has been (thanks to performance contracts and project indicators) greater emphasis on cooperation with the business sector through contract research. Nevertheless, these positive efforts are accompanied by a range of negative side effects such as the deliberate generation of applied R&D results (e.g. patents) without any interest in their actual utilisation. In the case of contract research, the efforts are undermined by the unclear situation in public support.
- Another tool to support the forming of long-term strategic partnerships between the public research sector and the corporate sector consists in the National Sustainability Programmes I and II that are used to support the development and sustainability of projects of centres that were

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<sup>95</sup>The share of corporate resources in the university sector’s R&D expenditure is only 1.0%, while for the government sector it is 3.4%. These values are way below the European average (Czech Statistical Office, *Cooperation between sectors in R&D in the Czech Republic in 2011*). According to the latest data published in November 2013 ([http://www.czso.cz/csu/redakce.nsf/i/statistika\\_vyzkumu\\_a\\_vyvoje](http://www.czso.cz/csu/redakce.nsf/i/statistika_vyzkumu_a_vyvoje)), even the rather considerable growth in corporate R&D investment in recent years did not translate significantly into the financial volume of contract research and it ranges around CZK 150 million/year in the case of universities and around CZK 1.7 billion/year for the government sector.

<sup>96</sup> It stands at 13%, with the EU average being 17 %. *Researchers' Report 2012*. EC, DG Research and Innovation.

<sup>97</sup> See the *International RDI Audit in the Czech Republic. Review of the IPR System* and Research, Development and Innovation Council (2012): *Analysis of the State of Research, Development and Innovation in the Czech Republic and a Comparison with the Situation Abroad in 2012*. Office of the Government of the Czech Republic.

built in the Czech Republic in 2007–2015 with financial participation of the European Regional Development Fund (ERDF). The provision of support from both programmes is conditional on the ability to achieve internationally competitive results and on evidencing active cooperation with foreign entities and the corporate sector<sup>98</sup>. By implementing these programmes, the Czech Republic also meets its commitment to ensure the sustainability of the constructed centres until 2020 and by reimbursing (merely) 50% of operating costs, i.e. costs of the renewal of these centres' equipment, from public funds it will actively stimulate their cooperation with the entrepreneurial sector.

- At least a *basic infrastructure for supporting cooperation with the users of results* (technology transfer centres, etc.) has been created in most research organisations, mainly thanks to support by the Structural Funds. Internal procedures for monitoring the intellectual property being created and methodologies for cooperation with the commercial sector are gradually being introduced, but often with limited ability to change the fundamental motivating factors within the academic environment. In many cases these entities fulfil the function of commercialising results and interconnecting both worlds *rather formally* (i.e. in terms of reaching the formal objectives of grant projects, especially those financed by the Structural Funds) without having adequate knowledge of the issues and without being sufficiently result-oriented.<sup>99</sup>
- Cooperation between public research and the application sector is one of the areas where the market failure can be felt and where most developed countries apply direct or indirect tools to support the interaction between both types of actors. In the Czech Republic, there are still serious deficiencies in this area. *Support programmes to improve research cooperation between public research and the business sector are poorly developed* in the Czech Republic.
  - The Centres of Competence programme (Technology Agency of the Czech Republic – CZK 9 billion, of which 70% national budget for 2012–2019, 33 centres supported) is in fact the first *programmes supporting long-term strategic partnerships between research organisations and companies* that include all stages of research and development and, at the same time, support the mobility and common training of doctoral students – the programme has existed since 2011<sup>100</sup> and the support has proven insufficient so far. This is also evidenced by the large excess of demand, with the success rate of applicants to the programme being only about 10%. Besides R&D centres and projects of large infrastructures for research, experimental research and innovations, the existing centres of competence can be considered another key building block of possible specialisation on disciplines within the RIS3.
  - Tools to support *horizontal mobility* are still completely lacking in the Czech Republic, which negatively impacts on the readiness of doctoral graduates to address practical problems.

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<sup>98</sup> The sustainability of centres built within the Operational Programme Research and Development for Innovation, the investment costs of which exceed EUR 50 million and that predominantly have the character of a large infrastructure for research, experimental development and innovation, will be supported by the National Sustainability Programme II. The National Sustainability Programme I will then be used to support centres built using resources from the Operational Programme Research and Development for Innovation and the Operational Programmes Prague – Competitiveness with investment costs of up to EUR 50 million.

<sup>99</sup> See the underlying analytical documents. Annex. Updated National RDI Policy, p. 93.

<sup>100</sup> Although support programmes have existed since the 1990s (MIT programmes and the MEYS 1M programme), their scope was limited and they failed to achieve the desired effect of establishing long-term cooperation and leveraging private funds.

- Programmes to support the commercialisation of RO's research results have been implemented within the Operational Programme Research and Development for Innovation, but their results have yet to be evaluated. In parallel, the new Gama programme (Technology Agency of the Czech Republic – CZK 2.77 billion, of which 64.9% national budget for 2012–2019, 10 projects have been selected thus far), which should have a similar focus.
- As a rare exception, there are high-quality programmes to *support entrepreneurship* of university students, help them implement their own business plans, or *establish technological companies* that have arisen from research results.
- The unsatisfactory situation is made even worse by the high rate of *dependence of Czech corporate R&D on the decisions of foreign parent companies* that scarcely give their Czech subsidiaries sufficient autonomy in the area of cooperation with the academic sector in the Czech Republic, and if they do, then only under conditions that are unilaterally favourable for the multinational companies. In recent years, there has been certain improvement due to the rather dramatic increase in R&D expenditure in the business sector in the Czech Republic (both in Czech branches of foreign companies and in the growing group of companies with Czech owners). Nevertheless *intervention measures* on the part of the public sector focusing on closer linkage between development capacities of foreign companies and public research in the Czech Republic *are insufficient* (absence of an elaborate system of subsequent care for foreign investors).

### Causes and evidence

- The causes of the low relevance of Czech research lie both in the framework conditions, including the structure of innovation demand in the Czech Republic, and in areas requiring interventions at the level of research organisations.

#### a) Regulatory framework

- The current *research evaluation methodology* and the allocation of institutional resources basically *discourage researchers in the public sector from continuous cooperation with the application sector*. The evaluation takes zero or limited account of contract research orders placed by the business sector, successful sale of intellectual property licences, the establishment of a spin-off company, or cooperation with companies in training students. In most research organisations, there is logically *no consensus as regards the role of cooperation with the application sector* within their mission and, by extension, no agreement on the adequate evaluation of this activity. Moreover, the application of an evaluation methodology often leads to the deliberate production of “applied results” pursuant to the valid evaluation methodology.<sup>101</sup>
- *Weak and poorly sophisticated innovation demand*, i.e. poorly sophisticated innovation needs within the Czech Republic's corporate sector (see the corporate sector analysis) only generate very limited professionally motivating challenges for research organisations. Therefore, in some areas of research, research organisations lack strong and relevant corporate partners able to formulate and co-finance long-term research cooperation. This is also evidenced by the fact that most academic teams perceive the possibility of cooperating with the corporate sector mainly as a source of additional financial resources and not as a source of additional research stimuli or an

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<sup>101</sup> There are known cases of deliberate patenting, where research organisations have no real interest in further developing the protected results, but they only have them patented in order to increase the amount of institutional resources for their institution based on the number of patents reported.



opportunity to cooperate on a theme of mutual research interest<sup>102</sup>. The mismatch between the expectations of companies and those of research organisations thus constitutes one of the key barriers to cooperation.

- *Tax considerations* may be one of the reasons why cooperation between research organisations and the corporate sector has not developed to a larger degree, despite increasing R&D investment in the private sector. Until 2013, internal R&D expenditure was tax-deductible in profitable companies; due to the legislative conditions, the purchase of R&D services can only be deducted since 2014<sup>103</sup>.

#### b) Research organisations

- There are serious *deficiencies* even at the level of research organisations' management, which fully applies to specific skills for *managing relations with the application sector*<sup>104</sup>. There are no motivational incentives for this activity and there is also a lack of financial resources for the flexible financing of research depending on current demand in the application sector. The career rules of most research organisations and universities give little or no significance to high-quality applied results, even in technical areas. This results in the *low prestige* of applied research among researchers and the unwillingness to engage in this activity. Despite the fact that there are honourable exceptions of research teams that cooperate with the practical sphere on relevant and scientifically important themes in the Czech Republic, it is safe to generally conclude that research organisations in the Czech Republic are not well-prepared for cooperation with the application sector and they lack motivation for such cooperation<sup>105</sup>.
- *Awareness of intellectual property issues* is generally *very poor* among research personnel, which causes serious problems during cooperation (the risk of disclosure of corporate partners' intellectual property, signing of contracts under conditions unfavourable for research organisations etc.). In extreme cases this can even lead to researching areas that have already been researched, i.e. that are already protected by intellectual property rights.
- The setting of *conditions and internal processes* in the area of contractual research, the setting-up of spin-off companies, the evaluation and remuneration for this type of results are often inadequately regulated within research organisations, which is demotivating and, in some cases, researchers may be forced to look for alternative ways of commercialisation (the results are utilised commercially under conditions unfavourable for the institution or even without its knowledge).
- *Support services in the assessment and subsequent protection of intellectual property* (especially assessment of the novelty and application potential of the achieved results, assistance in protecting intellectual property) have been gradually evolving within research organisations in recent years, thanks to the establishment of technology transfer centres. Nevertheless *the level*

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<sup>102</sup> See the results of the survey carried out within the International RDI Audit (*Annex 5 to the Final Report: Science-Industry Linkages*).

<sup>103</sup> In the future, it will be important to monitor and assess the impact of this tax-deduction "equality" of purchases of R&D services on the volumes of these services implemented by universities and public research institutions.

<sup>104</sup> See especially the *International RDI Audit, Annex 5 Science-Industry Linkages*, or Berman Group (2010b).

<sup>105</sup> The best-known case is that of the Institute of Organic Chemistry and Biochemistry AS CR, but there are other cases, such as the Department of Cybernetics at the Faculty of Electrical Engineering, Czech Technical University, or the Research Institute of Textile Machines in Liberec and other, usually smaller facilities.

*of provided services is very varied*, they are scarcely on a satisfactory professional level and some organisations completely lack consistent support.

- At the level of research teams, in the vast majority of cases there are no *qualified capacities for the business development of the achieved R&D results*, i.e. for identifying promising results, searching for suitable partners for commercialisation, negotiating the content and conditions of joint projects of applied R&D. Most researchers are not prepared for such type of activity nor are they trained in this area; mechanisms that would aid such activities (e.g. regular meetings with corporate sector representatives) are scarcely institutionalised.
- The *mechanisms for verifying the commercial applicability of results* and for verifying technologies (proof of concept) are completely inadequate. The logical outcome is that even promising results of research fail to be utilised in most research organisations.
- *Awareness of the basics of entrepreneurship and training in this field* for university students and researchers are *inadequate and unsystematic*. Only very exceptionally are educational activities followed by practical support services for start-up entrepreneurs from among students and academic staff.
- *The mobility of researchers into and out of the corporate sector is very limited*. The mobility of researchers from the corporate sector to research organisations is a wholly exceptional occurrence. This creates a cultural barrier hindering closer cooperation and widens the gap between the two worlds.
- *Small size of research teams* and lack of long-term funding for research activity is also a factor that *reduces the ability to focus systematically on working with corporate partners*. Small teams suffer from a lack of resources for parallel work on grant projects and high-risk contracts for companies, which is why they prefer the more secure grant resources<sup>106</sup>.

## Consequences

- The main consequence of this unsatisfactory state of cooperation between research organisations and the application sector is the generally low application relevance of research in the Czech Republic. This is also evidenced by the fact that Czech companies fail to sufficiently use public research as a source of expertise and possible innovation advantage<sup>107</sup>. Subsequently, the low level of interaction between public research and the application sector results in a situation where *pouring public investments into R&D within the Czech economy has little effect* and public investments in R&D have low economic return.
- A vicious circle emerges in this area, where low application relevance of public research, poor motivation to cooperate and *poor preparedness* (at the level of institutions and individual researchers) *for cooperation* discourages companies from cooperating with the academic sector, while – on the contrary – the poorly sophisticated innovation demand of companies and the unfulfilled expectations of a client approach on the part of companies discourage researchers from cooperating with the companies. Mutual expectations differ greatly and the parties rarely succeed in *breaking the initial distrust* without which it is not possible to develop any long-term strategic cooperation.

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<sup>106</sup>See e.g. *The International RDI Audit*, Annex 5, *Science-Industry Linkages*.

<sup>107</sup>See the underlying analytical documents. Annex. The updated National RDI Policy, according to which innovative companies do not use universities as a source of their innovative activities in two thirds of cases (p. 86).

- The practical consequence of the isolation of the two sectors is the *low number of R&D results* that are produced by research organisations and *that are actually commercially utilised* (e.g. the number of licences purchased by corporate entities from universities and research organisations, or the volume of contract research). A side effect of the low level of cooperation and relevance of public research, which should not be taken lightly, is also the dissatisfaction of employers with the quality of the practical knowledge of university graduates (NTF, 2011b), including doctoral programmes that should prepare the young generation of scientists for addressing research problems in practice.
- From the perspective of the Smart Specialisation Strategy, this problem area needs to be addressed both through removing selected regulatory obstacles and, above all, through a range of horizontal measures that will generally increase the inadequate level of interaction between research and the application sector. At the same time, the potential of existing capacities should be utilised, especially the potential of high-quality regional R&D centres (OP RDI) and competence centres as priority areas that should be targeted by vertical interventions (e.g. specialised programmes to support cooperation with technologically advanced companies, including branches of multinational companies).

### 3.2.5. Problem area 4: Inadequate international openness of the Czech research environment

#### Manifestations and subproblems

- The environment of research organisations in the Czech Republic is characterised by *a significant lack of openness*. In contrast to the entrepreneurial sector, which underwent significant internalisation of the Czech corporate sector (including the adoption of best management practices) due to the privatisation of Czech companies and globalisation of the economy, the environment of research organisations has not been subjected to any strong pressure calling for a change of the current practices and for rationalisation of its operation since 1989 (with the exception of the privatisation of some departmental research institutes).
- In the 1990s, public resources for research were sharply reduced, which acted as a “push factor” forcing some researchers (often the more active ones) to leave. Since the beginning of the 21st century, there has been a *gradual increase in the volume of public resources for research*, but it *was not accompanied by adequate emphasis on quality improvement* and, in turn, additional resources were in many cases invested in research teams that had survived the crisis of the 1990s thank to a belt-tightening strategy, without any ambition for growth or expansion. Such *research teams and organisations are often unprepared – psychologically and managerially – to substantially develop their facilities, they are not ready to open up, and they have low motivation and limited ability to attract and retain foreign experts*. This concerns both the lack of openness to foreign countries and entry of foreign researchers (or researchers with foreign work experience) and very limited mobility between research organisations within the Czech Republic, as well as mobility towards the application sector (see problem area 3). The lack of openness has translated into a very small share of foreign employees in science and technology<sup>108</sup>.

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<sup>108</sup> The share of research experts in the Czech Republic ranges around 2%, by contrast e.g. in neighbouring Austria it is 11%. Eurostat 2012 – [http://epp.eurostat.ec.europa.eu/portal/page/portal/science\\_technology\\_innovation/data/database](http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/database)

- *The international mobility of researchers in the Czech Republic ranks among the lowest in the EU<sup>109</sup>, which is undoubtedly one of the reasons for the relatively poor participation of Czech research facilities in international research cooperation. Despite the improving trend, which translates e.g. into the growing participation of Czech scientists as co-authors of publications with other foreign authors, the lack of openness still poses a problem for many Czech research teams. The lack of (long-term) international mobility and exposure to different behavioural and working patterns often lead to rigidity, lack of openness to new approaches and, in extreme cases, even to the conservation of a culture that does not create a stimulating environment necessary for high-quality research (lack of openness to external stimuli, rigid hierarchical management structure instead of meritocracy, unsatisfactory age structure, unsound practices in recruiting new employees)<sup>110</sup>.*
- *With few exceptions, the Czech research environment is characterised by the tendency to stay at the home facility within the same research team for one's entire scientific career, where changes in the team only occur due to generation replacement (so-called *in-breeding*). In 85% of research groups in the Czech Republic it is expected that their doctoral graduates will take researcher positions in the "parent" team<sup>111</sup>. The Czech Republic ranks among countries with the greatest share of non-mobile researchers (a share of more than 50% as compared to less than 40% in most developed countries)<sup>112</sup>, which has unmistakably *negative consequences for achieving and maintaining top research quality*<sup>113</sup>.*
- *Compared to most European countries, in the Czech Republic there is a rather generous mechanism for supporting the participation of academic facilities in the EU framework programme through providing additional financing for eligible project expenditure from national sources; the Czech Republic can also profit from the opportunities resulting from the existence of a rather extensive international scientific diaspora<sup>114</sup>. Despite these opportunities, the possibilities for using international grants, including EU framework programme grants, remain poorly utilised – this is not due to a low success rate of applications (which is roughly the same as the European average), but mainly due to low interest and a low number of submitted projects with Czech participation (RDIC, 2013). The opportunities for research cooperation with the neighbouring countries are used only marginally and unsystematically, despite the possibility of using cohesion policy resources (cross-border cooperation programmes) for this purpose.*
- *In recent years the openness to foreign employees has started to slowly improve thanks to massive support for new tools that explicitly promote the coming of foreign researchers, or*

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<sup>109</sup> Only 44% of Czech researchers have spent at least three months in a researcher position in another country, compared to the EU average of 56%. *Researchers' Report 2012*. EC, DG Research and Innovation. p. 96.

<sup>110</sup> The International Audit, Annex 3, pp. 19–21 (conclusions of the pilot verification of international peer-review).

<sup>111</sup> International Audit, p. 54.

<sup>112</sup> *Comparative Benchmarking of European and US Research Collaboration and Researcher Mobility*. Science Europe, 2013 (<http://www.scienceeurope.org/downloads>).

<sup>113</sup> See e.g. *Science Europe Position Statement: Horizon 2020: Excellence Counts*. Science Europe, 2012 (<http://www.scienceeurope.org/downloads>). Bibliometric data for Czech research also document that a Czech author without a foreign co-author has roughly half the citation rate of Czech publications with a foreign co-author (see the *International RDI Audit*).

<sup>114</sup> The size of the Czech "research diaspora" is estimated to comprise 4–7% of scientists with Czech citizenship. When we include all researchers with Czech nationality, i.e. those who already have foreign citizenship, this number increases to 10–17% of all researchers in the Czech Republic (Kostecká, Y., Bernard, J., Kostecký, T., 2007).

researchers with experience of working abroad, to the Czech Republic (mainly from the Operational Programme Education for Competitiveness). Even though the effect of this tool will be felt with a delay, there are already cases where the quality of research has improved due to this measure, which will require strengthening in the future. In addition, the application of these tools coincides with the deepening economic crisis in some parts of Europe, due to which there are also foreign researchers not only from Asia and countries of the former Soviet Union, but also from South European countries on the Czech Republic's researcher market. In the case of R&D centres supported by the Operational Programme Research and Development for Innovation, there have also been international selection procedures for top management positions in several cases, which gradually opens at least some Czech research organisations to the international community. Nevertheless, these tools mostly prevent the participation of Prague-based facilities, which limits their impact on the Czech research system as a whole. *Also, incoming of researchers from abroad is not linked to long-term human resource development strategies* in the accepting institutions, including guaranteed long-term funding for newly-constituted research teams (e.g. in the form of a permanent contract if the integrated scientist proves useful).

### Causes and evidence

- The reasons for the lack of openness of Czech research lies both in the framework or regulatory conditions and in factors related to the nature of the internal management and operation of research organisations, especially in the area of HR management and career rules.
  - a) Regulatory framework
- At the top level, the Czech Republic still lacks a holistic strategy for RDI internationalisation that would include activities of all departments and agencies that are engaged in this area<sup>115</sup>. This is also connected with the low level of the Czech Republic's participation in European activities intended to strengthen the integration of the European Research Area (ERA) and generally in activities intended to strengthen ERA structuring (ERA-NET, ERA\_NET Plus and other projects).
- In the field of regulation at the national level, greater openness and mobility are hindered by *formal requirements for the acknowledgement of academic titles from abroad* and generally also overly complex *procedures for approving career advancement*. In the case of universities, it is the requirement to teach in Czech that prevents any greater engagement of foreign academicians.
- *Immigration barriers* also constitute a notable obstacle, mainly in the case of researchers from countries outside the EU where there is no qualified central support service to provide support to foreigners coming to the Czech Republic (e.g. through representative offices of the Czech Republic in foreign countries). Even in the case of employees from EU countries, there are still a notable number of obstacles hindering the integration of foreign researchers into the Czech environment (e.g. problems in transferring retirement rights etc.).
- Lack of openness to foreign speaking scientists is illustrated by the fact that in most Czech grant programmes it is *obligatory to submit grant applications in Czech*.
- At the national level, there is *no strategy to support international cooperation* with clearly defined priorities and objectives and with the definition of areas in which the Czech Republic

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<sup>115</sup> See the updated National Research, Development and Innovation Policy of the Czech Republic for the period 2009–2015 with an outlook to 2020, measure 16.

wants to cooperate, the countries and institutions it wants to cooperate with and why, supported by stable financing<sup>116</sup>.

- There are absolutely *no tools* to systematically *support the circulation of brains*, such as possibilities of sabbatical<sup>117</sup>, and tools supporting the setting up of new research groups open specifically to researchers coming from outside the research organisation are used very scarcely. It can be generally concluded that there are *minimal incentives or bonifications for internationally open research facilities* that actively strive to diversify the personnel “gene pool”. Recent exceptions include the Operational Programme Education for Competitiveness and international search committees<sup>118</sup> for large infrastructure projects under the Operational Programme Research and Development for Innovation. In the area of applied research, the new Delta programme (TA CR) launched in 2014 could bring some change.

#### b) Research organisations

- At the level of research organisations, there is usually *no international cooperation strategy*<sup>119</sup> or there is only a formal one. Such strategies only scarcely take the form of explicitly defined strategic partnerships, i.e. the definition of specific strategic partners and the clear content of research cooperation with these partners. This is also connected with the absence of the long-term financing of strategic research cooperation at the national level.
- Despite certain improvement thanks to using the pan-European network called Euraxess to advertise research jobs<sup>120</sup>, research organisations in the Czech Republic still show *serious deficiencies in their HR management policy* and in their procedures in *recruitment and filling vacant positions*<sup>121</sup>. These are felt as the low number of researchers with foreign experience (or even experience from another research organisation within the Czech Republic) and subsequently *encourage in-breeding*<sup>122</sup>.
- Most research organisations in the Czech Republic *lack qualified services to facilitate integration of foreign researchers and students* (soft services), most support and internal processes are only available in Czech and the responsible employees are not prepared for working in English (typically e.g. HR agenda).
- While *international research cooperation* in the form of participation in international projects and *long-term mobility* (i.e. more than three months) is preferred by research organisations, it is *scarcely supported*. In the case of mobility, this is often probably due to concerns about brain drain.

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<sup>116</sup> This problem is targeted by measures of the updated National Research, Development and Innovation Policy of the Czech Republic for the period 2009–2015 with an outlook to 2020, where the need for an interdepartmental strategy for RDI internalisation is explicitly formulated in measure 16.

<sup>117</sup> Sabbatical – paid, partially paid or unpaid leave provided by universities to university teachers for the purpose of scientific work, self-education, work on a publication and/or mental hygiene.

<sup>118</sup> An internationally staffed committee of assessors.

<sup>119</sup> Only about 40% of research organisations have a similar strategy in place. Boekholt et al. (2011): International Co-operation in R&D. Final Report – 6. International Audit of Research, Development&Innovation in the Czech Republic. Manchester Institute of Innovation Research&Technopolis Group

<sup>120</sup> See EC (2012): *The Researchers Report 2012: Monitor human resources policies and practices in research*. Scorecards.

<sup>121</sup> See e.g. the International Audit, Annex 5 – results of the pilot verification of the new assessment methodology.

<sup>122</sup> A practice where a university produces graduates who then remain in the “home” working group, which promotes intellectual stagnation.

- In the case of research cooperation in the form of international grants, there are often inadequately-set internal procedures that are associated with greater administrative demands and, in some cases, even a higher rate of payment to the central budget<sup>123</sup>, which often discourages research teams from cooperation. High-quality, client-oriented *support in the form of grant management* is rather scarce within research organisations.

## Consequences

- The absence of a *supra-departmental strategy for RDI internationalisation* together with the understaffed state administration bodies responsible for this area result in poor participation in pan-European research cooperation and, in the future, may jeopardize the drawing of resources from the Horizon 2020 programme and undermine potential synergies between H2020 projects and cohesion policy resources in 2014–2020.
- High quality of research is not conceivable without *the circulation of brains* and systematic creation of *conditions for absorbing new stimuli from different environments*. One of the consequences of the low openness of Czech research organisations is their low attractiveness to researchers with different experience (i.e. poor ability to retain such researchers in the long-term) and the ensuing negative impacts on overall research quality. The Czech research environment is not very attractive from an international perspective due to its language specificity and – compared to the countries with the most advanced research systems – it is also unattractive due to low salaries. Inability to ensure greater openness and permeability of the career system of Czech research impacts on its poor ability to attract and retain a critical number of researchers with experience from different environments.
- The low “genetic diversity” of Czech research organisations is intensified by their conservative HR practices. Eventually, it may lead to the *drain of talented young researchers* who are not given adequate conditions for their development, and to the *gradual re-emigration of employees from abroad*, i.e. even in the case of researchers who have been attracted to the Czech Republic in the previous years. Unless the barriers to the arrival of researchers from abroad and to scientific mobility in general are gradually removed in the Czech research environment, the selection of talents for research careers will remain limited to the Czech Republic (and possibly Slovakia) in the future as well. Persisting lack of openness would mean losing any hope of achieving top international research quality.
- International openness and mobility of researchers has a clearly positive impact on the degree of *participation in international research cooperation*. In this respect, the Czech Republic’s results are unsatisfactory in the long-term<sup>124</sup>. Unless sufficiently robust mechanisms are put in place to support the circulation of brains from and to the Czech Republic and to anchor the foreign scientists that are already present, there is unlikely to be any increase in the activity of Czech research teams in international research cooperation, including future participation of Czech research teams in Horizon 2020.

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<sup>123</sup> Underlying analytical documents. Annex. Updated National RDI Policy, p. 83.

<sup>124</sup> According to the results of the International Audit survey, as many as 84% interviewed directors of research organisations reported that their facility had no income from international grants (*International Audit, Annex 6A International cooperation in R&D*). By contrast, facilities that have received foreign key personnel for research groups within the Operational Programme Education for Competitiveness show high activity in the area of international grants.

- The low openness of the Czech research environment and the low number of researchers with experience from a different research environment also translate into *low openness to good practices in the development and implementation of research policy in the Czech Republic*. Foreign good practices are adopted only slowly and are often resisted by well-established actors. This applies to both the national, system level and the level of individual institutions and teams. In the Czech Republic, project assessment by international panels from abroad and the filling of vacant positions through transparent international selection procedures are still a rare practice. This, too, is a result of the low number of foreign researchers (or researchers with foreign experience) in the Czech Republic.
- In terms of smart specialisation, it is necessary to deal with regulatory barriers that prevent greater openness and internationalisation. At the same time, it is necessary to create horizontal intervention tools that will generally increase the openness and quality of Czech research. In areas where it can be evidenced that research quality is at an international level and is linked to the Czech Republic's application potential, it is advisable to also implement vertical measures (e.g. programmes supporting the entry of foreign scientists, support for strategic partnerships of Czech research facilities with leading foreign partners etc.).

### 3.2.6. Problem area 5: Deficiencies in R&D policy management and governance

#### Manifestations and subproblems

- According to the findings of the International Audit of Research and Development in the Czech Republic, the distrust in the system can be considered the most fundamental problem of the Czech R&D system. *The distrust* is partially associated with political instability since 2006, which resulted in the gradual politicisation of research and development issues that have gradually become the subject of the assertion of particular interests of individual groups of actors<sup>125</sup>.
- One of the manifestations of the distrust is the *absence of consensus as to the further strategic direction of R&D policy in the Czech Republic*, including a more specific focus on addressing social and economic challenges of Czech society. An accompanying phenomenon is the lack of a long-term concept of R&D policy and the uncertainty as to its further direction, including financing uncertainty.
- The absence of a generally accepted strategy is exacerbated by *fundamental deficiencies in accomplishing the specified strategic objectives*. The fundamental inconsistency between the declared objectives and the efficiency of the mechanisms to accomplish them, i.e. the low efficiency of implementation structures, undermines the willingness to address the strategy which is then reduced to merely a formal document.
- In the absence of a clearly defined strategy, it is only logical that there is also *a lack of research orientation in the form of thematic research programmes*, without which there are no conditions for implementing long-term and ambitious problem-oriented research that could achieve a true breakthrough in the given research area.
- *The R&D governance system* shows similar deficiencies, especially the inadequate application of the subsidiarity principle. The key role within the entire system is played by the Research, Development and Innovation Council (RDIC), which is responsible for both long-term strategic issues (strategy and strategic intelligence) and a wide range of "micro-management" issues

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<sup>125</sup>The International R&D Audit in the Czech Republic.



(preparation of the national R&D budget, assessment methodology etc.). However, the RDIC is acutely understaffed for such extensive tasks, and no adequate mechanisms to ensure effective cooperation and coordination are in place for the purpose of formulating strategic objectives<sup>126</sup>. The fundamental deficiencies of the R&D governance system include the unclear separation of policy-making and executive bodies, poor capacities for rigorous strategic work, the lacking role of the creator of consensus on strategy and the author of the tasks for the implementation bodies<sup>127</sup>.

- *There is a high turnover within public administration in research.* The accompanying phenomena of personnel instability include *low qualification level*, low strategic intelligence and strategic governance ability and – last but not least – low ability to ensure the accomplishment of specified objectives as mentioned above.
- Another side effect of the inadequate performance of public administration is the *unsuitable methodological setting of research support programmes*, which leads to increased *administrative burden* on researchers. This is connected with the poorly interconnected legislative and methodological rules that complicate the activities of both researchers and auxiliary administrative staff<sup>128</sup>. The manifestations include strict adherence to formalism in fulfilling the research objectives instead of placing emphasis on efficiency and benefits of research activities<sup>129</sup> at all levels (both individual projects and support programmes), tendency towards preference of the least risky projects (i.e. financing that which has already been researched) where it is certain that the planned results will be achieved, at the expense of original but risky research. Frequent changes of the conditions for research programmes that are implemented without consultation with beneficiaries lead to uncertainty among research organisations.
- Another manifestation of the instability and low qualification of state administration in the area of R&D policy is the *insufficiently rigorous preparation of strategies and policies, lack of continuity*, insufficient emphasis on developing evidence-based policy, and the nearly non-existent evaluation of the social and economic benefits and impacts of projects and programmes on a cascading principle<sup>130</sup>. By contrast, there is also a tendency towards simplified solutions that may ultimately prove to be harmful (e.g. a mechanistic quality evaluation model versus a long-term plan to improve the evaluation culture that would gradually improve quality management)<sup>131</sup>.

### Causes and evidence

- The causes of the inefficient management and governance of Czech research lie both in the framework regulatory conditions, and in the conditions existing within the state administration bodies that are responsible for R&D policy.

#### a) Regulatory framework

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<sup>126</sup> For more information see Pazour, M., Kučera, Z. (2012): Suggestions for improving the effectiveness of the research, development and innovation management system in the Czech Republic. Analyses and underlying documentation for implementing and updating the National Research, Development and Innovation Policy.

<sup>127</sup> For more information see the International R&D Audit, Annex 2. *R&D Governance in the Czech Republic* and the recommendations of the International Audit.

<sup>128</sup> Especially lack of consistency between Act No 130/2002 Coll., No 218/2000 Coll. and No 341/2005 Coll.

<sup>129</sup> Underlying analytical documents. Annex. Updated National RDI Policy, p. 12.

<sup>130</sup> See the recommendations of the International RDI Audit.

<sup>131</sup> See the International R&D Audit.

- The *absence of a respected arbiter* can be seen as the main reason for distrust in the R&D policy system. The Czech Republic lacks a public administration body that would be perceived by the key players (in both the academic and business sectors) as impartial and that would be able to facilitate consensus on long-term strategy and supervise its fulfilment.

#### b) Stare administration of R&D policy

- The distrust in the R&D policy system also results from negative experience with the real-life implementation of existing strategies, which has been caused by the *inadequate capacity and quality of the public administration officers* responsible for implementing R&D policy. The low attractiveness of the career outlooks of public administration employees in combination with low salaries fail to create sufficiently attractive conditions for hiring qualified experts. For existing public administration employees, there are *no tools to systematically improve qualifications*, the possibility of acquiring foreign experience and good practices (e.g. in the field of project assessment, evaluation of R&D programme contribution, institutional financing, evaluation of measures for increasing cooperation with the application sector, etc.).
- It is only logical that – without consensus on the research strategy – there are *no tools for targeting the research effort at long-term problems of the society and economy* in the Czech Republic, which would concentrate effort and function as leverage for additional investments on the part of the private sector. Although national research priorities<sup>132</sup> have been defined, their accomplishment is still unsatisfactorily implemented via a targeted programme to support research within priority themes<sup>133</sup>. It is obvious that the actual fulfilment of the Smart Specialisation Strategy is only possible if the defined priorities are supported both from sufficient resources intended for regional policy, and from national resources through gradually orienting – at least in part – national resources towards priority areas. Also, it is the factual *absence of thematically focused research programmes* that sets the Czech Republic apart from most comparable countries<sup>134</sup>. This fact reduces the role of research and research policy as a tool to address the problems that are defined by social demand, but it also clearly evidences the lack of interdepartmental coordination in research and development in this area<sup>135</sup>.

#### Consequences

- The missing coordination mechanisms at the national level and the lacking consensus as to the further strategic direction limit the ability *to concentrate and mobilise necessary resources around key problem-oriented long-term research themes*. This results in the fragmentation of public investments in R&D and their low efficiency and poor contribution to addressing social and economic problems. This constitutes a problem that is all the more serious because, at the same time, public investments in R&D are increasing in the Czech Republic.

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<sup>132</sup> *National Priorities of Oriented Research, Experimental Development and Innovations* (<http://www.priority2030.cz/novinky/priority-orientovaneho-vyzkumu-experimentalniho-id:17/>).

<sup>133</sup> There is currently no thematic, oriented research programme in the Czech Republic; the Epsilon programme (TA CR) is still in a preparatory phase. The existing programmes of targeted support are based on the “bottom-up” principle. In addition, there are no specified amounts of resources that should be allocated to individual research areas within each generic programme.

<sup>134</sup> See e.g. the comparison between the Czech Republic and other countries within the Erawatch project (<http://erawatch.jrc.ec.europa.eu/>).

<sup>135</sup> See measure 7 in the updated National Research, Development and Innovation Policy of the Czech Republic for the period 2009–2015 with an outlook to 2020.

- The consequence for the Smart Specialisation Strategy is the necessity of systemic changes in R&D policy governance, both in terms of modification to the competences of responsible authorities (i.e. clearly defined competence for the coordination of programmes financed from national resources) and in terms of strengthening the professional and administrative capacity of public administration. At the same time, these are the prerequisites for implementation in the form of thematic research programmes (vertical measures). However, their implementation requires reaching the necessary consensus.

### 3.3. Human resources

#### 3.3.1. Introduction

In the current knowledge-oriented economy, the quality of human resources constitutes the key determinant of the international competitiveness of a given country (OECD, 2013), which is based on the ability to develop innovative solutions, and products and services that are difficult to copy. In turn, these allow the achievement of “high road” competition. In this race, it is therefore very important to focus on 3 mutually interlaced stages of the intentional production and development of the research and innovative potential of people.

The first stage can be perceived as a general level of equipment with realistically applicable knowledge and skills. This is the reason why great attention is given to the systems of initial and further education as the differences in their performance ultimately determine the differences in the economic standing of individual countries. E.g. a PIAAC study has shown that the level of reading, numerical and ICT literacy of Japanese high-school students and Italian university students is roughly at the same level(OECD, 2013). This first stage represents both an independent source of innovative ideas and solutions, and human resources with a high-quality foundation for activities in research and development.

The second stage deals with the issue of which people should be prepared for a career in research and development and how, as it would be neither reasonable nor effective to prepare the entire population for such a career. One way to do this is to use a system for identifying and developing talent. The essence of that system lies in developing an individual according to their potential and talents, which should ultimately strengthen mainly those abilities and skills in which it is easiest for them to succeed in the labour market to the largest extent, regardless of which occupation they eventually choose.

The last stage in developing research, development and innovative potential lies in working with the researchers themselves. The way in which they are recruited, assessed, developed etc. is very important for correctly utilising their potential and for achieving maximum productivity.

This chapter of the analysis deals with each of these stages separately, brings evidence of the current situation and searches for areas for further improvement. The Czech Republic has been found to have a good starting position in many of the areas considered, and it is important to remove those factors that are slowing down the entire system. However, it has also been found that hesitation in remedying the mistakes in these areas may cause us to lose our current position. The fundamental strategic document for the field of education is the Education Policy Strategy of the Czech Republic up to 2020, not the RIS3 Strategy.

#### 3.3.2. Problem area 1: The outputs of the education system are average quality with no improvement

The purpose of the initial education system is to equip pupils and students with competencies that are important for their personal and professional lives. The professional employability of graduates is then a product of the quantity, quality and relevance of the knowledge and the expert, general and soft skills acquired during the education process. Deficiencies that occurred within initial education

and issues relating to the consequences of the obsolescence of knowledge and skills of an individual are addressed by further education.

The PIAAC international comparison of selected general skills showed that numerical literacy of the Czech population aged 16 to 65 is at an above-average level among 24 OECD countries, whereas reading literacy and the ability to address problems within a technologically demanding environment are at an average level (OECD, 2013). However, if the Czech economy wants to associate its further growth mainly with technology- and knowledge-intensive activities, the situation can only be seen as a good baseline for accelerated improvement in the quality of education in terms of international comparison. The results of the PISA international comparison, which measures reading, maths and natural science literacy of pupils at age 15 in 65 countries, however, do not indicate any improvement in the quality of education. On the contrary, it turns out that in some areas the younger population's skills are worse than those of the population group aged 16–65 years. An analysis of the results from five PISA rounds, which took place between 2002 and 2012, shows that Czech pupils' reading literacy is below average, maths literacy is about average, and natural science literacy is above average, when compared to other countries (these are the prevailing results of the survey), but the long-term trend is not growing in either case. The long-term stagnation or even decline in the results of Czech pupils indicates that, in the area of human resources, the Czech Republic has failed to create conditions for improving its international competitiveness and, by extension, its relative standard of living. It should also be noted that there are significant differences in the results of pupils from different schools, which points to the high selectivity of Czech schools (Palečková, Tomášek et al., 2013). In terms of teaching quality, the Czech education system thus provides a highly inconsistent service.

Other general competencies worth noting include the knowledge of a foreign language and ICT, the importance of which will increase greatly in the future (e.g. Balcar, 2011; Burdová, Paterová, 2009; Kalousková, 2007; Kalousková, 2006; Kalousková, Šťastnová, Úlovcová, Vojtěch, 2004). Employers see the quality of foreign language communication as a weakness of university graduates, who are supposed to have the highest potential for research, development and innovation (e.g. Balcar, Filipová, Gottvald, Šimek, Šmajstrlová, 2008), especially in the case of graduates from technical and natural science studies (Kopicová, 2013). By contrast, they evaluate graduates' ICT skills very positively. Overall, it can be concluded that 80% of Czech employers are satisfied with the knowledge and skills required for work, while in the Western countries this percentage ranges between 91% and 99% (Kopicová, 2013).

The importance of an individual's soft skills (communication, cooperation, flexibility etc.) for high-quality work performance is perceived by employers as roughly equal to the importance of expert skills (Burdová, Paterová, 2009; Kalousková, 2007; Kalousková, 2006; Kalousková, Šťastnová, Úlovcová, Vojtěch, 2004). Their development within the system of initial education is seen as insufficient across Europe (Balcar, Homolová, Karásek et al., 2011). A survey among Czech employers in late 2013 revealed that employed university graduates have roughly 69–83% of the level required for 15 soft competencies as defined by the National System of Occupations (these are the preliminary results of the survey provided by authors Balcar and Šimek; Kopicová, 2013, and McKinsey & Company, 2010, indicate virtually the same data).

Further education, which follows initial education, subsequently addresses all education needs of individuals that may result from the insufficient accumulation of knowledge and skills within initial

education or from their obsolescence. It shows that the participation of the Czech population in further education, regardless of its form, achieves average values when compared to other countries. Deeper analyses of the content of further education in each country have shown that this education not always focuses on areas that limit the individual's employability in the labour market (OECD, 2013; Eurostat database).

### **Causes of the problem**

- Applicants applying for pedagogical universities have lower-average scores in SCIO tests of general scholastic aptitude. Only 10% of the applicants applying for these universities rank among the top 20% of persons with the best results. For comparison, this 20% share of the best students include 68% of law students, 23% of economics students, and 15% of forestry, agriculture and veterinary students (McKinsey & Company, 2010). In the longer-term, the relatively lower quality of students of pedagogical disciplines translates into the quality of teachers.
- Pedagogical study programmes focus primarily on mastering the curriculum. Only 14-21% of the content of pedagogical programmes focuses on pedagogy and didactics, and only 4% on practical teaching (McKinsey & Company, 2010). The graduates of universities with such focus are familiar with the curriculum that needs to be taught to pupils, but their teaching skills are insufficient.
- Teachers at universities have no obligation to master the skills needed for providing quality education, i.e. skills in the fields of didactics, andragogy etc. (Leisyte, L. et al., 2011). This is left solely up to them. As a result, there are considerable differences in the quality of teaching, depending on each teacher.
- Teachers at all education levels and their pupils and students lack contact with "practice" (NTE, 2011), which translates into teachers' poor awareness of the latest trends and market needs and students' inability to apply acquired knowledge in addressing specific problems.
- To date, the curriculum reform has failed to deliver the envisaged results even though the process of necessary change to the education system has been initiated. While the Framework Education Programmes (FEP) define the knowledge and skills to be acquired by each pupil, given the absence of adequate professional guidance and other accompanying steps and tools to support teachers they often only result in formal implementation without required improvement in the quality of teaching (see e.g. the Annual Report of the Czech School Inspectorate 2009/2010). FEP are vague in describing the expected level and quality of the results of education, which is why teachers are often unsure as to the knowledge and skills that need to be taught to their pupils. Without standards and subsequent evaluation and diagnostic tools, teachers' role in the practical implementation of the curriculum reform is very complicated (NERV, 2011).
- The Czech Republic is one of few European countries where systematic and nationwide evaluation of the quality of teaching is not in place. The absence of such objective evaluation makes it impossible to identify schools with above-average and below-average results that need to be understood as the school's contribution to pupils' development and not as mere measurement of pupils' results in absolute terms (to a high degree, these are influenced by their social and economic background). Another factor is also the negative attitude of most schools to evaluation and self-evaluation (e.g. Straková et al., 2009), as well as the limited possibilities and interest of school oversight authorities in conducting evaluation (for details see McKinsey & Company, 2010).

- Even though the development of pupils' soft skills is included in the Framework Education Programme, no systematic methodological guidance is available to teachers in order to achieve this objective. As a result, none of the levels of the Czech education sector, including tertiary education, systematically supports the development of the soft knowledge that is demanded and highly valued by employers (NTF, 2011; Leisyte et al., 2011). While innovative programmes for the systematic development of soft competencies have already been created and successfully tested in the Czech Republic, their general application is hindered by the lack of strategy and experience with the use of best practice examples.
- Despite mandatory classes of foreign languages, which begin already in primary schools, the language competencies of the Czech pupils and students in English and other foreign languages are insufficient, especially in graduates from technical and some natural science programmes (NTF, 2011). The classes usually focus on mastering grammar, whereas conversation in foreign language is insufficient. At the same time, neither pupils nor students feel the need to learn a foreign language at a high level, because even at universities, working with foreign language publications is mostly not required in order to graduate, and there are no obligatory courses in foreign languages (this is mainly due to legislative restrictions on classes in foreign languages, the insufficient number of teachers that are able to provide such classes, and the absence of obligatory English classes, which would worsen the position of students who prefer different languages).
- A serious problem is the pupils' attitude to school, which is one of the worst within the countries being compared, and their low interest in science, research and development (McKinsey & Company, 2010). This fact strongly undermines the potential for the development of the Czech Republic's human resources and, by extension, its research, development and innovation potential.

#### **Consequences of the problem and the risks resulting from failure to address it**

- Should there be continued stagnation or even a decline in the quality of education outputs, it would negatively impact on the Czech Republic's international competitiveness and, in turn, standard of living compared to other countries whose education systems will improve.
- The current quality of the outputs of the education system does not provide the conditions for achieving above-average results in research, development and innovation. It can be expected that, as before, only a few individuals will achieve top-quality science results (relatively independently of the education system) and, even though these individuals will significantly affect the development of their disciplines, their effect on the image of Czech science and research will be negligible.
- There is a risk of creating a situation in which individual causes of the current situation will further strengthen: declining results of education – lower prestige of the teaching profession – fewer top-quality applicants interested in studying pedagogical disciplines – declining quality of teaching (and, in turn, deteriorating attitudes of the pupils to schools) – declining results of education...

#### **3.3.3. Problem area 2: Dysfunctional system for identifying and working with talent**

Identifying areas of activities in which an individual will be the most productive, and developing them in that direction, is the essence of working with talent, which is absent from the Czech education

system. As a result, the potential of human resources is used inefficiently. However, it is necessary to point out that talent may take many forms (e.g. artistic talent, scientific aptitude, entrepreneurial talent), but the education system often mistakes talent for good school results. Also, it needs to be noted that each person has a different level of talent, and the following text is not limited to only identifying and developing persons with extraordinary levels of talent.

As mentioned above, the Czech education system focuses on identifying persons with good school results and on their further development, especially through a suitable choice of education. The approach of elementary schools to developing these pupils is not uniform. Some schools emphasise the need for accelerated development of talented children, whereas others mainly emphasize the integration and development of disadvantaged children. As a result, one group of pupils is often developed at the expense of the development of others. According to 54% of teachers, addressing the above problem through individual work with pupils depending on their aptitude and needs is impossible (McKinsey & Company, 2010).

The development of children with greater scholastic aptitude is often involves sending them (by their parents and school staff) to grammar schools that prepare them for university studies. Approximately 20% of all pupils attend grammar schools and 9% of pupils attend more selective six-year and eight-year grammar schools (McKinsey & Company, 2010)<sup>136</sup>. However, many talented pupils do not choose this type of education, as 25–30% of students of vocational schools perform better in SCIO tests of general scholastic aptitude than the less successful portion of grammar school students (McKinsey & Company, 2010). The combination of the current per-pupil system of school financing, the significant population decline and only moderate adjustments to the capacities of the different study programmes in schools has resulted in the lack of students of vocational schools and the declining average quality of students (in terms of average scholastic aptitude) at grammar schools and selective vocational schools. The above facts show that grammar schools do not perform the function of schools for extraordinarily talented pupils. This conclusion is entirely consistent with the fact that the Czech system of initial education does not define any type of school that should perform this function.

It may also be mentioned that limited knowledge of one's own preferences and possibilities, and the nature of the different study programmes often results in the incorrect choice of a study programme. For example, experience from the Gateway to Technical Career project, which was organised at technically-oriented secondary schools in the Moravian-Silesian Region, show that roughly one half of students of these schools consider their choice to be inappropriate and do not plan to work in the area they are studying. This fact, along with the lower popularity of technical and natural science programmes<sup>137</sup> that are often perceived by students as more challenging, results in a significant lack of persons wishing to work in technical areas, which can be observed both in tertiary education and in the labour market. The structural disproportion between supply and demand in the labour market, as described above, in many cases highly negatively impacts on the possibilities for the further

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<sup>136</sup> The PISA 2012 assessment shows that the Czech education system is highly selective, because it shows rather small differences in the results of students within a single school but substantial differences between the results of different schools. To a large extent, these are influenced by the average social and economic background of the students (Palečková, Tomášek et al., 2013).

<sup>137</sup> According to the classification of core study programmes, natural sciences and studies include e.g. mathematics, geology, geography, chemistry, physics and informatics, i.e. programmes that are often perceived as technical programmes.



development of companies or even entire industries. The timely identification of aptitude for studying technical programmes would minimise the occurrence of this phenomenon and the inefficiently spent costs for the professional preparation of pupils and students.

However, the decline in the quality of students can also be observed at universities (Leisyte et al., 2011; NTF, 2011), which have expanded their capacities in line with the Bologna Process, despite the above facts. This could be illustrated using the trends in the number of students at universities, which almost doubled over ten years (2001–2011) and reached almost 400 thousand students (the number of employees of universities increased by about a quarter). Within the age group of 20–29 years, 12% of people were studying at a university in 2001; while in 2011 it was more than 27% (Research, Development and Innovation Council, 2013). It is also notable that, as in the case of secondary schools, universities have not undergone any optimisation in terms of the relative proportions of the different study programmes, so that the proportion of students of technical and some natural science programmes relatively decreased, while the capacities of social-science study programmes increased. In the future, this will lead to significant problems in technical areas, namely when it becomes necessary to replace retiring university-educated employees (Kopicová, 2013; NTF, 2011).

In terms of research, development and innovation, the most interesting group comprises students of doctoral programmes as these represent the most important source of new researchers. However, many universities have significant difficulties in attracting sufficient numbers of qualified candidates and, in response to that, they are recruiting 90–95% of doctoral students from among the graduates of their own master's study programmes. The rate of successful graduation from doctoral study programmes ranges between 25% and 45%, and the most frequent causes of non-completion include the low amounts of doctoral scholarships and starting a work career outside the university. On the other hand, 75% of successful graduates prefer staying at their respective institution in a researcher position (Leisyte, L. et al., 2011). Doctoral study programmes as such take place on an individual basis, i.e. the student cooperates with the instructor who plays the role of a mentor in performing the study and research and development tasks of the student.

In 2011, students of doctoral programmes accounted for 6.5% of the total number of students. This value ranks the Czech Republic among top countries within the EU (Research, Development and Innovation Council, 2013). However, if we take into account the low rate of successful completion of this education level, the number of graduates from doctoral programmes is slightly below the OECD average (OECD, 2013b). While the proportion of students of technical and natural science programmes is 26% for bachelor's and master's programmes, in the case of doctoral programmes it is 48%. This means that almost half of all students of doctoral programmes study technical or natural sciences, which is the highest share of technically oriented doctoral students within the EU (Research, Development and Innovation Council, 2013) and a very high share among OECD countries (OECD, 2013b). On the other hand, the share of students with this orientation in bachelor's and master's programmes is insufficient, which negatively affects the development and innovative potential of technically oriented companies. Given the limited number of available jobs in university and government research, it is also necessary to focus on developing doctoral students' soft skills that are required in the private sector, because the lack of these skills often limits their employability outside the public sector (Leisyte et al., 2011). The low level of foreign and inter-sector mobility of doctoral students is another factor that significantly limits their employability, regardless of whether they chose to work in the public or private sector after completing their studies.

## **Causes of the problem**

- Support (methodological, knowledge, financial etc.) for identifying each pupil's aptitude for success in different areas of human activity (business, research and development, art etc.) is neither sufficient nor is it adequately followed up by individual work with the pupil (e.g. in the form of mentoring, individual planning of personal development etc.) in order to prepare them to make maximum use of their natural talents.
- The attempts to make the highest level of education accessible to the largest number of persons possible (without a corresponding increase in resources for teaching) results both in the decline in the average scholastic aptitude of university students (this also applies to pupils of selective facilities within the regional education sector) and in the unification of the approach to these students. Ultimately, this translates into a decline in the average quality of the outputs of education (NTF, 2011). The above factors very negatively influence the possibilities for the intensive and individualised development of talented individuals, which mainly occurs in areas that are perceived as a path to a prestigious profession or, on the contrary, as the least demanding way to obtain formal education.
- The higher number of students in schools and, in turn, the relatively lower number of students with high scholastic aptitude makes it difficult to identify those who might be suited for inclusion in scientific training in the form of doctoral study programmes (Leisyte, L., et al., 2011). Their success rate is also influenced by the quality of work of their instructor, which differs greatly among individual instructors, and by their willingness to accept low income during the period of their studies.

## **Consequences of the problem and the risks resulting from failure to address it**

- The continuation of current trends, including the unification of teachers' approach to pupils and students, will further limit the effective utilisation of the productive potential of the Czech Republic's human resources, and the guidance of pupils to the most suitable study programmes and areas. This would not only help in achieving high productivity of individuals, but there would also be a positive impact on the currently unbalanced structure of school graduates in terms of their disciplines, which translates into a shortage of graduates from technical and natural science programmes that are employable under real-world conditions. Also, support for entrepreneurial talent would contribute to creating a strong domestic entrepreneurial background. The importance of the above is underlined by the fact that increased efficiency of human resources represents one of the most important sources of economic growth.
- The facts mentioned above will also negatively impact on the quality of human resources in research and development, because individuals with a high aptitude for this work will not have been developed from their early youth in order to reinforce their talents and teach them to apply them in practice (regardless of whether they eventually use them in research or another area).

### **3.3.4. Problem area 3: Shortage of quality human resources for R&D**

At the end of 2011, a total of 55,697 full time employees (FTE) worked in research and development in the Czech Republic, which means 82,283 physical persons. Most of these employees were working in the business sector (53%, mainly in the manufacturing industry and services), university research (27%, with a dominant focus on technical and natural sciences), and government research (20%, with a dominant focus on natural sciences). Correspondingly, out of the total number of 2,720 R&D

facilities, 48% employ fewer than 5 employees (FTE) and 17% employ 5–9.9 employees; by contrast, 9% employ more than 50 employees (Research, Development and Innovation Council, 2013). An international comparison shows that the Czech Republic has an average number of R&D employees within OECD countries (OECD, 2013b) – the number is higher than average in the government sector (similarly to other post-communist countries) and lower than average in the university sector, and equal to average in the industrial sector (Research, Development and Innovation Council, 2013).

Researchers account for 55% of all employees in R&D and the second largest group comprises technical staff who account for 31% of employment in this sector. In three out of four cases, researchers do R&D in the area of technical and natural sciences, which corresponds to the specialisation of doctoral students (see above). Foreigners are rather rare in Czech R&D, as out of the 82.3 thousand individuals employed in this sector, only 3.5 thousand do not have Czech citizenship, of which 1,500 are Slovaks (Research, Development and Innovation Council, 2013).

The Czech Republic has about 10 employees in R&D (FTE) per 1,000 employed persons, which is below the European average of about 11 employees. In some countries (Finland, Denmark) this share is twice as high. The situation is similar in the case of researchers. The Czech Republic has 6 researchers (FTE) per 1,000 employees, whereas the European average is 7 researchers. However, in Norway, Japan, Sweden, South Korea, Denmark and Finland this figure is almost three times as high (Research, Development and Innovation Council, 2013).

Given the autonomy of the business sector in issues relating to recruiting, developing and using human resources in R&D, further attention is focused on the university and government sectors. The most important source of new employees in research are an organisation's own doctoral graduates (their significance as a source of human resources will continue to grow in the future) and other research organisations in the region (Leisyte et al., 2011). This indicates that this labour market segment focuses inwards and has a certain territorial limitation, despite the fact that the selection of new employees is fully in the hands of each research facility. Ultimately, this significantly limits the creation of new stimuli not only for research, but also for the further development of the institutions. The above may also lead to lower quality of recruited human resources: 30–40% of employees in government and university research consider the shortage of qualified academic staff to be one of the obstacles to R&D in the Czech Republic, which may be reinforced by the similarly perceived quality of the HR development and management systems of the various institutions (Leisyte et al., 2011).

From this perspective, it is appropriate to ask whether the salary, working, technical and other conditions of academic facilities constitute factors that discourage job applicants from other sources. The study by Leisyte et al. (2011), which presents the general results of an evaluation of work and salary conditions in public research organisations, indicates relatively high general satisfaction of R&D employees, especially in terms of working conditions and opportunities for career growth. The respondents were least satisfied with the salary conditions and the working conditions when compared to foreign countries. In-depth analysis of salaries in this sector revealed that salaries at lower academic positions were only slightly higher than the average salary in the Czech Republic, whereas higher academic positions had salaries comparable with average salaries of managers in the business sector. The international comparison indicates that average salaries of Czech researchers are slightly below the EU-25 average (European Commission, 2007). However, when looking at the

structure of the countries in this comparison, it is obvious that attracting researchers from more developed countries is not possible under common salary conditions.

This is also confirmed by the statistics on the nationality composition of the 3.5 thousand foreign researchers working in the Czech Republic as mentioned above. These mainly include Slovaks, Ukrainians and Russians – in addition, the conditions for a career in Czech research is also interesting for Indians. By contrast, the main destinations of migrating Czech researchers are the USA, Germany, the United Kingdom, France and Switzerland. They are mainly attracted there by the opportunity to gain new experience (83%), improve their qualifications (57%), better working conditions (43%), a specific research area (38%), and better financial conditions (33%). The income level, career opportunities and social environment for research in the Czech Republic then become the factors that prevent them from returning (Leisyte et al., 2011). Language skills, contacts with foreign research organisations and insufficient funding of foreign trips were not identified as significant factors hindering international mobility. By contrast, these included concerns about losing work after a longer-term interruption of employment and teaching at the home university. For the above reasons, short-term mobility (up to 3 months) tends to be preferred, which – however – is considerably less effective in terms of personal development (Leisyte et al., 2011). Mobility between public institutions in research and the business sector is also low. The cause can be seen mainly in the insufficient competencies of researchers in public institutions for work in the business sector (e.g. deficiencies in problem solving or entrepreneurship) and – to a lesser extent – in the impossibility to interrupt their career for a prolonged period (Leisyte et al., 2011).

In terms of the lack of openness, one specific problem is the low participation of women in research activity<sup>138</sup>. At present, women account for 60% of university graduates and 44% of doctoral students; however women account for only 27.4% (headcount) or 24.7% (FTE) among researchers, (Tenglerová, 2014). In 2012, this proportion was the lowest since 2001, i.e. since gender statistics have been published. Also, the Czech Republic has the lowest proportion of women in decision-making groups throughout Europe (European Commission, 2013b). Due to inadequate conditions, Czech research is losing a substantial portion of potential talent.

### **Causes of the problem**

- HR management in the various research institutions and universities does not correspond to current needs and trends. In some institutions, the planning and implementation of personal development, evaluation of employees as well as the recruitment of new employees are of insufficient quality.
- New human resources for R&D, including new doctoral students, are recruited within a stable (and rather self-contained) group of people that is defined by its affiliation with a specific region or research sector. As a result, the same people tend to be “recycled” and no “new blood” is drawn into the system (e.g. the involvement of practitioners is minimal).
- Although increasing the number of doctoral graduates is more than desirable (while maintaining or improving their quality), their employability in the university and government sectors is highly limited. Insufficient development of knowledge and skills that are crucial for the business sector complicates their employability in private research.

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<sup>138</sup> This fact is also pointed out in the conclusions of the International Audit (<http://audit-vav.reformy-msmt.cz/aktuality/zaverecna-zprava-z-audit-u-systemu-vyzkumu-vyvoje-a-inovaci-v-cr>).

- The international and sector mobility of R&D employees is relatively low, especially due to concerns about losing their job during a longer-term stay outside their home organisation. However, there are some other barriers to mobility such as insufficient awareness, financial resources, language skills etc.
- The insufficient involvement of researchers from other countries represents another example of the lacking transfer of stimuli from outside. In this case, mainly short-term stays of teachers in the Czech Republic are used, because the academic environment is unable to offer competitive salaries to experts from developed countries. However, there are some other obstacles such as administrative problems associated with visas, inadequate facilities for families of the foreign researchers etc.
- In the area of *gender discrimination*, there is no programme to promote gender equality in research at the national level, and there are no effective tools to facilitate bringing together the private and professional obligations of young researchers (both men and women). Despite repeated references to this problems in strategic documents, no systematic care has been given to this problem either at the level of state institutions or at the level of most research organisations.

#### **Consequences of the problem and the risks resulting from failure to address it**

- The insufficient utilisation of the possibilities of modern HR management in the various research organisations will result in conserving the existing situation in recruiting new employees and developing existing employees. As a result, no adequate stimuli will be generated to change the current situation.
- Recruiting new employees of research organisations mainly from among a relatively closed group of people (most frequently doctoral graduates from the university in question or researchers from other research organisations within the region) often fails to bring sufficient incentives for further development of research and the research organisation. In the long-term, this situation may result in the stagnation of the development of organisations that mainly use this type of recruitment, and in a decline in the quality of human resources in these organisations, i.e. in connection with the perceived decline in the quality of doctoral graduates. The absence of persons from corporate practice may result in the limited ability to commercialise the outcomes of R&D.
- If the problem of gender imbalance continues to be disregarded, there may be a significant *loss of the human potential of Czech female researchers*. In the future, this deficiency needs to be addressed through specific measures to facilitate the inclusion of women in research positions.
- The insufficient development of soft and entrepreneurial skills will continue to hinder both the employability of doctoral graduates in corporate research and cooperation of research organisations and the business sphere. This situation negatively affects the utilisation of the potential of all of the parties mentioned above.

#### **3.3.5. Digital agenda in human resources**

Development in ICT is related not only to the development of ICT infrastructure but also to the development of the population's digital literacy. If the digital literacy of the Czech Republic's population is not sufficient, investments in ICT infrastructure will only bring marginal results.

Therefore, the development of horizontal competencies in IT is crucial at all levels of the education system<sup>139</sup>, including further education and education of the oldest portion of the population. Only a digitally literate society will be able to compete in the coming information and digital economy.

The Czech Republic is one of the countries that advocate Internet freedom – in practical terms, this means minimal regulation of the Internet. This puts increased demands on Internet users because, in addition to basic digital literacy, they must be able to critically evaluate the content and self-control its use. The Czech Republic is one of the average EU countries in terms of the proportion of Internet users with medium to high competencies in its use. A digitally literate and critically thinking society can much more easily protect itself against the threats awaiting less-knowledgeable users in the virtual world.

Compared to other EU countries, the share of Czech households with an Internet connection is slightly below average (63% in the Czech Republic, 67% in the EU27), while Internet coverage in rural areas is at the average level. Likewise, Internet coverage of companies is at the average EU level.

However, the question is not Internet coverage alone, but also the level of its actual usage. In this respect, we can focus on its usage for shopping and communication with authorities. In the Czech Republic, roughly 40% of users shop over the Internet. This value is significantly lower when compared to the EU (57% of users), the USA (66% of users) or South Korea (94% of users). Also, the usage of Internet for communication with the authorities is one of the Czech Republic's weaknesses. The share of the population that uses the Internet for communication with authorities or even for filing forms is one of the lowest within the EU. Less than 20% of the Czech population uses the Internet for communication with the authorities and 4% for filing forms. However, the above situation is also caused by the fact that the online availability of services for the citizens is the seventh worst in the European Union.

## **3.4. Social innovations**

### **3.4.1. Introduction**

Social innovation is not a new topic, as people have always sought new solutions to pressing social problems. However, there is a growing influence of factors that further increase the importance of social innovation. The most important ones include the increasing global competition, the changing position of Europe in this competition, including the impact of its ageing population, the harsh impacts of the financial crisis on employment, especially among young people, the impacts of climate change etc. As a result, there is a need for new solutions in a wide range of social areas, i.e. not only in the social and health care systems, employment policy and education, but also in the promotion of entrepreneurship, industrial policy and the development of cities and municipalities in order to ensure the sustainability of the quality of life and employment opportunities for the population. Within this effort, social innovation can help as a social laboratory in which new solutions to these societal challenges are developed and tested in a creative and positive spirit. The European Union and its member states need such an environment very much (European Commission, 2012; Guide to

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<sup>139</sup> The Ministry of Education, Youth and Sports is preparing a strategic plan entitled Digital Education/Touch Your Future, which aims to include the latest digital technology in teaching across the Czech Republic.

Social Innovation). Social innovation is of strategic importance and it is dependent on a developed culture of partnership and cooperation.

The European Union is characterised by the coexistence and interaction of several levels of government – national (member states), supranational (EU) and sub-national (regional and local authorities), where this coexistence and interaction constitutes the essence of what we call multilevel governance (MLG). But this is not just about a simple transformation of goals adopted at the European or the national levels into activities at the regional or local levels, but also about aligning objectives at the regional and local levels with European strategies. At the same time, MLG strengthens accountability of sub-national authorities in the national context and encourages their participation in the implementation of Community policies (White Paper on Multilevel Governance 2009/C 211/01).

In the state, business and civil sectors of OECD countries, there is increasing cooperation and partnerships are established to encourage economic development, employment and social inclusion. Well-functioning partnerships are an effective tool to effectively address complex social challenges and they often operate with a high innovation potential. Countries often support these partnerships and sometimes help establish them; such established organisations then help ensure that political decisions take greater account of the local needs and have greater impact in real life. Partnership activities have a wide scope: they can promote cooperation between actors of local development, contribute to greater synergy between the various initiatives and suggest ways to improve current practices. They address strategic planning, set out common goals to achieve better results and apply the local development strategy in practice. For local partnerships to fulfil their mission, substantial effort is required in order to generate confidence among all actors and ensure their full involvement.

### **3.4.2. Problem area 1: Insufficient use of partnership co-operation and creativity of key actors in addressing complex social challenges**

#### **Manifestations and subproblems**

- Underdeveloped culture of multi-sectoral and multi-level governance.
- Insufficient degree and intensity of partnership co-operation between relevant institutions at both the horizontal and vertical levels, where such co-operation is necessary.
- Unclear or sluggish demand of the public sector towards the professional community and the civil society for new solutions to complex social challenges.
- Slow response of the public sector to the opportunity to use new forms of cooperation and creative solutions to social problems on the part of actors within the professional community and the civil society.
- By contrast, social innovation outside the public sector is developing dynamically, often based on inspiration from abroad, as evidenced by the existence of demand and supply that can be built upon.

#### **Causes and evidence**

- While the division of the “playing field of social needs” among key actors at central, regional and local levels increases transparency (who is responsible for what), it also reinforces

“departmentalism” and limits partnership co-operation in cases where it is needed for integrated solutions to complex social problems.

- In the Czech Republic, there is no infrastructure for the development and dissemination of social innovations; the public sector has never clearly declared its interest in creating and further using new solutions (i.e. innovation demand).
- The level of awareness of social innovations and their benefits is low, and so is the amount of financial resources that are provided for the strategic support of social innovation (MLSA, 2014; Operational Programme Employment).

### **Consequences**

- The limited degree of co-operation among the key actors at the horizontal level, especially at the central level that is the most distant from addressing specific problems in the places where the people live, negatively affects the systemic and strategic framework for co-operation and the search for optimal solutions at regional and local levels.
- Low involvement of well-proven prototype solutions to social and strategic problems in the mainstream or relevant policies at the national level (up-scaling and mainstreaming). Insufficient use of the creative potential of the population in order to find smart solutions to complex social problems



### 3.5. SWOT analysis

Strengths	Weaknesses
<b>Entrepreneurship and innovation</b>	
<ul style="list-style-type: none"> <li>• Industrial and technical tradition associated with the technical creativity supporting technical incremental innovations</li> <li>• Multi-industry sector of flexible (contract-oriented) suppliers with developed competencies in the area of production and technical development</li> <li>• Position in the geographical centre of Europe – over 200 million customers with a high purchasing power can be served within a one-day truck drive from Prague</li> <li>• The price-quality ratio of technically qualified experts, especially in engineering (including automotive and aerospace industry), electric engineering and IT</li> </ul>	<ul style="list-style-type: none"> <li>• Complex and unstable regulatory framework for enterprise (complexity, frequent and poorly predictable changes, administrative demands, investor protection etc.)</li> <li>• Low innovation demand in the area of higher-order innovations. Minimal number of endogenous companies able to push technological boundaries in their area.</li> <li>• High dependence of economic development on activities of foreign companies (dependence on the business strategies and decisions of foreign companies)</li> <li>• Insufficiently developed entrepreneurial culture and non-technical competencies of companies (strategic management, marketing, innovation management etc.)</li> </ul>
<b>Research and development</b>	
<ul style="list-style-type: none"> <li>• Growing trend in public expenditure on R&amp;D (despite the economic crisis)</li> <li>• Significantly concentrated investments, and improvement in equipment with instruments and in the condition of research infrastructures thanks to support by the EU Structural Funds (R&amp;D centres from OP RDI)</li> <li>• Inclusion of several infrastructure projects from the Czech Republic in projects of the pan-European ESFRI network, including ELI Beamlines (the only ESFRI project based in the Czech Republic)</li> <li>• Existence of the concept of support for large infrastructures and the Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic</li> <li>• Slightly growing demand for research cooperation on the part of the business sector (due to growing business R&amp;D expenditure – interest in graduates and project cooperation)</li> <li>• Existence of research teams of international quality in several areas with immediate application potential (instruments and instrument equipment, nuclear physics and technology, engineering and aerospace, computer sciences, mathematics, selected sub-areas of chemistry, electric engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Inadequate governance of the system of R&amp;D policy management (unclear responsibilities and roles: strategic/advisory vs. executive/implementation)</li> <li>• Administrative burden</li> <li>• Deficiencies in strategic management and absence of a research strategy in RO, deficiencies in managerial and strategies competencies of the management staff of RO</li> <li>• Low inclusion of women in RO management</li> <li>• Deficiencies in public administration performance in the area of research, development and innovation, quality evaluation, and insufficient preference for high-quality research</li> <li>• Too low share of institutional financing, excessive dependence of research on grants – difficult planning of research, financial uncertainty and instability of RO</li> <li>• Low attractiveness of research career to talent from the Czech Republic and abroad</li> <li>• Lack of openness of the environment, in-breeding, conservative culture in RO</li> <li>• Lagging behind (in quality and modernisation) of research infrastructure in Prague, even though Prague concentrates most R&amp;D capacities</li> </ul>

Strengths	Weaknesses
<p>and telecommunications, clinical medicine and biomedical sciences)</p> <ul style="list-style-type: none"> <li>• Existence of extensive diaspora, the alumni network of Czech research organisations</li> <li>• High-quality academic ICT infrastructure combined with high-quality scientific background for its administration and development</li> </ul>	<ul style="list-style-type: none"> <li>• Duality in the financing of R&amp;D (especially of infrastructure) between the regions and Prague, due to the prevailing use of ESIF for this purpose, whose possible use does not correspond to the distribution of R&amp;D capacities in the Czech Republic.</li> <li>• Low interaction between RO and the business sector</li> <li>• Generally inadequate preparedness of RO for cooperation with the practical sector at all levels (institutions, specialised auxiliary facilities/Technology Transfer Office, research teams, individual researchers)</li> <li>• Low demand for results of public research by domestic and foreign companies</li> <li>• Low relevance and focus of research; low practical fulfilment of research priorities, absence of long-term strategic and problem-oriented programmes of R&amp;D</li> <li>• Low publicity and awareness of high-quality results of R&amp;D in the Czech Republic and abroad</li> </ul>
<b>Human resources</b>	
<ul style="list-style-type: none"> <li>• Above-average level of numerical literacy and average level of reading literacy and the ability to address problems in a technologically demanding environment in the adult population (good baseline for further development)</li> <li>• High interest of doctoral students in technical and natural sciences</li> <li>• High interest of doctoral graduates in R&amp;D work</li> <li>• ICT skills of graduates are perceived as sufficient by employers</li> </ul>	<ul style="list-style-type: none"> <li>• Absence of defined results of education</li> <li>• Lacking system for the nationwide evaluation of the quality of teaching</li> <li>• Significant differences in the results of education between schools and regions</li> <li>• Persisting poor level of reading, numerical and natural science literacy among pupils at age 15</li> <li>• Insufficient development of soft competencies in schools</li> <li>• Insufficient level of foreign language skills, especially in graduates from technical and natural science programmes</li> <li>• Negative approach of Czech pupils and students to schools</li> <li>• Low interest of above-average students in studying at pedagogical faculties and in teaching careers</li> <li>• Low focus of pedagogical programmes on practice</li> <li>• University teachers are not obligated to develop their pedagogical skills</li> <li>• Lacking or inadequate contact of teachers and students with practice</li> <li>• Lacking system for identifying and working</li> </ul>

Strengths	Weaknesses
	<p>with talent</p> <ul style="list-style-type: none"> <li>• Insufficient assistance to pupils and students in identifying their professional preferences and subsequently selecting suitable education</li> <li>• Lack of high-quality graduates from technical and some natural science programmes at all levels of the education system</li> <li>• Low rate of successful completion of doctoral studies that, despite the above-average number of doctoral students, results in a below-average number of graduates</li> <li>• Large increase in the number of university students without a corresponding increase in the number of university employees</li> <li>• Compared to developed countries, a below-average number of researchers and employees in R&amp;D</li> <li>• Low proportion of women in research, and inadequate attention paid to this problem at the level of RO and public administration</li> <li>• HR management at the various research institutions and universities does not reflect current needs and trends (frequent recruitment of employees from a sector- and region-limited group of persons, insufficient international and regional mobility, low involvement of foreign researchers)</li> </ul>
<b>Social innovation</b>	
<ul style="list-style-type: none"> <li>• Dynamic development of social innovation outside the public sector</li> </ul>	<ul style="list-style-type: none"> <li>• Absence of a clear public-sector demand for innovative solutions to social problems</li> <li>• Slow response of the public sector to possible solutions to social problems on the part of actors within the professional community and the civil society</li> <li>• Limited room for partnership co-operation between relevant actors, which is needed for integrated solutions to complex social problems</li> <li>• Insufficient amount of financial resources for strategic support for social innovation</li> </ul>
<b>Digital agenda</b>	
<ul style="list-style-type: none"> <li>• Declining price/cost of Internet connection and equipment increases users' demand for the use of digital services</li> <li>• Effort of ISP to quickly develop high-speed next-generation networks (i.e. LTE/4G)</li> <li>• Good quality of research related to the areas of e-infrastructure and ICT, leading to</li> </ul>	<ul style="list-style-type: none"> <li>• Underdeveloped physical infrastructure for expanding broadband Internet connections (especially outside metropolitan areas)</li> <li>• Low usage of digital technologies for communication between business partners</li> <li>• Lack of access to scientific information in digital form, in the form of specialised</li> </ul>

Strengths	Weaknesses
<p>commercially successful results and synergistic links between research facilities and business activities</p> <ul style="list-style-type: none"> <li>• High usage of eGovernment services by companies</li> <li>• Introduction of modern digital technologies into teaching in schools</li> </ul>	<p>databases and electronic scientific journals</p> <ul style="list-style-type: none"> <li>• Low usage of the Internet by the population to communicate with public administration, which is also associated with poor access to these services for citizens in electronic form and their poor user-friendliness</li> <li>• Inadequate and slow progress in eGovernment and low usage of these services within individual authorities/offices and in internal communication</li> </ul>

### External analysis – factors that influence the Czech Republic and its NIS

Opportunities	Threats
<b>Politics and legislation</b>	
<ul style="list-style-type: none"> <li>• The adoption of the Act on Public Service, provided that it improves expertise in public administration</li> <li>• The use of new tax advantages for companies in acquiring R&amp;D results from research organisations</li> <li>• New Civil Code</li> <li>• Changes that support a more flexible labour market, higher flexibility of employment, including part-time employment</li> <li>• Changes in the institutional funding of RO that give priority to commercially applicable results and the quality of results over quantity.</li> </ul>	<ul style="list-style-type: none"> <li>• Instability of the political scene that decreases the credibility of the Czech Republic to foreign partners, investors and domestic companies</li> <li>• Corruption and the influence of interest groups on decision-making in public administration</li> <li>• Changes in the tax system that worsen the conditions for the business sector and enterprise in the Czech Republic</li> <li>• Frequency and unpredictability of regulatory changes for entrepreneurs and research organisations</li> <li>• Complexity of the system of Structural Funds administration, high transaction costs</li> <li>• Frequent and unpredictable changes to the administration of the Structural Funds – uncertain environment for beneficiaries</li> <li>• Loss of the population's confidence in political decision-making / democratic principles of government</li> <li>• Ineffective and poor enforceability of law in the Czech Republic, growing distrust in the law enforcement system</li> <li>• Implementation of ill-conceived reforms and changes to key systems – education and universities, pension system, ...</li> <li>• Bureaucratic system strongly undermining the efficiency of institutions at all levels, including companies (this includes both the agenda relating to the core activities, and activities associated with the setting-up of companies, etc.)</li> </ul>

Opportunities	Threats
<b>Economic and financial</b>	
<ul style="list-style-type: none"> <li>• Accession to the Eurozone – reduction of transaction costs for companies, higher attractiveness of the Czech Republic to investors</li> <li>• Interest among foreign companies in investing in activities that have higher added value in Central European countries</li> <li>• Open innovation: demand of MNC for innovations creates room for high-quality companies with high-quality activities</li> <li>• Reintegration of the value chain: co-location of production plants of suppliers with own production plants</li> <li>• Concentration of R&amp;D activities of MNC: acquisition of additional activities that follow or serve production, including R&amp;D and strategic business services or any part thereof</li> <li>• Re-industrialisation – the return of production activities to traditional regions, including Europe</li> <li>• Shift in global demand, growing demand on the eastern markets where the Czech Republic has a good reputation</li> <li>• Growth of business opportunities in new and emerging markets in Asia, South America and Africa</li> <li>• Distributed knowledge networks – the use of competencies of Czech R&amp;D teams in specific knowledge domains for the needs of the global innovation demand</li> </ul>	<ul style="list-style-type: none"> <li>• High growth rate of the Czech Republic's debt and failure to address the structural causes of debt<sup>140</sup></li> <li>• Growing demand for raw materials and energy resources – growing prices, dependence of the Czech Republic on imports</li> <li>• Concentration of R&amp;D activities of MNC: <ul style="list-style-type: none"> <li>- R&amp;D activities will concentrate outside the Czech Republic</li> <li>- if plants not requiring knowledge-based production remain in the Czech Republic, there is a risk of their relocation to countries with cheaper inputs or close to the R&amp;D activities of MNC</li> </ul> </li> <li>• Loss of competence in traditional and specialised areas</li> <li>• Growing competition from East Asian countries in industrial areas that are based not only on cheap workforce, but also on knowledge- and technology-intensive activities</li> <li>• Weak innovation demand of the public sector – the state and the public administration do not support innovative solutions in the area of their competence, they do not order them from potential suppliers</li> <li>• Strong economic linkage to the European Monetary Union, negative impacts on the Czech Republic if German export weakens</li> <li>• Increase in non-tariff barriers to international trade</li> <li>• European regulation: <ul style="list-style-type: none"> <li>- excessive transposition – goldplating, impacts on manufacturing companies</li> </ul> </li> <li>• Reduced ability of companies to foresee changes and new trends at the global level</li> </ul>
<b>Social and demographic</b>	
<ul style="list-style-type: none"> <li>• Interest among talented foreigners in work/career in the Czech Republic: <ul style="list-style-type: none"> <li>- from countries eastward of the Czech</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Population ageing and poor sustainability of the pension<sup>141</sup> and health care systems from the state budget perspective</li> </ul>

<sup>140</sup> According to the latest data, government debt (% of GDP) increased by 0.2 pp in 2013. In 2014 and 2015, the Ministry of Finance expects it to decrease to 43.9% and 42.2% of GDP respectively.

Opportunities	Threats
<p>Republic</p> <ul style="list-style-type: none"> <li>- from countries in Southern Europe</li> <li>- relocation of interest outside Prague as well (to cities, towns for career, if it exists)</li> </ul> <p>Everything depends on the development of knowledge-intensive activities, opportunities for young people</p> <ul style="list-style-type: none"> <li>• Positive impacts of population ageing – new business opportunities (products and services)</li> <li>• Qualitative change of the “typical citizen in retirement age” – active in both social and economic life</li> <li>• Growing number of people seeking self-realisation beyond material security (consequences include the development of entrepreneurship and the social benefits of the activities implemented)</li> </ul>	<ul style="list-style-type: none"> <li>• Size and age structure of the population – the number of people aged 8–18 is half the number people aged 35–45, which causes: <ul style="list-style-type: none"> <li>- a gradual change in the lifestyle and values, different attitude to consumption and work</li> <li>- loss of talent, low numbers of university students – also fewer students of technical secondary schools</li> </ul> </li> <li>• Persistently declining quality of graduates and the growing proportion of humanities-oriented graduates, along with the retirement of experienced employees will result in a lack of workforce demanded by the industry (in terms of both areas and depth of knowledge)</li> <li>• The drain of talented and highly qualified employees from the Czech Republic (brain drain)<sup>142</sup></li> <li>• Reduced need for human labour due to productivity growth</li> <li>• Social instability in society due to increasing gaps (increased perception of gaps) between population groups – perception of social divide, growth of “secondary” and “grey” labour market</li> <li>• Bad image of entrepreneurs in the society</li> <li>• Low attractiveness of the entrepreneurial career, high sensitivity to perception of entrepreneurial risk</li> <li>• Deteriorating conditions for disadvantaged population groups (mothers after maternity leave) – their poor access to qualification-intensive segments of the labour market, loss of potential experts</li> </ul>
<b>Technological</b>	
<ul style="list-style-type: none"> <li>• Continuing digitalisation and automation and development of advanced production technologies, and subsequent change in production chains</li> <li>• Changes to transport processes in the different transport modes (e.g. autonomous means of transport in mass and individual passenger transport) and transport systems (transport in big cities) will change the demand for solutions in the production of</li> </ul>	<ul style="list-style-type: none"> <li>• High costs for intellectual property protection in Europe</li> <li>• New technologies for natural gas and crude oil extraction (slate gas and oil) – reduced energy prices, ultimately the shift of production to areas with cheap labour</li> <li>• Growing energy costs due to support for RES – transfer of (energy-intensive) productions to countries with lower costs (i.e. not only lower costs of energy), loss of the potential</li> </ul>

<sup>141</sup> The sustainability of the pension system will be partially covered by the extension of life expectancy for the next 20–25 years.

<sup>142</sup> Negative overall balance of talent.

Opportunities	Threats
<p>transport means</p> <ul style="list-style-type: none"> <li>• Growing pressure on the use of primary agricultural resources. Ensuring sufficient raw materials for food and fuels in the long-term</li> <li>• Energy production decentralisation. Growing importance of renewable energy sources and their technologies</li> <li>• New IT technologies for more efficient organisation and operation of the economy and society <ul style="list-style-type: none"> <li>- new technologies for processing, retaining and transmitting large volumes of data</li> <li>- IT system solutions for developing “smart cities” infrastructure</li> </ul> </li> <li>• New approaches in health care and treatment of diseases: <ul style="list-style-type: none"> <li>- drugs adapted to the specific needs of the patient</li> <li>- earlier and faster diagnosis in health care (reducing costs across the system)</li> </ul> </li> </ul>	<p>of innovation demand in some areas</p> <ul style="list-style-type: none"> <li>• Digitalisation and automation of production – lower use of non-specialised workforce</li> </ul>

## 4. Research and economic specialisation of the Czech Republic

### 4.1. Introduction: the concept of specialisation

In the context of the Czech Republic, smart specialisation needs to be understood as a tool to orient public investment and create suitable framework conditions in the area of creating and using knowledge and innovation, in order to reinforce competitive advantage within the global economy. The objective of smart specialisation is to establish a unique combination of capacities, knowledge and skills based on the existing economic and social potential of the country and the knowledge base, where it is crucial to strengthen the critical mass and diversification within the specialisation, i.e. to use existing assets and knowledge in new areas of application.

Although smart specialisation includes both investment in public research and investment in corporate innovation, its success is dependent on the involvement of actors that are aware of the potential market applicability of new knowledge and innovations and are able to identify new opportunities for innovation activities in both the private and public sectors<sup>143</sup>. If this condition fails to be met, it is neither possible to expect that innovations will be implemented in the sense of products and services benefiting the customers and society (in the case of public consumption) nor is it possible to expect any improvement in competitiveness.

The logic underlying the selection of specialisation areas also needs to be viewed in this context, i.e. economic specialisation that reflects the existing (i.e. to date) competitive advantage is crucial. The competitive advantage may be based on the cost efficiency, geographical location (which, in the case of the Czech economy, represents the prevailing sources of the competitive advantage to date) or on expertise, knowledge and innovation ability within a segment of economic activity. In terms of smart specialisation, a competitive advantage that is based on expertise and innovation ability plays a crucial role.

The existing research specialisation in the public sector needs to be viewed as a source of impulses for applications that may become an important source of competitive advantage. However, this is only possible if knowledge sources are properly linked to economic activities in the private, public and non-profit sectors.

In terms of defining smart specialisation areas, it is necessary to distinguish between two key effects that are decisive for identifying potential new opportunities for application. On the one hand, there are *social challenges*, and on the other hand, there are *knowledge domains* that represent often unintended consequences of the economic and social development to date, with which we have to cope as a society.

In terms of smart specialisation *social challenges* represent external stimuli that may take the form of social and economic needs and threats but, at the same time, that produce opportunities for innovative solutions, including technological and social innovations. Therefore, they can be regarded as demand-based stimuli for which there is no adequate supply of solutions yet. For the purposes of smart specialisation in the Czech Republic, social challenges are defined – with a link to the trends

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<sup>143</sup> See the definition of smart specialisation and the *entrepreneurial process of discovery* in Guide to Research and Innovation Strategies for Smart Specialisations (RIS3) (p. 8) that emphasises reinforcement of the competitive advantage of a country/region. <http://s3platform.jrc.ec.europa.eu/s3pguide>



and objectives identified in the National Priorities of Oriented Research, Experimental Development and Innovation<sup>144</sup> – as follows:

- Competitive knowledge-based economy
- Sustainability of the energy sector and material resources
- Environment for quality life
- Social and cultural challenges
- Healthy population
- Safe society

*Knowledge domains* represent a set of findings and technological abilities of a generic, cross-cutting nature with a wide spectrum of potential applications in many areas of both private and public consumption. For the purpose of smart specialisation under the conditions existing in the Czech Republic, knowledge domains are defined in accordance with the definition of Key Enabling Technologies<sup>145</sup> as follows:

- **Advanced materials**
- **Nanotechnology**
- **Micro- and nanoelectronics**
- **Photonics**
- **Advanced manufacturing technologies**
- **Industrial biotechnology**<sup>146</sup>

Knowledge in these areas alone does not represent a source of competitiveness unless it is used creatively for specific applications defined by both the private, public or non-profit sectors. However, the ability to acquire and further develop such knowledge also represents a key prerequisite for implementing radically new technological solutions and higher-order innovations, for the ability to improve the position of the companies in global value chains, and for ensuring the long-term efficiency of the public sector. From the perspective of specific innovations and application solutions, expertise in each knowledge domain represents a key input for creating the supply of potentially available solutions.

However, at the same time, further research focusing on the use of knowledge in these knowledge domains needs to be oriented towards topics that have been defined by both the public sector (especially with respect to social challenges) and private business entities. Therefore, these purely technological knowledge domains have been extended to include **the social-science knowledge needed for non-technical innovations** (i.e. knowledge needed for identifying the changing needs of the demand from the public and private sectors, especially social-science knowledge that constitutes a key prerequisite for marketing and organisational innovations and for innovation management in

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<sup>144</sup> See <http://www.priority2030.cz/>.

<sup>145</sup> The European Commission defines Key Enabling Technologies (KETs) as technologies that are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly skilled employment. See Commission Communication COM (2012) 341 final.

<sup>146</sup> Knowledge domains, conceived as *Key Enabling Technologies* (KETs), are – in their nature – close to *general purpose technologies* as defined in the document entitled *National Priorities of Oriented Research, Experimental Development and Innovation* (<http://www.vyzkum.cz/FrontClanek.aspx?idsekce=653383>). For the purposes of defining the specialisation areas, the concept of key knowledge domains was brought in line with the concept applied by the European Commission.

general). Non-technical innovations constitute key knowledge that is needed for defining the problems, whose solution may be facilitated by technological knowledge, and – in their nature – form a cross-cutting knowledge domain that is relevant for most application areas (in industry, services, public and private sectors). Furthermore, the **knowledge domain for digital economy and cultural and creative industries**<sup>147</sup> has been added. For the purposes of the Smart Specialisation Strategy, knowledge for cultural industries includes knowledge and skills in applied and industrial design, visual (graphic and fashion design, painting etc.) and performing arts (music, dance etc.) and knowledge and skills in traditional and modern living culture that can be used in the cultural industries. Knowledge for the digital economy includes knowledge for new media, publishing and media, digital content processing, and audio-visual production.

In the case of knowledge domains and social challenges, the public sector and public investment in research and innovation plays a dual irreplaceable role. It fulfils the function of the investor that needs to ensure the existence of the corresponding level of fundamental knowledge and expertise in the knowledge domains that are important in terms of the long-term competitiveness of the economy and effectiveness of public administration, including making sure that corresponding mechanisms are in place to link the supply of knowledge with the demand from users. On the other hand, the public sector should be a partner that defines – in cooperation with the corporate sector – the key social challenges to be preferentially addressed and directs public resources correspondingly. The public sector may facilitate the above through supporting the development of new applications and solutions to problems in cooperation with the corporate sector or through an effort to directly provide new applications and solutions in areas where the public sector plays the role of an important client (e.g. in the area of public and semi-public goods such as health care, environmental protection, education, food sufficiency). In addressing social challenges, it can be assumed that there is a need for combining technological expertise from different knowledge domains with in-depth knowledge of an area, including knowledge for non-technical innovations.

By contrast, the private sector has an irreplaceable role in *identifying the application themes* (through the *entrepreneurial process of discovery*) aimed at innovations, new products and services that can succeed within specific market niches<sup>148</sup>. This may include both the use of new findings within each knowledge domain, and solutions that are based on already available technologies but provided in a new way, or on solutions of a non-technical innovation nature that, however, may substantially contribute to the competitiveness of the economy, especially in services.

On the one hand, smart specialisation must provide sufficient investment in knowledge domains that are necessary for maintaining and reinforcing the existing competitive advantage, but it must also

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<sup>147</sup> This area has been defined in line with the Programme Declaration of the Government from February 2014, where this area is referred to as a specific strategic priority of the Czech Republic's R&D policy (see <http://www.vlada.cz/cz/media-centrum/dulezite-dokumenty/programove-prohlaseni-vlady-cr-115911/>). In line with UNESCO's definition, creative industries are defined as "sectors of organised activity whose principal purpose is the production or reproduction, promotion, distribution and/or commercialisation of goods, services and activities of a cultural, artistic, or heritage-related nature" (see <http://www.unesco.org/new/en/santiago/culture/creative-industries/>).

<sup>148</sup> While in the case of knowledge domains, the further development of knowledge usually takes place in areas with low technological maturity, at the level of clarifying and verifying basic principles in the sense of *technology readiness levels* 1 to 4, in the case of most innovation activities of companies this involves research that is closer to market application (technology readiness levels 5 to 9). For details, see e.g. EC (2013): *Innovation – How to Convert Research Into Commercial Success* (<http://s3platform.jrc.ec.europa.eu/guides>).

create conditions for developing new application areas and opportunities, including those that will respond to the social challenges identified. Last but not least, smart specialisation needs to define (within the priority areas of economic specialisation) tools to ensure closer links between companies and research organisations as the bearers of expertise in the various knowledge domains.

The following text analyses the economic specialisation of the Czech Republic, including an analysis of the knowledge intensity of each economic sector, which provides elementary guidance for identifying strong companies whose future technological and innovative needs are determinative for selecting the specialisation areas. Also, the text describes the existing areas of research specialisation, which provide an insight into the knowledge domains that can be used as a potential source of the Czech Republic's competitive advantage.

In addition to the analyses that have been carried out for the purposes of this strategy, and in addition to the documents mentioned above, some **documents that had been prepared specifically for that purpose** were used in proposing the specialisation domains of the Czech economy: (i) The working draft of the main conclusions of the analytical foundation for establishing the research specialisation of the Czech Republic, prepared by the Technology Centre of the AS CR for MEYS Group III, and (ii) MIT priorities for the area of industrial R&D and innovation – working version, prepared by MIT from June to September 2014.

## 4.2. Specialisation of the Czech Republic

### 4.2.1. Economic specialisation

The Czech Republic is a small, open economy. Despite short-term fluctuations that are related to the economic cycle, the share of exports in GDP has been growing in the long-term. In 2013, exports totalled CZK 3,174 billion, which accounts for 77.7% of the GDP<sup>149</sup>. Therefore, an export analysis is the initial step for identifying smart specialisation domains. Through the export analysis, we identify the main areas in which the Czech Republic's economy is competitive at the international level. Within these areas, we further identify main product groups in which the Czech economy has an important international position.

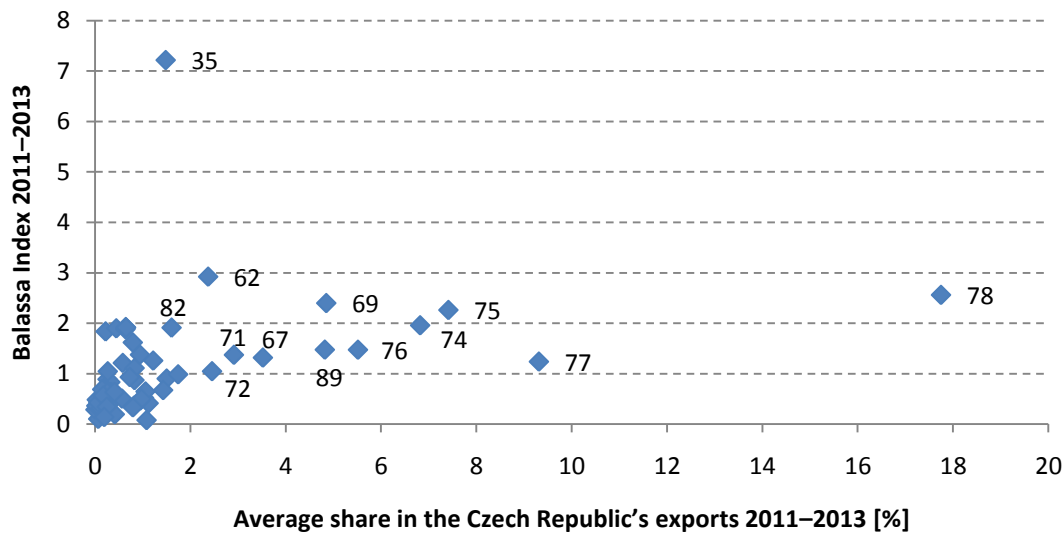
The first step in the export analysis is the identification of the SITC 2<sup>150</sup> product classes with the highest share in the Czech Republic's exports. In order to eliminate the effect of year-to-year fluctuations, share in exports is calculated as the average share in 2011–2013. Share in exports is an indicator of the significance of individual product classes for the Czech economy. The second step is the calculation of the revealed comparative advantage for the SITC 2 product classes. As before, the year-to-year fluctuations are eliminated by using the average for 2011–2013. The comparative advantage is measured using the Balassa Index (hereinafter the BI) where the numerator contains the share of the SITC 2 class in the Czech Republic's exports and the denominator represents the share of the same SITC 2 class in total world exports. The result of the first two steps is shown in **Ошибка! Источник ссылки не найден.** below.

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<sup>149</sup> The value is based on foreign trade statistics (cross-border concept). In 2012, exports amounted to 75.9% of GDP, in 2000 only to 47.3% of GDP (CZK 1,121 billion).

<sup>150</sup> SITC 2 – Standard International Trade Classification SITC 2 denotes the level of detail of classification, i.e. two digits.

Chart 4: Export specialisation of the Czech Republic at the level of SITC 2 classes



Source: Own calculations based on data from UNCTAD and CSO (database of foreign trade). Note: For better understanding, SITC 2 class codes are only used for export items that clearly exceed the values achieved by most export items.

**Ошибка! Источник ссылки не найден.** demonstrates that the main drivers of Czech exports are (i) automotive industry – SITC 78, (ii) electrical engineering and electronics industry – SITC 75, 76 and 77, and (iii) mechanical engineering industry – SITC 71, 72 and 74. Items within the metal-working industry (SITC 69) and metallurgical industry (SITC 67) also have a significant share in exports. The extent and export power of the last two industrial areas shows a strong background for the mechanical engineering, automotive and electrical engineering<sup>151</sup> industries. Field surveys of the corporate sector showed that especially the automotive industry – as a sophisticated customer – increases<sup>152</sup> the transnational competitiveness of these traditional industrial areas, which have a large share in employment. As a result, the dominant automotive, electrical engineering and mechanical engineering industries represent – to a large extent – the drivers of the internal restructuring of other traditional industrial areas. At the same time, they support export from related areas. This applies for example to SITC 62 “Rubber manufacturers, n.e.s.”, which is largely due to the concentration of tyre manufacturers (not only for vehicles). A specific example is SITC 89 “Miscellaneous manufactured articles, n.e.s.”. However, this is a highly varied structure of difficult-to-classify products<sup>153</sup> that cannot be regarded as a specific area. The high share of this item in exports and the BI (a value slightly above 1) corresponds to the Czech Republic’s very broad

<sup>151</sup> The metallurgical and metal-working industries are sources of important modules and components e.g. for products in heavy-current electrical engineering (e.g. generators, electric motors etc.), automotive frames, machines etc.

<sup>152</sup> Companies in the automotive industry push very strongly on reducing unit costs and, in turn, improving production efficiency and absorption of modern technologies in their suppliers (see Berman Group, 2010: An analysis of the material priorities and the needs of the different areas within the responsibility of the MIT for the purposes of targeting support from the EU Structural Funds in the next programming period 2014+). These companies, often in the metal-working, metallurgical and plastics industries, have gradually achieved a high production efficiency, which has allowed them to successfully penetrate into other markets outside the automotive industry.

<sup>153</sup> From medical products to pens and pencils, from costume jewellery to ornamental products for tourists. However, the area of medical products and aids shows particularly interesting dynamism.

manufacturing base that is oriented towards European markets<sup>154</sup>. Another specific item is electricity (SITC 35). The Czech Republic ranks among top world exporters of electricity, and it significantly strengthened this position over the monitored period (see Table 1 below).

**Table 1: SITC 2 classes with the highest share in Czech exports**

Export item – SITC 2		Share in Czech exports (%)		Balassa Index (BI) in CR	
Code	Title	2002–2004	2011–2013	2002–2004	2011–2013
<b>78</b>	<b>Road vehicles</b>	<b>15.53</b>	<b>17.75</b>	<b>1.68</b>	<b>2.56</b>
<b>77</b>	<b>Electrical machinery, apparatus &amp; appliances n.e.s.</b>	<b>10.20</b>	<b>9.31</b>	<b>1.17</b>	<b>1.23</b>
<b>75</b>	<b>Office machines &amp; automatic data processing equip.</b>	<b>5.79</b>	<b>7.42</b>	<b>1.15</b>	<b>2.26</b>
<b>74</b>	<b>General industrial machinery &amp; equipment, and parts</b>	<b>6.61</b>	<b>6.82</b>	<b>1.78</b>	<b>1.95</b>
<b>76</b>	<b>Telecommunications &amp; sound recording apparatus</b>	<b>3.65</b>	<b>5.52</b>	<b>0.81</b>	<b>1.47</b>
89	Manufacturers of metal, n.e.s.	5.58	4.85	2.67	2.39
<b>69</b>	<b>Miscellaneous manufactured articles, n.e.s.</b>	<b>4.20</b>	<b>4.82</b>	<b>1.15</b>	<b>1.47</b>
67	Iron and steel	4.34	3.52	1.67	1.31
<b>71</b>	<b>Power generating machinery and equipment</b>	<b>3.03</b>	<b>2.92</b>	<b>1.20</b>	<b>1.37</b>
62	Rubber manufacturers, n.e.s.	3.16	2.46	1.21	1.04
72	Machinery specialised for particular industries	2.29	2.37	3.15	2.92
82	Furniture and parts thereof	2.51	1.61	2.51	1.91
<b>35</b>	<b>Electric current</b>	<b>0.66</b>	<b>1.48</b>	<b>3.23</b>	<b>7.22</b>
x	Share of items 1 – 5 in Czech exports	41.77	46.82	-	-
x	Share of items 6 – 10 in Czech exports	20.31	18.57	-	-
x	Share of top 10 items in Czech exports	62.08	65.39	-	-

Source: Own calculations based on data from UNCTAD and CSO (database of foreign trade). Note: SITC 2 classes in which the BI increased over the period under review are indicated in bold

Table 1 shows that the aggregate share of the five most important SITC 2 classes has increased by 5 pp over the past ten years. By contrast, the aggregate share of the sixth to tenth most important items slightly decreased. Together with the trends in the BI values, the data document an increase in the level of specialisation of the Czech economy in the period under review.

In the global economy, dynamic development also takes place in the export of services. However, the Czech Republic is lagging behind in this area. While the Czech Republic's share in world exports of goods is close to 1%, for services this is only 0.5%<sup>155</sup>. This difference documents the relative underdevelopment of the sector of the services in the Czech Republic as compared to top OECD countries and it is in line with the conclusion that the main driver of the Czech economy is the manufacturing industry<sup>156</sup>, namely the industrial areas mentioned above. The volume of the export of services is an order of magnitude lower than the export of goods. The Czech Republic has a comparative advantage in services that are associated with transport and travel (see Table 2 below), which corresponds to the Czech Republic's geographical position in the centre of Europe. From the RIS3 perspective, one important and growing part within this item is logistics<sup>157</sup>. This is an area whose development is largely driven by the development of industrial areas. On the other hand, the

<sup>154</sup> Berman Group (2010): An analysis of the material priorities and the needs of the different areas within the responsibility of the MIT for the purposes of targeting support from the EU Structural Funds in the next programming period 2014+.

<sup>155</sup> Calculated based on UNCTAD data (<http://unctadstat.unctad.org>).

<sup>156</sup> International Competitiveness Strategy of the Czech Republic for 2012–2020.

<sup>157</sup> A one-day trip of a truck dispatched from Prague may service a market of about 200 million people whose purchasing power is very high in global comparison.

conditions for the development of logistics and related services represent a significant part of the overall conditions for the development of the manufacturing industry and services relating to customer care<sup>158</sup>. Transport and especially logistics can thus be perceived as a specific part of the Czech Republic's specialisation that is mainly based on the above industries.

**Table 2: Balassa Index of types of export services, Czech Republic vs. world; three-year averages**

	Category	Average 02–04		Average 09–11		BI	
		CZ	World	CZ	World	Average 02–04	Average 09–11
	Services total	100	100	100	100	1	1
<b>1</b>	<b>Transport</b>	<b>27.07</b>	<b>21.58</b>	<b>24.03</b>	<b>20.22</b>	<b>1.25</b>	<b>1.19</b>
<b>2</b>	<b>Travel</b>	<b>43.80</b>	<b>28.78</b>	<b>34.30</b>	<b>24.55</b>	<b>1.52</b>	<b>1.40</b>
3	Other services	29.13	49.62	41.67	55.03	0.59	0.76
3.I	Telecommunication services	2.03	2.34	2.52	2.51	0.87	1.01
3.II	<b>The building industry</b>	<b>1.44</b>	<b>2.07</b>	<b>3.66</b>	<b>2.72</b>	<b>0.69</b>	<b>1.35</b>
3.III	The insurance sector	0.07	2.66	1.27	2.48	0.03	0.51
3.IV	Financial services	3.18	6.41	0.35	7.34	0.50	0.05
<b>3.V</b>	<b>IT and information services</b>	<b>1.47</b>	<b>3.94</b>	<b>6.89</b>	<b>5.61</b>	<b>0.37</b>	<b>1.23</b>
3.VI	Intellectual property rights and licence fees	0.55	6.11	0.49	6.63	0.09	0.07
3.VII	Other corporate services	17.91	22.82	25.38	25.15	0.78	1.01
<b>3.VIII</b>	<b>Personal, cultural and recreational services</b>	<b>1.95</b>	<b>0.98</b>	<b>0.92</b>	<b>0.81</b>	<b>1.98</b>	<b>1.14</b>
3.IX	Public services n.e.c.	0.53	2.28	0.18	1.77	0.23	0.10
5	Market services total	99.47	97.72	99.82	98.23	1.02	1.02

Source: Own calculations based on data from UNCTAD

Transport and travel account for over 58% of total exports of the services. Their share in Czech exports of services is declining, especially in the case of travel. For both, the BI value slightly decreased over the period under review, but it still remains greater than 1. Tourism, which is partly included in item 2 Travel, is specific in terms of the RIS3. Given that, except for Prague, the Czech Republic does not have any significant attractions of international significance that would also generate important export income of national importance, tourism will be a specialisation at regional rather than national level.

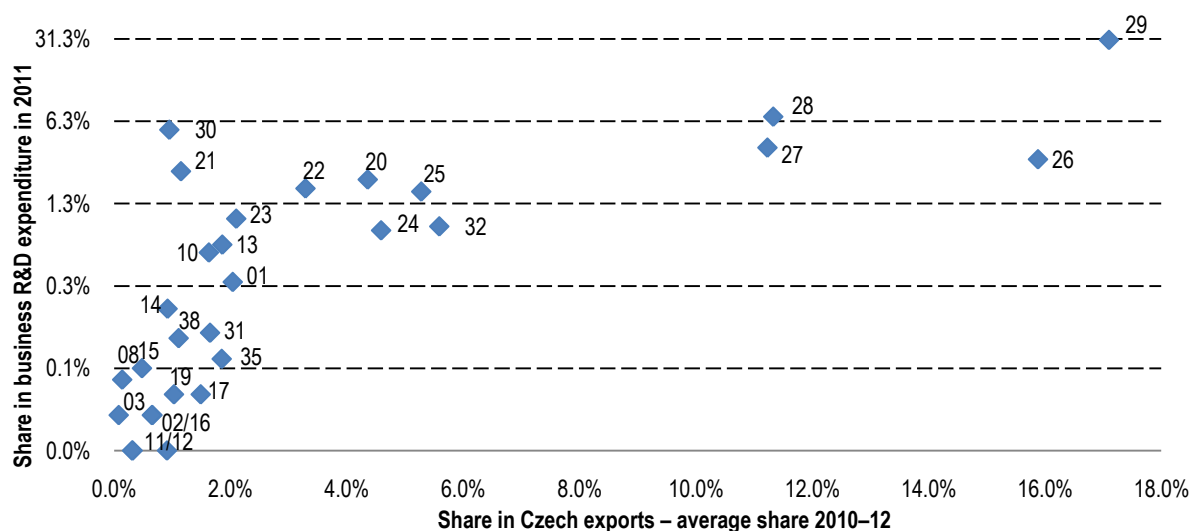
In contrast, IT services have experienced a significant increase in BI. Moreover, IT reports the highest rate of the long-term growth of the export of services. Over the past decade, the share of this category of services in total exports of services increased from 1.5% to almost 7% (see Table 2 above). This trend is attributable both to the development of activities of global centres of customer services, and the dynamic development of enterprise in SW development and related services. Given the nature of IT services, which also include a wide range of supporting services necessary for implementing the export of industrial goods, the area of IT services and digital economy services (including software development) may be regarded as one of the key branches of the Czech economy. Further growth of knowledge-intensive services, including IT services, can be considered a necessary prerequisite for further increasing the value of Czech exports and improving the position of

<sup>158</sup> Over the past decade, services related to the trend of growing individualisation of consumption and customer care have been developing. One example may be the provision of customised surgery sets to hospitals where the surgery sets include instruments and devices (manufactured in different countries) custom-made for surgeons that do surgeries in the given hospital. In this way, hospitals in surrounding countries (e.g. in Germany) are also served from the Czech Republic.

Czech companies in global value chains. Besides IT services, cultural and creative industries<sup>159</sup> also need to be included among important areas of services with a high export orientation.

In addition to export importance, the next step assesses the importance of areas in terms of their share in corporate expenditure on research and development (R&D). To this end, export data according to SITC 2 items have been recalculated according to the NACE classification, which is used to structure data for most indicators, including indicators of corporate R&D capacities. A comparison of the importance of NACE sections according to their share in exports and business R&D expenditure is shown in **Ошибка! Источник ссылки не найден.** below.

**Chart 5: NACE sections by their share in Czech exports and business R&D expenditure, 2010–2012**



Source: Own calculation based on CSO (Research and development) and UN COMTRADE data

Note: Titles of sections and data are listed in the annex. Through expert matching, export data in SITC 2-digit classification were converted to the NACE 2-digit structure of economic activities. For maximum accuracy, export data in a SITC 4-digit classification were also used for some NACE items. Business R&D expenditure: Only non-capital expenditure is included in order to avoid distortion due to extraordinarily large capital expenditure.

**Ошибка! Источник ссылки не найден.** confirms the dominant export importance of the automotive (NACE 29), electronics (NACE 26), mechanical engineering (NACE 28), and electrical engineering (NACE 27) industries. With respect to share in business R&D expenditure, the automotive industry dominates the domestic economy, accounting for about one third (30.6%) of R&D expenditure in the corporate sector. On the other hand, this position is largely attributable to Škoda Auto a.s., the biggest Czech exporter that significantly contributes to this item. It is followed by mechanical engineering with a 7% share in business R&D expenditure, and manufacture of other transport equipment (5.3%). The combined share of the electrical engineering and electronics industries in business R&D expenditure amounts to 6.7%. Other industries with relatively significant shares in business R&D expenditure include the pharmaceutical industry (NACE 21), chemical industry (NACE 20), metal-working industry (NACE 25), and rubber production (NACE 22). In terms of

<sup>159</sup> See for example the Good Country Index, which identifies the Czech Republic as one of the top countries globally with respect to the relative intensity of the export of cultural goods relative to the size of the national economy (for details, see UNCTAD (2010): Creative Economy: A Feasible Development Option. Report 2010, (www.goodcountry.org).



knowledge intensity, the manufacture of medical products (NACE 325) is also an important sector. Its share ranges from 1.5% to 2.3% of business R&D expenditure. This specialisation is also reflected in the participation and success in projects of the Seventh Frame Programme, where the Czech Republic has mainly been historically successful in thematic priorities ICT, Nanosciences, nanotechnologies, materials and new production technologies (NMP), and Transport (including aerospace<sup>160</sup>) – within these priorities, the Czech Republic also reports significant involvement of companies (Hebáková, Granger, 2013).

The comparison of industries according to knowledge intensity is affected by significant differences between individual industries with respect to the innovation regime and the need for inputs to the innovation process in the form of the results of research and experimental development. These differences are reflected in the very varied levels of business R&D expenditure relative to generated GVA, by industry. Therefore, the significantly higher R&D expenditure relative to GVA in the chemical and pharmaceutical industries as compared to the food and metal-working industries does not necessarily mean that the former two are more innovative or ambitious in terms of technological innovation. Table 3 below compares the knowledge intensity of selected industries in the Czech Republic with the knowledge intensity of the same industries in OECD countries. The values show that NACE 30 – Manufacture of other transport equipment is the only industry with above-average knowledge intensity. The automotive industry (NACE 29) is slightly below average. The pharmaceutical industry (NACE 21) is lagging behind more significantly, but it still reaches about 80% of the average intensity in OECD countries (see Table 3 below).

**Table 3: Knowledge intensity in selected industries – Czech Republic vs. OECD average**

NACE	NACE – Description	BERD share in GVA (average for 2006–2009)		
		Czech Rep.	OECD countries	OECD=100
21	Manufacture of pharmaceutical products and preparations	25.34	30.20	83.9
30	Manufacture of other transport equipment	12.19	8.92	136.7
29	Manufacture of motor vehicles	7.71	8.54	90.3
26/27	Manufacture of computer, electronic and optical products / Manufacture of electrical equipment	4.25	14.52	29.3
28	Manufacture of machinery and equipment	3.04	6.24	48.7
20	Manufacture of chemicals and chemical products	2.37	8.69	27.3
22	Manufacture of rubber and plastic products	1.26	3.27	38.4
24	Manufacture of basic metals; metallurgy; casting	0.83	2.27	36.4
25	Manufacture of fabricated metal products	0.53	1.15	46.0
13/14/15	Manufacture of textiles, wearing apparel, leather and related products	1.11	1.96	56.7
10/11	Manufacture of food products, beverages	0.33	1.04	31.1
17	Manufacture of paper and paper products	0.02	1.37	1.4
23	Manufacture of other non-metallic mineral products	0.85	1.51	56.4
	HI-TECH manufacturing industry – combined	12.06	25.02	48.2

Source: STI Database OECD. Note: 1: BERD = Business Expenditure on R&D, GVA = Gross Value Added.

Note: According to the definition used by OECD ISIC Rev. 3, the aggregate hi-tech manufacturing industry includes the following industries: aircraft and spacecraft; pharmaceuticals; office, accounting, and computing machinery; radio, television, and communications equipment; medical, precision, and optical instruments. The knowledge intensity of the

<sup>160</sup> The term refers to an industry dealing with technologies for air transport and the aerospace industry.



business sector has increased in the Czech Republic since the period under review, which is why the values in Table 3 should not be overestimated.

Note: The knowledge intensity of the business sector has increased in the Czech Republic since the period under review, which is why the values in Table 3 should not be overestimated. No newer data is available.

In other industries, the knowledge intensity of the business sector is far below the OECD average in the Czech Republic. This is particularly important in the case of the main export industries, namely in the mechanical engineering (NACE 28), electrical engineering/electronics (NACE 26 + 27), metal-working (NACE 25) and metallurgical (NACE 24) industries. In these industries, the share of business R&D expenditure in generated GVA is less than half of the level common in OECD economies. This fact is documented by the overall position of the Czech economy in the area of innovations, which is characterised by:

- the dominance of innovations in the form of absorption of foreign technology over innovations based on own technologies / technical knowledge
- the low number of companies operating at the technological boundary of their industry that are able to generate higher-order technological innovations that are new to the market
- dependence on large foreign companies, the vast majority of which have most of their R&D capacities outside the Czech Republic

The above characteristics of the business sector result in low innovation demand in the area of higher-order innovations, which limits the potential for research co-operation and technological transfer between companies and research organisations.

Given that transport means<sup>161</sup> are basically machines that are fitted with latest electronics and use many electrical-engineering components, the above presentation of data on exports and business R&D expenditure can be summarised as follows: *the economic performance of the Czech Republic is based on industrial production, with the decisive position of industries relying on knowledge and technologies in the field of mechanical engineering, electrical engineering, and electronics. An important part of these application industries are information technologies and related services<sup>162</sup>, which are an integral part of modern technologies in mechanical engineering, electrical engineering and transport systems.* In addition to the automotive industry, which is the dominant driver for a major part of companies in the mechanical engineering, electrical engineering and other supply industries, other drivers include industries such as power engineering and investment units for the petrochemical, metallurgical, mining and mechanical engineering industries. A large portion of the overall production in mechanical engineering and electrical engineering “ends up” in these industries. The importance of power engineering and investment units lies, among other things, in the good image of “Made in Czech” in the emerging markets of post-Soviet countries and some countries in Asia. In addition to these traditional industries, the manufacture of drugs and medical products, i.e. an industry with a relatively high knowledge intensity and growing economic dynamism, is becoming important in terms of specialisation at the national level.

The automotive, mechanical engineering, electrical engineering and related IT industries, as well as the manufacture of drugs and medical products are the main industries in many other countries. It is therefore important to identify specific branches within these industries that represent the main competitive power of the economy. These branches, i.e. the companies within these branches, are

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<sup>161</sup> Be it cars, aeroplanes or buses.

<sup>162</sup> The share of relevant NACE 62 and NACE 63 in business R&D expenditure exceeds 10%.

important for identifying the knowledge domains whose development will be the focus of smart specialisation.

Overall, based on the above combination of available empirical data on the one hand (data on export intensity, intensity of R&D expenditure, trends in turnover in time), and based on the on-going process of entrepreneurial discovery that was launched in 2013 at the regional level on the other hand, it is possible to identify the areas of the economic specialisation in which the Czech Republic shows above-average growth potential. These include **manufacture of transport means, mechanical engineering, electronics and electrical engineering, IT services and software, electricity production and distribution, drugs and medical products**<sup>163</sup>.

It needs to be emphasised that virtually all identified application areas (except for IT services and, in part, health services and care) are manufacturing industries. This reflects the current economic specialisation of the Czech Republic and, in the future, it is desirable to orient the research specialisation correspondingly. However, this must not lead to the wrong conclusion that only industrial production should be supported. On the contrary, given the increasing global commodification of manufacturing activities, it is desirable to **increase the share of related qualified services** (for example construction, testing, design, customised development, consulting services, or marketing services) in the Czech Republic's economic performance.

Within these application areas, there are Czech business entities that show high knowledge intensity, positive economic dynamism, and promising potential for the future. These areas represent the concentration of key knowledge-intensive and innovation activities of businesses, which have been identified – using the entrepreneurial discovery process – from the regional level and verified through data analyses at the national level. These are the application areas<sup>164</sup> in which specific knowledge and technological competences are applied on a large scale and which should be developed and strengthened in the future within the Smart Specialisation Strategy.

#### **Manufacture of transport means and equipment**

Passenger cars and their components (lights, combustion engines, transmissions, brakes etc.), development, design, construction and testing

Aircraft, particularly ultra-light aircraft, their components, development, design, construction and testing

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<sup>163</sup> This conclusion is also consistent with the conclusions of the analytical findings of the Ministry of Industry and Trade (2014) – the document entitled Priorities of the Ministry of Industry and Trade for the area of industrial research, development and innovation from September 2014 that identifies the following priorities: 1. transport means and their components; 2. advanced manufacturing and mechanical-engineering technologies; 3. electronics, electrical engineering, optics, photonics, ICT and related IT services; 4. special machines and equipment and precision devices; 5. advanced materials, technologies for their processing; 6. new chemical technologies, procedures and products, biotechnology and drugs; 7. technologies for the aviation and aerospace industries. Unlike the RIS3, the approach of the Ministry of Industry and Trade's document, does not distinguish between application areas and knowledge domains in which there is potential for applying knowledge in generic, enabling technologies across a larger number of application areas.

<sup>164</sup> However, this is not an exhaustive list but rather an overview of the application areas identified so far, which should not be overlooked. On-going additions and refinement should be a permanent part of the entrepreneurial discovery process, which will be coordinated from the national level throughout the implementation of RIS3 by the national RIS3 manager.

Space technologies<sup>165</sup>, including their use outside space applications

Electric vehicles and electric drive units

Rail vehicles and their components, development, design, construction and testing

Materials with low energy and material demands

Communication and security systems, electronic control and information systems, development, design, construction, testing

### **Mechanical engineering**

Power engineering (turbines, boilers, combustion and gasification equipment etc.)

Engineering and design for investment units

Manufacturing equipment in mechanical engineering, mechatronic systems, machining and forming machines and tools

Precision mechanics and metering technology

Pumping equipment

Textile machines

Progressive materials and technologies for their processing, surface finishing

Design activities, modelling, simulation

Optimisation of manufacturing processes

### **Electronics and electrical engineering**

Industrial automation, communication, identification, control equipment

Robotics, artificial intelligence

Switching technology, circuit breakers, switches, distributors

Microelectronics

Analytical, metering and scientific devices

Electric motors and electric rotary machines and devices

Optics, optoelectronics, lasers and their applications

### **IT services and software**

Network technologies and network security

Antivirus SW

Database, information and expert systems, enterprise SW

Creative IT services, digital media (engineering and architectural services, computer games, audio-visual and promotional services)

Internet services and mobile applications

Computer modelling, virtual prototyping

Applications based on the products of space systems

### **Electricity production and distribution**

Production and conversion of energy, devices for energy production and distribution

Transmission and management of production and transmission of electricity, smart energy networks

Performance electronics, heavy-current electrical engineering

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<sup>165</sup> Space technologies are formally included as a part of the manufacture of transport means, but – in fact – their use is reflected in many other industries and sectors and, conversely, space technologies use the results of and inputs from many other industries and knowledge domains.

Nuclear power engineering  
Mining and use of coal  
Renewable energy sources, use of waste for energy recovery  
Energy materials  
Low-carbon technologies and energy savings  
Energy optimisation of activities for transport and transport security

#### **Drugs and medical products and methods**

Medical equipment and aids  
Implants and medical replacements, biologically active materials  
Diagnostic devices  
Drugs, pharmacology  
Health services and care (spa and balneology, clinical studies, bio-statistics etc.)

In addition to six application themes derived from the economic and innovation dynamism of relevant application areas, an additional seventh theme was added to reflect the need for innovations in the area of natural resources, agriculture and food<sup>166</sup>. This is an area in which the Czech Republic currently has no immediate comparative advantage on an international scale, but it is reasonable to assume that the area is critical with respect to maintaining long-term competitiveness and preventing risks (sustainability of development, resource security and sufficiency) that may jeopardise prosperity of the economy and society in the long-term. Within this theme, too, narrower application areas have been identified that show significant dynamism in terms of the new findings produced and the applications achieved.

#### **Natural resources, agriculture and food**

Separation and remediation technologies for the environment and the food industry  
Technologies for water and soil processing, purification and treatment and for waste processing  
The food industry and food security  
Agricultural and food technology (biotechnology, microbiological procedures etc.)  
Production of alcoholic beverages (incl. brewing) and related supply chains  
Freshwater aquaculture and fish processing

In addition to specifying in detail the application areas within the national economic specialisation, region-specific specialisations were also identified from the regional level that should also be considered in setting up future interventions as part of implementing the Smart Specialisation Strategy. The following table summarizes the territorial aspect of the areas of national economic specialisation and an overview of region-specific specialisations that – even though they go beyond the national specialisation – represent significant application areas on a regional scale. For a more detailed description of the region-specific areas of economic specialisation, see the different regional annexes to the National RIS3 Strategy.

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<sup>166</sup> Empirically, the identification of this application theme relies on the conclusions of the *Working draft of the main conclusions of the analytical foundation for establishing the research specialisation of the Czech Republic* (TC AS 2014), and on priority 3 as defined in the document entitled *National Priorities of Oriented Research, Experimental Development and Innovation*.



**Table 4: Presence of key areas of knowledge application (economic specialisation) in the Czech Republic's regions**

		Self-governing regions													
		PRG	CB	SB	PL	KV	UL	LB	HK	PA	VYS	SM	OL	ZL	MS
Areas of national specialisation	Manufacture of transport equipment	X	X	X	X	X		X	X	X	X	X	X	X	X
	Mechanical engineering	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Electronics and electrical engineering	X	X	X	X	X		X	X	X	X	X	X	X	X
	IT services and software	X			X				X	X		X		X	X
	Electricity production and distribution	X	X	X	X	X	X		X		X	X			X
	Drugs and medical products	X	X		X				X	X		X	X		X
	Natural resources, agriculture and food		X	X	X	X		X	X				X		
Areas of region-specific specialisation															
	Chemistry and chemical industry		X			X	X			X			X		
	Glass, ceramics					X	X	X							
	Rubber and plastic industry					X			X				X		
	Media	X													
	Textile							X	X	X					

#### 4.2.2. Research specialisation

Research activities in the Czech Republic cover a wide spectrum of directions and, to a certain degree, they cover all key knowledge domains (or KET) – material research, nanotechnology, micro- and nanoelectronics, photonics, advanced manufacturing technologies, and industrial biotechnology. In most knowledge domains, the Czech Republic has a research base of sufficient quality that is able to produce internationally competitive results and that can be a high-quality partner to the application sector in identifying new application directions and technological solutions. However, in an international comparison, the publication and patent outputs indicate three knowledge domains with above-average parameters. These include **photonics, advanced materials and, to a lesser extent, nanotechnology** (Kučera and Vondrák, 2014), where the former two areas achieve higher values in both publication and patent parameters, while nanotechnology has low values.

However, this finding alone is not sufficient for assessing whether above-average publication outcomes have a potential for use in innovations. Nevertheless, they indicate that there are Czech research facilities in these areas that produce new findings that are well received internationally. These facilities should not be overlooked as key partners in identifying new opportunities within innovation platforms and the entrepreneurial discovery process.

When examined in a more-detailed classification of areas, the Czech Republic shows mostly below-average values compared to the world average. Above-average levels with respect to measurable

parameters (i.e. primarily bibliometric characteristics)<sup>167</sup> are only achieved by Czech research activities in two scientific areas (instruments and instrumentation, and energy science and technology), and in about forty narrowly defined sub-areas<sup>168</sup>. The areas, in which the Czech Republic consistently achieves above-average values in the form of quotation response<sup>169</sup> and, at the same time, the total scientific production achieves the minimum number of publications<sup>170</sup>, include both areas that have immediate links to the areas of the Czech Republic's current economic specialisation, and areas where, conversely, there is only weak linkage to economic areas with a potential for using research results in applications<sup>171</sup> (see Table 5 below that shows areas with an above-average RCIO, i.e. greater than 1).

The first category includes, above all, the following research areas: instrumentation (instruments and instrumentation and microscopy), physics and material sciences and power engineering (especially nuclear physics, nuclear sciences and technology), some sub-areas of chemistry and chemical engineering (spectroscopy, electrochemistry, textile materials, applied chemistry), computer sciences (computer sciences and software engineering), areas of electrical engineering and telecommunications (automation and control systems, telecommunications), areas of mechanical engineering (mechanical and aerospace engineering, general engineering), and biomedical areas (medicinal chemistry, toxicology, medical laboratory technologies). In these areas, there are – in the Czech Republic – both strong research teams and potentially complementary companies in economic sectors that show positive dynamism in the form of exports and investments in R&D and can be expected to be interested in applying the results of research organisations. Direct links between knowledge domains of the above research areas and sub-areas can be expected in the following sectors: manufacture of transport equipment, mechanical engineering, electrical engineering and electronics, and manufacture of drugs, but also in some other narrower market niches such as manufacture of scientific and analytic instruments, special textiles, chemical engineering etc.

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<sup>167</sup> While we need to be aware of the numerous methodological limitations (e.g. different weight of co-authorship of articles depending on the publication practice in each area, different presence of Czech journals among the periodicals registered under WOS in different areas), bibliometric indicators in exact sciences are a rather reliable, internationally comparable indicator of the quality of the research activity. By contrast, specialisation with respect to patent activity has not been considered for this purpose due to the minimal number of international patents applied by Czech entities (40 to 50 each year in the case of the European Patent Office, and even fewer in the case of the US Patent and Trademark Office).

<sup>168</sup> This is a classification of areas used by WOS Thomson Reuters. The data is taken from the bibliometric analysis of publications with Czech authors (or co-authors) for 2003–2009: Vaněček, J. (2011): *A map of the research and application potential of the Czech Republic: Field and institutional analysis of R&D results in the Czech Republic*. (<http://www.vyzkum.cz/FrontClanek.aspx?idsekce=15138>).

<sup>169</sup> The analysis relies on assessment based on the RCIO relative citation index that shows the average citation rate of publications of authors and co-authors from a given country relative to the world average for the given field. These are the results of bibliometric analyses for 2003–2009.

<sup>170</sup> Generally, it needs to be taken into account that research in the Czech Republic in the vast majority of areas lacks critical mass, in most of the branches, the Czech Republic's share in global publication production exceeds 1% only in three sub-areas (nuclear, molecular, and chemical physics; nuclear sciences and technology; ecology).

<sup>171</sup> See Žižalová, P. (2011): *A map of the research and application potential of the Czech Republic: Assessment of application potential* (<http://www.vyzkum.cz/FrontClanek.aspx?idsekce=15138>).

**Table 5: Above-average cited sub-areas in the Czech Republic.**

Top-level field	Sub-field	Field RCI in the Czech Rep.	No. of publications in the Czech Rep.	Share of publications in the field worldwide (%)	Share of publications in the Czech Rep. (%)
AGRICULTURE AND FOOD SCIENCE	SOIL SCIENCE	1.208	157	0.696	0.207
BASIC MEDICAL SCIENCES	CHEMISTRY, MEDICINAL	1.008	355	0.595	0.468
BIOLOGICAL SCIENCES	ORNITHOLOGY	1.193	76	1.071	0.100
BIOLOGICAL SCIENCES	MARINE & FRESHWATER BIOLOGY	1.088	367	0.638	0.483
BIOLOGICAL SCIENCES	FISHERIES	1.065	222	0.809	0.292
BIOMEDICAL SCIENCES	MEDICAL LABORATORY TECHNOLOGY	1.353	132	0.729	0.174
BIOMEDICAL SCIENCES	ANATOMY & MORPHOLOGY	1.168	91	0.902	0.120
BIOMEDICAL SCIENCES	TOXICOLOGY	1.049	513	0.946	0.676
CLINICAL MEDICINE	MEDICINE, GENERAL & INTERNAL	2.522	240	0.235	0.316
CLINICAL MEDICINE	RHEUMATOLOGY	1.959	110	0.462	0.145
CLINICAL MEDICINE	TROPICAL MEDICINE	1.365	16	0.126	0.021
CLINICAL MEDICINE	ALLERGY	1.054	36	0.252	0.047
CLINICAL MEDICINE	CRITICAL CARE MEDICINE	1.033	74	0.314	0.097
CLINICAL MEDICINE	OBSTETRICS & GYNECOLOGY	1.029	192	0.326	0.253
COMPUTER SCIENCES	COMPUTER SCIENCE, SOFTWARE ENGINEERING	1.155	217	0.583	0.286
EDUCATIONAL SCIENCES	PSYCHOLOGY, EDUCATIONAL	1.151	3	0.033	0.004
ELECTRICAL ENGINEERING AND TELECOMMUNICATION	TELECOMMUNICATIONS	1.116	44	0.088	0.058
ELECTRICAL ENGINEERING AND TELECOMMUNICATION	AUTOMATION & CONTROL SYSTEMS	1.089	132	0.405	0.174
ENERGY SCIENCE AND TECHNOLOGY	NUCLEAR SCIENCE & TECHNOLOGY	1.270	822	1.437	1.083
ENVIRONMENTAL SCIENCES AND TECHNOLOGY	URBAN STUDIES	1.964	11	0.138	0.014
ENVIRONMENTAL SCIENCES AND TECHNOLOGY	BIODIVERSITY CONSERVATION	1.757	99	0.595	0.130
ENVIRONMENTAL SCIENCES AND TECHNOLOGY	FORESTRY	1.400	175	0.805	0.231
ENVIRONMENTAL SCIENCES AND TECHNOLOGY	ECOLOGY	1.030	772	0.896	1.017
GENERAL AND INDUSTRIAL ENGINEERING	ENGINEERING, MULTIDISCIPLINARY	1.068	149	0.334	0.196
HEALTH SCIENCES	HEALTH POLICY & SERVICES	2.201	2	0.011	0.003
HEALTH SCIENCES	NURSING	1.330	10	0.047	0.013
CHEMISTRY AND CHEMICAL ENGINEERING	SPECTROSCOPY	1.338	638	1.347	0.840
CHEMISTRY AND CHEMICAL ENGINEERING	ELECTROCHEMISTRY	1.217	473	1.013	0.623
CHEMISTRY AND CHEMICAL ENGINEERING	MATERIALS SCIENCE, TEXTILES	1.152	82	0.916	0.108
CHEMISTRY AND CHEMICAL ENGINEERING	CHEMISTRY, APPLIED	1.050	448	0.651	0.590
INFORMATION AND COMMUNICATION SCIENCES	COMMUNICATION	1.018	14	0.137	0.018
INSTRUMENTS AND INSTRUMENTATION	INSTRUMENTS & INSTRUMENTATION	1.518	663	0.950	0.873
INSTRUMENTS AND INSTRUMENTATION	MICROSCOPY	1.035	81	1.294	0.107
LAW AND CRIMINOLOGY	MEDICINE, LEGAL	1.329	25	0.339	0.033
MATHEMATICS	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	1.061	169	0.426	0.223
MECHANICAL ENGINEERING AND AEROSPACE	ENGINEERING, AEROSPACE	1.285	102	0.587	0.134
MECHANICAL ENGINEERING AND AEROSPACE	ENGINEERING, MECHANICAL	1.104	212	0.288	0.279
MULTIDISCIPLINARY JOURNALS	MULTIDISCIPLINARY SCIENCES	1.170	257	0.343	0.339
PHYSICS AND MATERIALS SCIENCE	PHYSICS, NUCLEAR	1.679	536	1.269	0.706
PHYSICS AND MATERIALS SCIENCE	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	1.003	1084	1.080	1.428
PSYCHOLOGY	PSYCHOLOGY, SOCIAL	1.639	15	0.089	0.020
PSYCHOLOGY	PSYCHOLOGY, APPLIED	1.336	5	0.035	0.007
SOCIAL AND BEHAVIORAL SCIENCES, INTERDISCIPLINARY	SOCIAL SCIENCES, BIOMEDICAL	1.462	4	0.033	0.005
SOCIOLOGY AND ANTHROPOLOGY	FAMILY STUDIES	2.931	2	0.023	0.003

Source: Vaněček, J. (2011): A map of the research and application potential of the Czech Republic: Area and institutional analysis of R&D results in the Czech Republic



The second category, i.e. the category of areas where the Czech Republic shows significant research specialisation, critical mass of results, and quality of research, but in which there is a relatively weaker business sector (and thus demand) with the potential for using unique knowledge, mainly includes some sub-areas of biological and environmental sciences and, to a lesser extent, medical sub-areas. In specific terms, these include sub-areas of clinical medicine (general and internal medicine, rheumatology, obstetrics and gynaecology), biological sciences (fisheries and sea and freshwater biology) and some sub-areas of environmental sciences (biodiversity protection, forestry, ecology). For these scientific disciplines, there are generally no strong and knowledge-intensive corporate partners with export potential – this is either due to historical specialisation or because the main users of the results of these research areas are partners in the public sector. However, these are areas that significantly contribute (or may contribute) to addressing social challenges and/or to innovations in areas where the public sector is the dominant user of the results (typically in health care and environmental protection). In some of the above areas there may be specific market niches in which the results of research can be commercially utilised, even though these are not key economic sectors in terms of the national economy, but they may have a specific position within some regions and their specialisations (typically freshwater aquaculture in the South Bohemian Region).

The existing research specialisation has recently been influenced by rather massive investments in public research thanks to the use of the Structural Funds, especially from the Operational Programme Research and Development for Innovation (OP RDI). In the future, these R&D centres should become the key building blocks of the Czech Republic's research specialisation (except for Prague, no building of significant additional capacities is envisaged) and it will be necessary to make maximum use of their knowledge potential to address both social challenges and research problems that have been defined in co-operation with the application sector. Thanks to these investments, a total of 8 centres of excellence and 40 regional R&D centres were created in the Czech Republic, which have significantly strengthened the critical mass in the selected areas. Also, a significant portion of the capital expenditure of Czech involvement in 11 projects of pan-European research infrastructures is linked to R&D centres. By far the largest project is ELI Beamlines, the only ESFRI Roadmap project whose basic part of the research infrastructure is located in the Czech Republic. In addition to this project, there are a number of R&D centres that, thanks to extensive investment in research infrastructures, represent national partner infrastructures for ESFRI infrastructures (Ministry of Education, Youth and Sports, 2011).

The impact of the R&D centres on research specialisation is delayed and has not yet fully translated into scientific production, but the structure in terms of areas is obvious from the orientation of their research. Out of the eight centres of excellence, two focus on information technologies (IT4Innovations and NTIS), two on biotechnologies and biomedicine (Biocev and Ceitec), two on materials research (Ceitec and CET Telč), one on laser physics and optics (ELI Beamlines), one on clinical medicine and biomedicine (ICRC), and one on research of global changes of climate and ecosystems (CzechGlobe).

The regional R&D centres financed by the Operational Programme Research and Development for Innovation focus mainly on energy research (7), materials sciences (6), biomedicine and biotechnologies (5), mechanical engineering (4), electrical engineering, electronics and instrumentation (3). Overall, it can be concluded that the creation of R&D centres has significantly strengthened the Czech Republic's research capacities in all five basic knowledge domains, while

reinforcing (at least in financial terms with respect to invested resources) the importance of research in the field of biotechnologies and natural sciences, partly in information technologies, and somewhat less in materials research. In terms of application areas, the most important ones include power engineering and mechanical engineering research (including various aspects of materials research), as well as biomedical and biotechnological research. While the first two application areas can be expected to have a direct link to existing areas of economic specialisation (mechanical engineering, manufacture of transport equipment, including manufacturers of components, power engineering), investment support for biomedical and biotechnological research means strengthening a research area in which there has historically been low demand by the private sector in the Czech Republic (manufacture of drugs and medical products). This means that, in the future, greater emphasis will need to be placed on strengthening the mechanisms for transferring knowledge from centres with such orientation into practical applications, and especially on searching for applications in specific niches that may use biotechnology and biomedicine knowledge in sectors of existing economic specialisation (e.g. scientific and analytical instruments, medical equipment, application of biotechnologies in the energy sector etc.).

From a regional perspective, the distribution of research capacities in areas of Key Enabling Technologies shows significant imbalance in the Czech Republic. The table below presents the distribution of research capacities in terms of the volume of scientific production in relation to KETs (prepared based on a study by Kučera and Vondrák, 2014). In addition to existing research capacities, whose activities already translate into research outputs, the table also includes – in parenthesis – the newly built capacities that are financed by the Operational Programme Research and Development for Innovation (indicated as (X)).

**Table 6: Presence of generic knowledge domains (KETs) in public research (research specialisation) in Czech regions<sup>172</sup>**

	Self-governing regions <sup>173</sup>													
	PRG	CB	SB	PL	KV	UL	LB	HK	PA	VYS	SM	OL	ZL	MS
Advanced materials	XX	X		X		(X)	X		X	(X)	XX	X	X	X
Nanotechnology	XX						(X)		X		XX	X	X	X
Micro- and nanoelectronics	XX			X					X		XX	X	X	X
Advanced manufacturing technologies	XX	(X)	X	X			X				XX	X	X	X
Photonics	XX	(X)	X				(X)		X		XX	X		X
Industrial biotechnologies	XX	X	X	(X)			(X)	(X)			XX	X		
Knowledge for digital economy, cultural and creative industries	X										X			

<sup>172</sup> In the case of separate facilities of a single research organisation, it was not possible to differentiate bibliometric outcomes that are attributable to a separate facility in regions other than the one in which the parent institution is based.

<sup>173</sup> The table shows self-governing regions in which there are research organisations that rank among the top 15 research organisations in the Czech Republic within the given KET area in terms of bibliometric performance (according to Kučera and Vondrák, 2014) (indicated as “X” and “XX” if there are multiple institutions in the region), or in which significant research capacities with relevance to the given knowledge domain are being built with OP RDI support (indicated as “X”). In the case of two non-technological knowledge domains the table is based on the regional priorities as declared in the different regional annexes to the National RIS3 Strategy.

Social-science knowledge for non-technical innovations	X													
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Overall, it can be concluded that in the Czech Republic there are research capacities in all five generic knowledge domains (materials research, nanotechnology, micro- and nanoelectronics, photonics, advanced manufacturing technologies, industrial biotechnologies) that, with few notable exceptions, do not achieve exceptional quality but are sufficient for absorbing knowledge and keeping up with global trends. In several specific niches there are high-quality research teams in the Czech Republic whose results are at an international level with respect to the production of scientific results. In the case of some of them it can be assumed – depending on the area of their general focus – that they may be an appropriate partner and a source of innovation impulses for key economic sectors as defined in the chapter on economic specialisation. These mainly include technical areas that have their counterparts in traditional economic sectors. In the future, it will be essential to provide further investment support to excellent research facilities, i.e. both those that received OP RDI support in the 2007–2013 programming period, and other facilities in Prague whose quality is above average (see the analytical part for a description of the specific problems in education and research in the capital city of Prague). At the same time, it will be necessary to increasingly target the orientation of support according to problems, i.e. with themes that have been defined in greater cooperation with the users of results from both the private and public sectors.

In addition to traditionally strong economic sectors, public administration and other organisations administering public goods represent an important group of users of research results, especially where there is a monopolistic or oligopolistic market situation (“public infrastructures”). These sectors include, above all, the health care sector and power engineering and energy management (electricity production and distribution), water and wastewater management, environmental monitoring and measures to mitigate negative impacts on humans and the environment (including the effects of climate change) and safety (including the administration of critical infrastructures and crisis management). At the national level, priority themes<sup>174</sup> have been defined whose research will receive preferential public resources from the public sector in the future. **Basically, these are the social challenges** to which the Czech society will have to respond and for which it is necessary to maintain and further develop an adequate knowledge background. Moreover, social challenges often require innovative solutions that are based on a combination of knowledge and expertise from various knowledge domains and, at the same time, addressing these challenges may in many cases not only bring solutions to social problems but it may also open new market opportunities for private entities.

The table below presents an overview of social challenges that will need to be addressed in defining vertically oriented interventions in research during the implementation of the Smart Specialisation Strategy.

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<sup>174</sup> National Priorities of Oriented Research, Experimental Development and Innovation (2012).

**Table 7: Social challenges of the Czech Republic<sup>175</sup>**

<b>Social challenges</b>	Competitive knowledge-based economy	Using new knowledge in the area of General Purpose Technologies Strengthening the sustainability of production and other economic activities Strengthening safety and reliability Mapping and analysing competitive advantages
	Sustainability of the energy sector and material resources	Sustainable energy sector Reducing the energy-intensity of the economy Material base
	Environment for quality life	Natural resources Global changes Sustainable landscape development Environmental technologies and eco-innovations Environmentally friendly society
	Social and cultural challenges	Demographic and social changes Government and administration Culture, values, identity and tradition Development and application of human potential People, science and new technologies
	Healthy population	Emergence and development of diseases New diagnostic and therapeutic methods Epidemiology and prevention of the most serious diseases
	Safe society	Safety of the citizens Security of critical infrastructures and resources Crisis management and security policy Defence, defensive capacity and deployment of armed forces

#### **4.2.3. Identification of knowledge domains and application themes of the smart specialisation**

The identification of the **knowledge domains** and **application themes** of smart specialisation in the Czech Republic was carried out based on three kinds of inputs: an analysis of economic specialisation, an analysis of research specialisation, and the National Priorities of Oriented Research, Experimental Development and Innovation up to 2030 that had already been defined and approved by the Czech government and that include social changes that need to be addressed by Czech-oriented research in the long-term.

The analysis of economic specialisation is a means of identifying the actors who may play an important role in identifying future technological needs and new knowledge that is required in order to define **application themes** that may lead to marketable innovations. Based on the main social challenges as defined in the National Priorities of Oriented Research, Experimental Development and Innovation, a general outline of the aspects of relevant social challenges has been added to the promising economic application themes<sup>176</sup> identified. This projection is done in the form of modifiers characterising the most significant effects of social challenges within the given application theme, for which it can be assumed with a high degree of certainty that they will be determinative of future trends in the application areas.

In addition to the analysis of economic specialisation, the proposed smart specialisation is also based on analyses of the Czech Republic's research specialisation<sup>177</sup>. It is used (i) as a means of identifying

<sup>175</sup> Defined based on the National Priorities of Oriented Research Experimental Development and Innovation (2012).

<sup>176</sup> The areas of economic specialisation have been identified using data on exports (according to SITC, 4 digits), business R&D expenditure and their trends in time.

<sup>177</sup> In the case of the research specialisation, the analysis is mainly based on bibliometric data (classified at the KET level, and also at the more detailed level of sub-area classification according to WOS Thomson Reuters).

**the knowledge domains** in which the research organisations in the Czech Republic excel and can thus be expected to become a source of quality inspiration and expertise for addressing applied problems; (ii) as a means of identifying research directions that have a historically strong position in Czech research and require preferential long-term cultivation of quality. The analyses done so far rely on statistical data that indicate above-average results in the knowledge domains of photonics, advanced materials and, to a lesser extent, nanotechnology. The subsequent entrepreneurial discovery process, which will be aimed at identifying more-specific knowledge domains that are required for addressing the application themes defined, will show whether the above-average results of research in these domains can become a source of innovations within the application themes.

The results of the analyses can be summarised in the following *knowledge matrix*. It provides a schematic overview of key application themes by area of the Czech Republic's economic specialisation (i.e. the areas in which knowledge can be marketed, where Czech entities show an above-average growth potential), including the perspective of social challenges and knowledge domains that may become a source of the supply of new knowledge for addressing application problems and/or show above-average research results in international comparison. In addition to the themes that have been identified as specialisation areas at the national level, there are also application areas that have been identified from the regional level as significant for smart specialisation, even though their significance is lower from the national perspective. These areas, too, will require attention.

The proposed areas of smart specialisation are based on the current situation (September 2014) of the institutional preparedness of the RIS3 implementation structures. The matrix therefore defines the themes relatively broadly, its fields are empty at this preparation phase, and it needs to be viewed as the framework for identifying vertical interventions, measures and projects at the national level (or at the regional level with subsequent implementation from the national level<sup>178</sup>). A more detailed identification of the contents of the actual vertical interventions will be addressed by field-oriented innovation platforms for priority knowledge application areas at the national level, as well as on-going inputs from regional innovation platforms. Individual innovation platforms are gradually being established since October 2014, and one of their key activities will be to gradually define the contents of the fields of the knowledge matrix. The actual process of refining meaning of specialisation, i.e. "filling in the fields" of the matrix, is subject to the entrepreneurial discovery process, i.e. the process of discovering new opportunities that will take place in an interaction between partners in the different innovation platforms in which the representatives of both the business sector and research organisations and the public sector are involved. In this way, it will be possible to refine and prioritise the application themes of smart specialisation that are defined as the intersection of social challenges, basic knowledge domains, and application opportunities. During the 2014–2020 programming period, preferential support will be gradually aimed at these vertical themes in the form of specific activities or projects (e.g. thematic calls for projects of applied R&D addressing specified themes, new university curricula to ensure sufficient numbers of high-quality graduates that are able to develop a given priority application direction of research etc.). The

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For the purposes of the Smart Specialisation Strategy, more detailed analyses of the research specialisation were performed by the TC AS in September 2014 as part of a separate study entitled the *Working draft of the main conclusions of the analytical foundation for establishing the research specialisation of the Czech Republic*.

<sup>178</sup> The implementation of vertical interventions from the regional level, i.e. the level of self-governing regions, is not considered within the RIS3. However, mechanisms are envisaged to transfer the needs defined from the regional level into proposals for interventions at the national level (see the chapter on implementation).

concept of smart specialisation and the entrepreneurial discovery process will thus be further developed throughout the implementation of the National RIS3 Strategy.

In cooperation with key partners, model operations (indicated in *italics* in the text) have also been identified in the proposal part of the Smart Specialisation Strategy for which it is proposed that the vertical dimension of interventions should be considered in the implementation phase. The specific form and degree of the “verticalisation”<sup>179</sup> of model operations will be discussed in innovation platforms and the RIS3 Management Committee at the national level. The model operations will include both model operations that are implemented as purely vertical (i.e. only projects that fulfil a vertical priority as defined in the corresponding national or regional innovation platform will be supported), and model operations with a specified degree of verticality where the share of resources or projects, whose support will be conditional upon clear links to fulfilling the vertical priorities of the Czech Republic or any region, will be defined. In addition to the “verticalisation” of some proposed interventions, it will be necessary to initiate steps at the national level in order to take account of the areas of the Czech Republic’s smart specialisation within long-term financial planning, so that a part of the state budget resources for research, development and innovation is gradually oriented towards the priority areas of research and innovation. Without this step, there is a risk that vertically oriented RIS3 interventions, which will be mainly financed from ESIF resources, will not be sufficiently linked to the main flow of national resources.

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<sup>179</sup> “Verticalisation” means gradual prioritisation, i.e. the narrowing of interventions to themes that are defined within each smart specialisation priority – as opposed to horizontal interventions, which will support the given activity without thematic restrictions.

**Table 8: The matrix of innovation and research needs of smart specialisation – knowledge domains vs. application sectors**

		Key application sectors and application themes – national							Key sectors of knowledge application – regional <sup>180</sup>				
		Manufacture of transportation equipment, sustainability and safety of transport	Advanced and cost-effective mechanical engineering and automation	Cost-effective solutions in electronics and electrical engineering	IT services, software and IT security	Sustainable and safe production and distribution of electricity	Drugs and medical products and methods for healthy ageing	Natural resources, sustainable agriculture and food safety and sufficiency	Chemistry and chemical industry	Glass, ceramics	Rubber and plastic industry	Media	Textile
Generic knowledge domains (KETs + non-technological domains)	Advanced materials												
	Nanotechnology												
	Micro- and nanoelectronics												
	Advanced manufacturing technologies												
	Photonics												
	Industrial biotechnologies												
	Knowledge for digital economy <sup>181</sup> , cultural and creative industries <sup>182</sup>												
	Social-science knowledge for non-technical innovations												

<sup>180</sup> These are application areas that differ from the priorities defined from the national level and, at the same time, have been identified by at least one region as an area of its smart specialisation (see section 4.2.1).

<sup>181</sup> This includes knowledge in the area of IT for new media, publishing and media, digital content processing, and audio-visual production.

<sup>182</sup> This includes knowledge in applied and industrial design, visual and performing arts, and knowledge and skills in traditional and modern living culture that can be used in the cultural industries.

## 5. Proposal section

The proposal section is structured according to the problem areas that are based on the analytical section of the RIS3. It starts with the draft proposal of the long-term strategic vision whose contents are based on the visions of existing documents and that has been discussed in the partner structures. Then there are five thematic fields – business and innovation, research and development, human resources, information and communication technologies and digital agenda, social innovations – in which the Czech Republic must achieve changes in order to be able to seriously strive to achieve the vision in the long-term horizon and to approach the vision in a real and measurable manner by 2022.

Each thematic field consists of one or more key areas of change for which strategic and specific objectives are proposed. For each specific objective, model projects, programmes or activities are proposed – model operations – through which the specific objective is to be achieved. The list of model operations is not exhaustive and it is expected to be further expanded and modified depending e.g. on how the RIS3 will be implemented through specific projects from operational programmes. With respect to the various model operations, the operations for which it is proposed that the vertical dimension of interventions should be taken into account in the implementation phase are indicated in *italics*. This means that for these interventions:

- a) the share (or volume) of the financial allocation of the model operation (e.g. a new subsidy programme or a call within an operational programme) will be specified that will be oriented towards support for the activities defined as an area of vertical specialisation; or
- b) support within the model operation will be restricted exclusively to supporting operations that contribute to fulfilling the vertical priorities of the Smart Specialisation Strategy where projects are obligated to clearly document compliance with the vertical priorities at the national or regional level.

The specific form and degree of the “verticalisation” of the model operations will be discussed in innovation platforms and subsequently approved by the RIS3 Management Committee at the national level.

### 5.1. Long-term strategic vision

The long-term strategic vision formulates the basic direction of the Czech Republic’s development with an emphasis on the knowledge economy and with an emphasis on the transformation of the economy in order to improve competitiveness based on innovations and reduce the Czech Republic’s dependence on competitiveness that is based on low costs. The long-term strategic vision focuses on a longer period than up to 2020 (or 2022). Even though the National RIS3 is being prepared for the above period, the long-term strategic vision has a longer validity.

Key aspects of the changes that are described in a separate chapter, are an integral part of the design and represent interventions that are below the long-term strategic vision to help achieve. In this sense, the key areas of change and the interventions described within these areas are the “operationalisation” of the vision, i.e. they describe the methods and ways to fulfil the vision.



The long-term strategic vision is not going to fulfil itself. The vision may only be fulfilled through joint effort of the key actors in the innovation system at both the national and regional levels. The vision is a flag that brings together actors with a different level of influence on the future of the innovation system, who are aware that success will not come without their personal and joint effort.

The long-term strategic vision for the development of the Czech Republic towards a knowledge economy is:

## **CZECH REPUBLIC – ENTERPRISING, CREATIVE AND ATTRACTIVE TO TALENT AND MONEY**

The contents and the component parts of the vision are explained and described below, including the way in which the progress of its implementation will be monitored and measured.

**Czech Republic – Enterprising** – the basis of prosperity in the 21st century is an enterprising person that has an active approach to life, desires to put their ideas to the test in a competitive environment and is willing to take the risks involved. Enterprising people think on an international scale, the companies they manage want to be successful not only at home but also in the European or global market.

### **How do we verify the fulfilment of this part of the vision?**

- The Czech Republic will be a country with an increasing intensity of business activities per 1,000 inhabitants
- The Czech Republic will be a country with an increasing share of young people up to 35 years of age doing business for a living
- The Czech Republic will be a country with an increasing share of newly established and surviving companies

**Czech Republic – Creative** – in order to do things differently, we also need to see them differently; the best way to get great ideas is to have a lot of ideas; being original requires creative thinking in a cultural, economic and technological context, and the basic element of creativity is not being afraid of making mistakes – these are only a few of the attitudes that are characteristic of creativity. The Czech society will learn to better stimulate creativity and appreciate and reward successful innovations.

### **How do we verify the fulfilment of this part of the vision?**

- The number of companies doing business in cultural, creative and similar sectors (incl. industrial design) will increase in the Czech Republic
- The Czech Republic will have the highest share of R&D activities located there by multinational companies among all CEE countries
- The Czech Republic will be a country with an increasing trend in the technological balance of payments – foreign trade in advanced technological services

**Czech Republic – Attractive to talent** – a talented person is creative and enterprising and likes an environment where they can use their ideas and activity. An enterprising and creative Czech Republic will provide such an environment – it will prepare the conditions for their development in a “creative ecosystem”.

### How do we verify the fulfilment of this part of the vision?

- The Czech Republic will create and develop functional systems to promptly identify the natural talents of people and use them for career consultancy, thereby improving young people's choice of occupation and the efficiency of expenditure on education
- The Czech Republic will create and develop functional programmes to develop extraordinary talents and creativity of people with aptitude and enthusiasm for enterprise, technical areas, science and research, thereby increasing their number and improving their competencies upon their entry to the innovation system
- The Czech Republic will create and offer a friendly working environment, i.e. a creative ecosystem for enterprise (at all levels)
- The Czech Republic will have a positive "talent balance" – BRAIN GAIN

**Czech Republic – Attractive to money** – an environment that encourages creativity (coming up with new things), values innovation (doing new things, doing things in a new way) and supports the entrepreneurial spirit and enterprise (taking risks that are part of market competition) is also attractive to both domestic and foreign investors.

### How do we verify the fulfilment of this part of the vision?

- The Czech Republic will be among the top 10 EU countries with the highest inflow of foreign direct investments relative to GDP
- The Czech Republic will be among the top 10 EU countries with the highest volume of private expenditure on science and research relative to GDP
- The Czech Republic will be among EU countries with an increasing volume of allocated private venture capital in companies set up in its territory

### Verification and measurement of the vision

In a structured form, the following table shows the baseline values of the indicators that will be used for measuring whether the Czech Republic is successful in fulfilling the vision and in progressing in the direction of the vision. To evaluate whether the vision is or is not being successfully fulfilled, it is also important to examine trends and not only the values that are measured at a single point in the given year. To allow for further comparison and evaluation of trends, the annex to the RIS3 lists time series and more detailed (structural) data for the indicators used below.

### Indicators for measuring the vision and its sub-aspects – baseline values

<b>Characteristic of the verification of the vision</b>	
<i>Indicator used for verification*</i>	<i>Year</i>
	<i>value</i>
<b>The Czech Republic will be a country with an increasing intensity of business activities per 1,000 inhabitants</b>	
Number of newly established companies per 1,000 inhabitants	2013
	9.45
<b>The Czech Republic will be a country with an increasing share of young people up to 35 years of age doing business for a living</b>	
Share of people up to 35 years of age doing business	2013
	10.26%

<b>The Czech Republic will be a country with an increasing share of newly established and surviving companies</b>	
New companies as % of all active economic entities	2013
	6.75%
<b>The number of companies doing business in cultural, creative and similar sectors (incl. industrial design) will increase in the Czech Republic</b>	
Number of legal and natural persons	2010
	63,260
<b>The Czech Republic will be a country with an increasing positive trend in the technological balance of payments – foreign trade in advanced technological services</b>	
	2012
Technological balance of payments, services (CZK million)	-2,882
Technological balance of payments, % of total income from export of services	-0.70%
<b>The Czech Republic will create and offer a friendly working environment, i.e. a creative ecosystem for enterprise (at all levels)</b>	
Total index – ease of doing business**	CR's rank 2014
	75
<b>The Czech Republic will have a positive “talent balance” – BRAIN GAIN</b>	
	CR's rank 2014–15
Capacity of the country to keep talent***	80
Capacity of the country to attract talent***	93
<b>The Czech Republic will be among the top 10 EU countries with the highest inflow of foreign direct investments relative to GDP</b>	
FDI-GDP ratio****	Average 2011–2013
	11th place
<b>The Czech Republic will be among the top 10 EU countries with the highest volume of private expenditure on science and research relative to GDP</b>	
BERD-GDP ratio****	Average 2010–2012
	14th place

\* Data sources are listed in the trend tables in the annex to the RIS3

\*\* Rank according to the Doing Business rankings published by the World Bank

\*\*\* Rank according to the Global Competitiveness Index

\*\*\*\* Averages for multiple years are indicated in order to reduce the impact of random fluctuations (e.g. major one-off investments)

## 5.2. Structure of the proposal section – key areas of change

The proposal section consists of six key areas in which the Czech Republic must achieve significant changes in order to strengthen the knowledge-intensity of the economy and to facilitate the development of the selected specialisation domains and their gradual refinement. The key changes are as follows:

- Higher innovation performance of companies
- Improved quality of public research
- Improved economic benefits of public research
- Better supply of HR, in terms of both quality and quantity, for innovative enterprise, research and development

- Development of eGovernment and eBusiness to improve competitiveness
- Improvement and better utilisation of social capital and creativity in addressing complex social challenges

These key areas of change are further structured into **strategic and specific objectives** whose achievement will contribute to achieving changes at the level of the key areas. For each specific objective, **model projects or activities** are proposed, but these are not a final or exhaustive list of activities or model projects. The model projects/activities include interventions that are currently being prepared or considered in the Czech Republic. At the level of the model projects/activities, many of them need to be verified in partnerships (e.g. in innovation platforms).

Given that the long-term process of co-operation and partnership with entrepreneurs and researchers as well as other actors from the quadruple helix is an integral and necessary part of the preparation and implementation of RIS (entrepreneurial discovery process), and given the variability of the environment and the components of the Czech innovation system, which cannot be avoided during the programming period, it is not possible – with sufficient certainty – to describe and plan each activity and model projects for the entire period of RIS3 implementation. On the contrary, proposing the final structure of the model projects and activities would go against the purpose of the process of searching for opportunities to develop the specialisation with the participation of entrepreneurs and researchers, which is inherent to the RIS3.

The key areas of changes are not self-contained and isolated, but their interventions rely on and complement each other. Of course, the level of linkage between individual model projects/activities is different.

### 5.3. Combination of interventions in the National RIS3

The Czech Republic is one of the countries that tend to be included in the category of moderate innovators according to IUS or, in some cases, even among innovation-based economies (for the purposes of the GCI rankings). However, both the analytical section of the RIS3 and analyses that have been performed for other purposes show that, in terms of knowledge-intensity and competitiveness based on innovation, the Czech Republic does not rank among the most developed countries, even though it is one of the top innovators among the less developed countries in Europe. It is therefore important for the Czech Republic to implement the interventions resulting not only in strengthening and developing specialisations, as is the case in the most developed countries and regions of Europe, but also to concentrate on interventions that develop the innovative system as a whole, improve its conditions and operation and complete it. Therefore, the RIS3 focuses on and contains two types of interventions:

- Interventions that are not oriented specifically towards selected sectors and that focus on completing the innovation system in order to improve conditions for effective investment in smart specialisation (horizontal interventions).
- Interventions that are aimed at selected domains and that lead to strengthening smart specialisation through searching for and utilising opportunities for innovation that result in the growth of companies and their increased success in global markets.

In the initial years, the first type of interventions will prevail within the National RIS3 as they are a pre-condition for improving the effectiveness of interventions resulting in the development of specialisation. During the implementation of the National RIS3 and with the involvement of entrepreneurs and researchers (entrepreneurial discovery process), new, emerging and promising opportunities for improving the specialisation will gradually be proposed within the domains of the specialisation, and this component of the RIS3 will be strengthened. During the implementation, the proposed domains of specialisation (at the national and regional levels) will be gradually refined in cooperation with entrepreneurs and researchers and will be supported and developed through investments. At the end of the programming period, interventions that develop the domains of specialisation will be more important than those aimed at completing and developing the innovation system as a whole.

Interventions to strengthen the domains of specialisation (vertical interventions) are proposed as part of the key areas of change described below. Vertical interventions are indicated in italics and are designed so that, in combination with horizontal interventions, they jointly contribute to achieving the objective for which they have been designed. Therefore, horizontal and vertical interventions are not designed separately, but rather so that their interaction contributes to achieving common objectives, whether strategic or specific. In this respect, the National RIS3 is an integral strategy aimed at transforming the Czech economy in the context of the growing importance of the knowledge economy. Further specifications of interventions within the domains of specialisation will be proposed at meetings of national innovation platforms, along with the concept of the selection conditions and the targeting of operations. The actual rules of the call will be defined by the relevant managing authority.

## 6. Key areas of change

### 6.1. Entrepreneurship and innovation

#### **Key area of change A: Higher innovation performance of companies**

The model of the Czech Republic's economic growth to date, which is based on the inflow of foreign direct investments and motivated by a cost- and location-related advantage, is gradually being depleted. Labour cost and the cost of other production inputs (especially energies) are rising in the Czech Republic. At the same time, other countries are emerging that offer attractive cost-effective opportunities for the territorial optimisation of the operations of multinational companies. In addition, there are growing signals pointing to the upcoming re-industrialisation of developed economies due to new technological and other trends<sup>183</sup>. The highly exhausted potential of this model of economic growth – together with an unstable business environment and negative economic mood – can be considered one of the main causes underlying the interruption of convergence of the Czech Republic's economic performance towards the level of developed economies after 2008.

The fundamental prerequisite for restoring long-term growth and, in turn, further convergence of the level of the Czech Republic's prosperity with developed countries (Germany, Austria etc.) is a substantial increase in the development dynamism and innovation performance in the endogenous<sup>184</sup> corporate sector. This portion of the economy, which includes the largest number of entities but lags behind in terms of performance, should become the second main pillar of the Czech Republic's economic growth. In the case of the sector of foreign companies, it is necessary to concentrate on their maximum interconnection with the local economy, which is the basic prerequisite for further related investments. To this end, it is necessary to consistently cultivate the entrepreneurial environment both in terms of predictable and lean regulation, and in terms of the conditions for developing knowledge-intensive activities. Another important opportunity is the development of R&D and other activities of foreign companies with links to successful local production capacities.

Developing the endogenous corporate sector and establishing the conditions for related investments of foreign companies with significant operations in the Czech Republic are the main directions within support for the Czech Republic's economic growth. For that purpose, the Smart Specialisation Strategy of the Czech Republic in the field of enterprise and innovation focuses on the following three strategic objectives:

1. Increasing the innovation demand in the business and public sectors. Lacking and, above all, low ambitions of the innovation demand in the application sector have many causes (see the analytical section of this strategy) that jointly contribute to the fragmentation of the national

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<sup>183</sup> For example, additive manufacturing, the energy revolution based on shale oil and gas, the need for more intense linkage between production and technical development etc.

<sup>184</sup> An endogenous company is a business entity established, owned and controlled by Czech citizens.

innovation system and the low innovation performance. The increase in the innovation demand of the application sector will be achieved through (i) strengthening the research and development capacities of businesses, with an emphasis on the implementation of the industrial research and development, (ii) improving the non-technical competencies of companies – strategic management, innovation management, marketing etc., and (iii) strengthening multi-faceted co-operation in line with the open-innovation trend that is being increasingly promoted within corporate innovation processes. Attention will also be given to initiating innovation demand in the public sector. Under this strategic objective, emphasis will be placed on interlinking the technical and non-technical competencies of companies. At the same time, attention will be focused on stimulating growth and innovation aspirations of entrepreneurs and executive managers of companies, especially SMEs. Special emphasis will be placed on innovations that are new to the market and not only to the company.

2. Increasing the level of enterprise in the society, with an emphasis on establishing knowledge-intensive companies in fast growing areas (not only IT). Developing the venture capital market and providing high-quality consulting and conditions for start-up technological companies are the main roads to achieving this objective; however, the start-up of first business will be supported in the largest part of the population possible. Successful, fast growing companies are most often established by mature people with previous entrepreneurial experience. The overall increase in the level of enterprise and entrepreneurship is in full synergy with the first strategic objective, because new technological companies are an important source of growth of innovation demand.
3. Increased internationalisation of SMEs. The domestic market is small and the vast majority of growth opportunities lie abroad, especially in the fast growing markets of emerging countries, to which the mass of global demand is gradually shifting. In the longer-term, higher internationalisation of SMEs is a necessary prerequisite for maximum economic benefit from the fulfilment of the above two strategic objectives.

Key area of changes A: Higher innovation performance of companies	
<b>Strategic objectives in key area of change A:</b> <b>A.1: Increasing the innovation demand in companies (and in the public sector)</b> <b>A.2: Increasing the level of enterprise in the society, with emphasis on the establishment of new, fast growing companies</b> <b>A.3: Increasing the internationalisation of SMEs</b>	<b>Indicators of strategic objectives/key area of change:</b> A.1: Number of companies with non-investment R&D expenditures of CZK 10+ million, number of new patent applications (international applications only – PCT, EPO, USPTO) A.2: (i) Number of incubated companies (in the national network of technological incubators) that are still active three years after establishment, (ii) number of fast growing companies (gazelles <sup>185</sup> ) out of the total number of companies incubated in the national network of technological incubators A.3: (i) Number of supported companies (SMEs) that increased or started their export within 3 years; (ii) number of SMEs that increased the number of target countries within 3 years of granting support (of which countries outside EU) or started their export
<b>Strategic objective A.1: Increasing the innovation demand in companies (and in the public sector)</b>	

<sup>185</sup> A “gazelle” is a company whose turnover increases by at least 20% for 4 years.

The innovation performance of the corporate sector as a whole is strongly dependent on companies' internal demand for innovations. In this area, the Czech Republic is facing several problems (see the description of the area of change above) that jointly limit the innovation demand and, in turn, the shift of the entire economy towards competitiveness that is to a larger degree based on creating and using new knowledge. The focus of the objective, however, reflects the structure of the local economy. Increasing the demand for innovations means both (i) increasing companies' effort to achieve higher-order innovations that are usually based on the intensive research and development, and (ii) shifting the strategic focus of companies away from the competitive advantage based on low costs towards an advantage that is based on quality and innovations, even if these are lower-order innovations requiring no extensive in-house R&D. At the level of companies, accomplishing this objective will translate into an increase in the volume of inputs (expenditure on innovations, including R&D expenditure) into the innovation process. At the level of the entire economy, the growth of innovation demand will translate into an increase in companies' total own expenditure on R&D<sup>186</sup>. Accomplishing this objective will translate into an increase in the number of companies that carry out their own R&D, i.e. that systematically spend some minimum amount of resources on this area. An increase in innovation demand will be achieved through three specific objectives:

1. Improving research and development capacities of companies: The purpose of this objective is to improve the ability of companies to implement technical innovations. Special emphasis will be placed on innovations that are new to the market in which the company operates, and not only to the company. Technical innovations usually require considerable investments in own R&D. R&D capacities mean both the resources<sup>187</sup> for financing research and development, and the infrastructure that is required for that.
2. Improving strategic management in SMEs: The commercial success of innovations, regardless of how good they are in technical terms, depends primarily on the correct identification of customers' needs and the ability to quickly launch the innovation on the market. A corporate strategy and the setting of key business processes are thus a necessary prerequisite for the efficiency of activities focusing on the ability to implement technological innovations (objective A.1.1). Therefore, the purpose of this specific objective is to help develop the non-technical competences<sup>188</sup> of SMEs, whose quality in the Czech Republic is not at a level comparable with most developed economies (see the description of the area of change above).
3. Strengthening the co-operation of companies in R&D and innovation: The global trend of the opening of companies' innovation processes (including global leaders) leads to the increasing importance of external cooperation in R&D and innovation. In the Czech Republic, this cooperation is not developed and the companies that need it often face significant obstacles. For SMEs, external cooperation is often the only way to obtain principal inputs for the internal innovation process. The purpose of this objective is to reduce (or eliminate, if possible) the barriers to establishing and developing bilateral as well as multilateral co-operation both among companies and with research organisations. In addition to increasing connectivity within the Czech Republic's innovation system, the purpose of the objective is also to increase its links to sources of new knowledge and business inspiration abroad.

<b>Specific objectives</b>	<b>Indicators of the specific objective</b>	<b>Model activities/projects/operations</b>
<b>A.1.1: Strengthening the research and development capacities of companies</b> Capacities mean both people in business R&D and related processes (manufacture of prototypes, product	<ul style="list-style-type: none"> <li>• Number of new patent applications by supported companies (international applications only – PCT, EPO, USPTO) – binding</li> </ul>	<i>Direct support for implementing business R&amp;D, including support for implementing joint projects of RO and companies, including the sharing of capacities of companies and RO</i>
		Direct support for protecting intellectual property of SMEs
		Support for the availability of talent for business development and

<sup>186</sup> The most suitable measure of the intensity of inputs into the innovation process is own non-investment business R&D expenditure (including own expenditure on external cooperation in this area). This applies despite the fact that the importance of R&D for innovations differs greatly depending on the type and the order of the innovation, as well as the relevant economic sector.

<sup>187</sup> Higher-order technical innovations usually require extensive and long-term experiments and, in turn, large investments in R&D that may even bankrupt the company if they fail. The high risk that is associated with this type of innovation is considered an obstacle to purely private investment in this type of innovation.

<sup>188</sup> Strategic management, marketing, innovation management and other key processes. Here, the competences relate to the entire company and not to individuals within the company.



<p>design, construction etc.) and infrastructure for implementing business R&amp;D.</p>	<ul style="list-style-type: none"> <li>Number of supported companies whose own non-investment R&amp;D expenditure has increased by X% within 3 years of project completion (X will be defined depending on company size) – monitoring</li> </ul>	<p>innovations in SMEs (e.g. the Innovation Assistant programme)</p> <p>Support for innovations through facilitating the absorption of new technologies (e.g. SW for digital design) – room for the use of financial engineering tools</p> <p><i>Public pre-commercial procurement</i></p> <p>Support for business R&amp;D infrastructure (in addition to subsidies, room for the use of financial engineering tools)</p>
<p><b>A.1.2: Improving strategic management in SMEs</b></p> <p>For many SMEs, even the mere involvement of managers in things other than daily operations and their increased attention to strategic issues concerning the development of the companies they manage will be a significant improvement. Given the variability of the problems and management approaches of SMEs, the improvement of strategic management will take many different forms.</p>	<ul style="list-style-type: none"> <li>Number of supported companies whose sales increased by X% within 3 years of project completion (X will be defined depending on company size) – monitoring</li> </ul>	<p>The network of internationally certified providers of consulting services<sup>189</sup> based on a two-tier procedure focusing on (i) identifying the new growth opportunities/development needs for SMEs, (ii) finding a way (solution) to utilise/fulfil them, and (iii) coaching/mentoring on the implementation of identified solutions in the company</p> <p>Interim management – a temporary manager responsible for re-designing the processes that need to be improved by the company</p> <p>Assistance service to improve awareness among companies about the importance and method of IPR protection, and the actual provision of international IPR protection</p> <p>Provision of high-quality management education in strategic management and innovation management (aimed mainly at employees with the potential to become future managers)</p>
<p><b>A.1.3: Strengthening technological co-operation of companies</b></p>	<ul style="list-style-type: none"> <li>Number of supported companies that have their own expenditure on R&amp;D cooperation one year after project completion <ul style="list-style-type: none"> <li>of which cooperation with research organisations</li> </ul> </li> <li>Number of supported companies that purchased a licence to use external intellectual property after project completion – monitoring</li> </ul>	<p><i>Shared capacities for industrial research, development, innovation and professional education – Science and Technology Parks, Centres of Competence<sup>190</sup>, clusters, innovation centres etc.</i></p> <p>Support for process and product upgrading of SMEs through production and development co-operation with foreign companies</p> <p><i>Technological platforms</i></p> <p>Activities focusing on initiating the establishment of new co-operation networks and open-innovation platforms (e.g. innovation vouchers, targeted networking etc.)</p>

<sup>189</sup> The providers are internationally certified (EBN) entities such as development agencies. The phase of identifying new growth opportunities or growth barriers of the company is implemented by the providers themselves. Subsequently, they assist the supported companies in implementing the next phase, during which a consultant with proven international expertise provides custom-tailored consulting services. The provider of support helps the company to find this expert. An inspirational example may be the Manufacturing Extension Partnership programme that is financed by the US Federal Government (many OECD countries and even regions within some countries have similar programmes).

<sup>190</sup> I.e. long-term joint programmes of applied research that are associated with PhD education, including the setting up of new legal entities.

	<ul style="list-style-type: none"> <li>• Volume of the drawing of H2020 resources by companies – monitoring</li> </ul>	
<p><b>The strategies and national documents to which the strategic and specific objectives are related:</b></p> <ul style="list-style-type: none"> <li>- A.1.1 + A.1.3 is in the National Innovation Strategy and the International Competitiveness Strategy of the Czech Republic for 2012–2020; A.1.2 is not there but a change in this sense is implicitly expected</li> </ul>		
<p><b>Strategic objective A.2: Increasing the level of enterprise in the society, with emphasis on the establishment of new, fast growing companies</b></p> <p>Enterprise or entrepreneurship represents a key driving force of innovation. In an international comparison, the Czech Republic belongs among countries with an average entrepreneurship level (see above). However, with the exception of IT, few new companies are being established in technological areas that are characterised by intensive creation and use of new knowledge. Another fundamental prerequisite for innovations is entrepreneurship within established companies. The entrepreneurial ambitions of the owners and managers of many mature companies, especially within the endogenous segment, are very limited and are often aimed at maintaining the positions instead of looking for new sources of growth. A common consequence is the limited innovation potential and, by extension, growth potential of the local economy, i.e. its endogenous segment – unless its dynamism increases, the economic performance of the country will remain strongly dependent on foreign companies<sup>191</sup>. The purpose of this strategic objective is the multi-faceted development of entrepreneurship and the entrepreneurial culture in the Czech society. The result will be an increased level of new business activity and a higher number of new companies in technological areas. In the longer-term, the activities of this objective will translate into increased entrepreneurial ambitions of the owners and managers of small companies. This change is an important prerequisite for the future existence of a higher number of large Czech companies that will drive the growth of the local economy. The increase in the level of enterprise in the society, with emphasis on the establishment of new, fast growing companies, will be achieved through three objectives:</p> <ol style="list-style-type: none"> <li>1. Increasing the number of new companies striving for innovations, especially higher-order innovations: The purpose of this objective is to provide adequate conditions for the establishment and development of new technological companies in areas with high growth potential. Starting a business in these areas is often more demanding and risky in terms of investment. While the founders of successful businesses of this type often have previous entrepreneurial experience, they need various specific services and conditions in order to implement their business plans. Almost all developed countries in the world are trying, in different ways, to create such services and conditions.</li> <li>2. Improving the availability of external financing for start-up entrepreneurs and companies with a short history: The purpose of this objective is to provide resources that are necessary for start-up entrepreneurs and dynamic companies with a short history, for whom obtaining external financing in the loan market is problematic. Another purpose is to connect these entrepreneurs and companies with investors who can bring not only capital, but also commercial experience or technological expertise into the company.</li> <li>3. Increasing interest in enterprise within the society: This objective is aimed at increasing the overall level of entrepreneurship in the society. New companies in technological areas or fast-growing companies (gazelles) are usually established by people with prior entrepreneurial experience. Therefore, supporting the overall level of entrepreneurship increases the likelihood that companies of this type will also be established. In addition, own entrepreneurial experience contributes significantly to spreading the entrepreneurial culture within the society. The Czech Republic faces the poor image of entrepreneurship and entrepreneurs (see above), and increasing the share of entrepreneurs in the society is a way to gradually eliminate this barrier to innovation.</li> </ol>		
<b>Specific objectives</b>	<b>Indicators of the specific objective</b>	<b>Model activities/projects/operations</b>
<b>A.2.1: Increasing the number of new companies striving for innovations, especially higher-order innovations</b>	<ul style="list-style-type: none"> <li>• Number of incubated companies (in the national network of technological</li> </ul>	<p>A network of technological incubators consisting of 4 to 8 internationally accredited providers of incubation services</p> <p>Support for Proof-of-concept activities (national and regional</p>

<sup>191</sup> Due to this dependence, economic development in the Czech Republic largely relies on business decisions taken outside the Czech Republic. Given the change in the relative prices and conditions between the Czech Republic (or Central Europe) and other regions, this creates a risk of long-term economic stagnation or decline.

	<p>incubators) that are still active three years after establishment</p> <ul style="list-style-type: none"> <li>• Number of fast growing<sup>192</sup> companies incubated in the programme of technological incubators</li> <li>• Number of internationally certified providers of incubation programmes</li> </ul>	<p>schemes, provided they are not identical)</p> <p><i>Cooperation of operators of business incubators, innovation centres and accelerators with top technological companies in providing special services for start-up entrepreneurs</i></p>
<b>A.2.2: Improving the availability of external financing for start-up entrepreneurs and companies with a short history</b>	<ul style="list-style-type: none"> <li>• Volume of seed and venture investments in companies in the programme of technological incubators</li> <li>• Volume of inactivated bank guarantees and unclassified loans for companies with a history of up to 3 years</li> </ul>	A national seed fund or a limited number of the regional seed funds
		Guarantees and preferential loans
<b>A.2.3: Increasing interest in enterprise within the society</b>	<ul style="list-style-type: none"> <li>• Share of university graduates that do business / start a business in the total number of graduates (to be calculated 2 years after graduation)</li> <li>• Number of entrepreneurs supported through a voucher, who run a business and have at least one employee 3 years after receiving support</li> </ul>	Voucher for start-up entrepreneurs to bridge financial difficulties in the transition from employment to enterprise (for graduates and possibly other specific groups)
		Shared infrastructure for prototype manufacture and development (e.g. FabLab, TechShop etc.)
		Marketing / awareness raising focusing on the social role of entrepreneurs
		Basic network of support for start-up enterprise (entrepreneurship consulting centres)
<p><b>The strategies and national documents to which the strategic and specific objectives are related:</b></p> <ul style="list-style-type: none"> <li>- A.2.2 is in the International Competitiveness Strategy of the Czech Republic for 2012 to 2020 and the National Innovation Strategy of the Czech Republic; A.2.1 + A.2.3 are not explicitly mentioned in any strategy, but changes in these directions are implicitly expected</li> </ul>		
<p><b>Strategic objective A.3: Increasing the internationalisation of SMEs</b></p> <p>The economic performance of the Czech Republic is strongly dependent on exports that, in turn, are largely driven by foreign companies. Even though the ability of endogenous companies to succeed in foreign markets is improving consistently, it remains strongly limited to the neighbouring countries and markets in Europe. SMEs, in particular, have to cope with insufficiently developed competencies and capacities for foreign trade and they also have to face many barriers to the internationalisation of their activities, especially as the geographical and cultural distance of the target markets from the Czech Republic increases. The purpose of this strategic objective is to stimulate the international expansion of local companies through both export and foreign direct investments that are an inevitable response to new growth opportunities in the rapidly changing world economy. Specific attention will be given to target markets with a high growth potential (see the Export strategy of the Czech Republic for 2012 to 2020). Through expansion in foreign markets, it is possible to substantially increase the overall benefit of the highly-developed technical competencies of local companies for the Czech Republic's economic growth. In this sense, this strategic objective has significant synergistic links to the first objective, which focuses on developing the technical competences of companies. Another important synergy lies in the fact that foreign expansion of local companies is strongly dependent on the ambitions of entrepreneurs and executive managers of local companies and it is also linked to the aspirations (demand) in the area of innovations. From the perspective of</p>		

<sup>192</sup> According to the definition of “gazelle” companies, fast-growing companies are those whose turnover increases by at least 20% in 4 consecutive years.

the various development phases of companies, the purpose of this objective is both to support the (global) expansion of well-established exporters, and to support small companies in their initial entry into foreign markets. Increased internationalisation of SMEs will translate into increased sales abroad, with an overall increase in turnover, and it will be achieved through the following objectives:

1. Improving the availability of strategic information about the target markets of local SMEs: The knowledge of trends and preferences in foreign markets, and of the regulatory specifics, is a key input for the management of the international expansion of companies. Usually, SMEs have limited capacities to obtain this knowledge internally. They also have to deal with the lack of experience with cultural differences in business customs. The purpose of this specific objective is to eliminate these barriers to the international expansion of SMEs.
2. Improving the key competences of the companies in marketing and foreign trade: The purpose of the activities within this specific objective is to help companies and their employees in becoming familiar with efficient methods to manage expansion in foreign markets, including business experience required for specific target markets. The activities of this objective will also focus on educating potential future traders and foreign trade managers.
3. Reducing the costs and risks of SMEs associated with their entry into foreign markets: The purpose of this specific objective is to reduce the risks and costs associated with export and investment abroad, especially in markets with substantially different regulatory rules and business customs. For SMEs, these risks often have such relevant weight (relative to turnover or financial reserves) that they prevent the implementation of foreign business or investment opportunities.

<b><i>Specific objectives</i></b>	<b><i>Indicators of the specific objective</i></b>	<b><i>Model activities/projects/operations</i></b>
<b>A.3.1: Improving the availability of strategic information about the target markets of local SMEs:</b>	<ul style="list-style-type: none"> <li>• Number of supported companies that increased their exports (while increasing or maintaining their sales) by X% or started to export within 3 years</li> <li>• Number of SMEs that increased the number of target countries (of which countries outside the EU) or started to export within 3 years of being granted support</li> </ul>	Specialised consulting aimed at facilitating the entry into a specific target market of SMEs
		Provision of strategic information to SMEs about development trends and their implications for specific markets
		Trade missions / temporary business representations
<b>A.3.2: Improving the capacities and competencies of companies in marketing and foreign trade</b>	<ul style="list-style-type: none"> <li>• Number of supported companies that increased their exports (while increasing or maintaining their sales) by X% or started to export within 3 years <ul style="list-style-type: none"> <li>○ Number of SMEs that increased the number of target countries (of which countries outside the EU) or started to export within 3 years of being granted support</li> </ul> </li> </ul>	Direct support for service centres and customer care services in the target markets of SMEs
		Specialised management education (export academy)
		Support for SMEs in obtaining certifications and other documents needed for entry into foreign markets
<b>A.3.3: Reducing the costs and risks of SMEs associated with their entry into foreign markets</b>	<ul style="list-style-type: none"> <li>• Number of supported companies that increased their exports (while increasing or maintaining their sales) by X% or started to export within 3 years</li> <li>• Number of SMEs that increased the number of target countries (of which countries outside the EU) or started to export within 3 years of being granted support</li> </ul>	Export alliance and mutual assistance in covering demand
		Shared business representations, shared distribution channels
		Export guarantees (EGAP)

**The strategies and national documents to which the strategic and specific objectives are related:**

- Export strategy of the Czech Republic for 2012 to 2020
- International Competitiveness Strategy of the Czech Republic for 2012–2020

**The conditions for and barriers to implementing interventions in this key area of change:**

- In order to increase the entrepreneurship and innovation performance of companies, the stability of the tax and regulatory environment needs to be improved significantly. Frequent changes that occur in the Czech Republic create uncertainty that complicates planning in companies. Uncertainty and poor predictability of changes always reduces entrepreneurship and innovation activity. The seriousness of the problem is documented by recent problems with the VAT rate, where the rate for 2013 was still uncertain in early December 2012.
- The Czech Republic's business environment is characterised by a high administrative burden on both new and well-established companies (75th place in the Doing Business rankings, 2013<sup>193</sup>). The Czech Republic ranks the worst in terms of: setting up businesses and connecting businesses to electricity (both 146th), tax payment (122nd) and investor protection (98th). In recent years, competing countries (see e.g. Poland, Romania, Estonia etc.) have been improving much faster than the Czech Republic where the changes are being postponed or only slowly implemented due to political instability. This negatively affects the perception of the country by foreign investors, which is a significant risk for the economy, as its growth is mainly driven by foreign companies.
- The development of the entrepreneurial culture and innovation atmosphere is being prevented by a high level of perceived corruption (see World Competitiveness Report, WEF, 2013). The level of perceived corruption affects the size of the portion of the society that – rather than personal effort in transparent competition – considers building and misusing personal connections and influence groups as the most effective method of economic self-realisation. At the same time, the high level of perceived corruption motivates entrepreneurs to focus on protecting what they have already achieved rather than on further growth, which is greatly exacerbated by the instability of the regulatory framework in the Czech Republic.

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<sup>193</sup> The World Bank compiles the Ease of Doing Business rankings for 189 countries in the world. The twelfth edition of this international comparison was published in October 2014.

## 6.2. Research and development

### Key area of change B: Improving the quality<sup>194</sup> of public research

The overall quality of research in the Czech Republic falls behind that of most developed countries in the OECD, despite the fact that this country has research teams that are at an international level. While there are positive trends in improving the quantity and quality of the results of research as measured through bibliometric parameters, the Czech Republic still fails to achieve satisfactory values. However, the implementation of high-quality research and further improvement in its quality by international comparison is a prerequisite for: (i) training highly-qualified human resources for research and innovation that are essential both for pushing the boundaries of knowledge and transferring existing knowledge from abroad into the Czech Republic, and for ensuring sufficient numbers of qualified experts for the needs of the application sector; (ii) the ability to come up with new technological solutions to existing and future problems of the economy and society, including problems identified by application partners in the fields of the Czech Republic's economic specialisation.

Within the context of the Czech Republic, it is essential to simultaneously strive to generally increase the quality of research, which is closely associated with the setting of suitable general conditions, and to increase the quality and problem-orientation of research in those knowledge domains<sup>195</sup> where the Czech Republic has already attained an international level. The target is both a general improvement in the quality and problem-orientation of Czech research and the creation of a limited number of internationally competitive research organisations that will become principle partners for the further development of the key knowledge domains within the Czech Republic's smart specialisation (see the chapter on specialisation).

The general improvement in quality and the problem-orientation requires both measures in the regulatory area at the national level, and measures at the level of individual research organisations. At the national level, this mainly involves changes in the *governance* of R&D policy; changes in the evaluation of quality and institutional financing with an emphasis on *peer review* elements and good international practices and the associated differentiation of quality and the reinforcement of the critical mass in the areas of good-quality research, improving the quality of the performance of public administration in R&D, increasing the qualifications of the responsible civil servants and improving the methodological level of the support programmes with the aim of improving the ability to implement the approved strategy, improve the evaluation of projects and support programmes, and reduce the administrative burden on researchers. At the level of research organisations, the prerequisites for a general increase in quality also include a general improvement in the strategic management of research activities, including the professionalisation of the support processes for research management and implementation.

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<sup>194</sup> The quality of the research is fundamentally dependent on the quality of human resources for research careers. For more on this topic, see the key change area *Better supply of HR, in terms of both quality and quantity, for innovative enterprise, research and development*.

<sup>195</sup> For more information see the chapter on specialisation. The knowledge domains are understood to mean the following areas of research: materials research, information and communication technology, electronics and photonics, advanced manufacturing technology, biotechnology and biomedicine.

Improvement in the quality and problem-orientation of research in the fields where the Czech Republic has achieved an international level of quality presupposes the concentration of resources into a limited number of priority areas of oriented research with links to identified key knowledge domains and application directions defined in co-operation with the application sector. There, it will be essential to ensure prioritised, stable financing that enables planned development (through implementing long-term, problem-oriented research agendas, including economic research in the area of non-technical innovations and the digital and creative industries, and through supporting partnerships with high-quality international partners, upgrades of research infrastructures, especially large infrastructures, including their operation), and through strengthening their international openness and co-operation, and also through increasing their attractiveness to talent from the Czech Republic and abroad.

<b>Key area of change B: Improving the quality of research</b>		
<b>Strategic objectives in key area of change B:</b> <b>B.1: Improving the quality and problem-orientation of research in knowledge domains that are relevant for intelligent specialisation</b>		<b>Indicators of strategic objectives/key area of change:</b> <ul style="list-style-type: none"> <li>• The share of specialist publications co-authored by domestic and foreign researchers</li> <li>• Number of participations of supported research teams implemented within the Horizon 2020 programme</li> <li>• Number of international patent applications (PCT) with an originator/co-originator from research organisations</li> </ul>
<b>Strategic objective B.1: Improving the quality and problem-orientation of research in knowledge domains that are relevant for intelligent specialisation</b> <sup>196</sup>		
<p>Improving the quality of research in the knowledge domains that are critical for strengthening smart specialisation is an essential prerequisite for the Czech Republic's long-term competitiveness. This requires (apart from identifying the actual knowledge domains) providing favourable and stable conditions for their further development in the form of the long-term financing of excellent teams (including teams deployed in Prague) with an emphasis on the problem orientation of research, and providing high-quality research infrastructures. In order to improve quality, it is also necessary to strengthen the openness of the research environment in the Czech Republic (active measures against in-breeding) through linkage to the international research community by means of international partnerships, support for international co-operation in R&amp;D and support for bidirectional international mobility.</p> <p>Improved conditions for the development of high-quality research facilities in the fields that are relevant for smart specialisation will translate into more-intensive involvement in international research cooperation (in the form of greater success in acquiring international grants, involvement in international projects of research infrastructures, and international patent activity) and eventually into the increased number and share of international researchers and researchers who graduated abroad but are active in the Czech Republic.</p>		
<b><i>Specific objectives</i></b>	<b><i>Indicators of the specific objective</i></b>	<b><i>Model activities/projects/operations</i></b>

<sup>196</sup> For more information see the chapter on specialisation in the Czech Republic.



<b>B.1.1: Providing stable conditions for the long-term development of high quality research facilities</b>	<ul style="list-style-type: none"> <li>The number of infrastructures in the Czech Republic that are involved in projects of the pan-European ESFRI infrastructures and included in the national roadmap of large infrastructures</li> </ul>	<i>Upgrading strategically significant research infrastructures and infrastructures constructed using the EU Structural Funds (especially from the OP RDI and infrastructures included in the Roadmap for large research experimental development and innovation infrastructures in the Czech Republic<sup>197</sup>), including securing long-term stable financing and support services (technical personnel) for the needs of open access. In the case of the ELI Beamlines project, the additional construction of infrastructure (within the phasing of the project).</i>
		<i>Improving the quality of the infrastructure conditions of universities and AS CR institutes that co-operate on research-oriented programmes with relevance for the RIS3</i>
		<i>Specifically supporting the modernisation and additional construction of research infrastructures at universities and AS CR institutes in Prague in research organisations that are critical for the implementation of RIS3</i>
		Support for access to sources of R&D information, specialist publications and data sources (magazines, e-books, bibliographic and scientometric databases etc.), including free access to the results (data and information repositories)
		Support for acquiring and retaining critical research staff in excellent research teams
<b>B.1.2: Increasing the international openness of public research in the Czech Republic</b>	<ul style="list-style-type: none"> <li>Number of new international co-operation projects within established international strategic partnerships<sup>198</sup></li> <li>Headcount of foreign researchers employed in research organisations in the Czech Republic</li> </ul>	<i>Strategic research partnerships with leading foreign facilities both within and outside the EU (the implementation of a joint research agenda, bidirectional mobility)</i>
		Support for the international mobility of research, technical and administrative R&D staff and students
		Projects for the establishment or development of selected research groups, including groups connected with the arrival of foreign

<sup>197</sup> Within the meaning of Act No 130/2002 Coll.

<sup>198</sup> The precondition is an international research partnership with international partners that have attained a demonstrably higher level of quality than the Czech partner entity.



		<p>researchers and reintegrating Czech scientists including the obligation of open competition for both domestic and foreign scientists</p> <p>Support for soft services for the arrival of foreign researchers and students (Euraxess etc.)</p> <p><i>Projects of international graduate schools, especially at doctoral level</i></p> <p><i>Specific support for strategic international R&amp;D projects (Teaming, Twinning, EIT KICs)</i></p> <p>Activities aimed at improving grant support, especially in the case of international grants (support for the activities of grant offices at RO)</p> <p>Implementing support activities to strengthen international research co-operation, including the involvement of research organisations in Joint Technology Initiatives and Joint Programming, ERA Nets, including the personnel reinforcement of capacities for strategic, information and administrative support and improved coordination at national level</p> <p>Preparing and subsequently implementing the marketing strategy of the Czech Republic for research and innovation in order to enhance the image of the Czech Republic as a technologically advanced country (incl. the promotion of R&amp;D achievements in the Czech Republic and abroad)</p>
<p><b>The strategies and national documents to which the strategic and specific objectives are related:</b></p> <ul style="list-style-type: none"> <li>- National Research, Development and Innovation Policy of the Czech Republic for 2009–2015</li> <li>- National Innovation Strategy of the Czech Republic</li> <li>- Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic – updated in May 2011 (MEYS)</li> <li>- The International R&amp;D Audit in the Czech Republic</li> <li>- National Reform Programme of the Czech Republic 2014</li> <li>- National Priorities of Oriented Research, Experimental Development and Innovations</li> </ul>		
<p><b>The conditions for and barriers to implementing interventions in this key area of change<sup>199</sup>:</b>  The implementation of <i>regulatory measures</i> aimed at increasing the effectiveness of the management of research policy, especially in the following areas:</p>		

<sup>199</sup> This includes measures of the updated National RDI Policy for 2009 to 2015 with a view to 2020, namely measures 1, 2, 5, 14, 15, 16, 17 and 18. Other intervention-type measures are included among the proposed model activities.

- Changes in the governance of R&D policy (including the necessary amendment to Act 130/2002) in order to strengthen the creation of a consensus on the strategy and achieve real prioritisation and subsequent strengthening of the critical mass in areas of high-quality R&D
- As of 2016, introducing a new methodology for evaluating research quality (based on good international practices, including the element of peer review, the combination of evaluation of the past and plans for the future, consideration of interdisciplinary differences, strengthening the element of application relevance in evaluation, and closer linkage between financing and the originator of the results) and the associated institutional financing with a substantial preference for (differentiation of) quality over mediocrity
- Strengthening the component of institutional financing over targeted financing with the aim of increasing the financial stability and predictability

The above changes will need to be translated into corresponding *legislation*, especially into Act No 130/2001 Coll., on support for research and development from public resources.

Systemic measures to improve the *quality of the performance of public administration* in the area of R&D, especially:

- ***Clearly defined competence for the coordination of programmes that are financed and co-financed from national resources) so that it is possible to thoroughly interconnect the financing of the defined priorities of smart specialisation from resources intended for regional policy (ESIF) and national resources***
- Stabilising civil servants in responsible institutions and improving their qualifications with the aim of improving the ability to implement the agreed research, development and innovation strategies
- Improving the methodological quality of support programmes with the aim of systematically reducing the administrative burden on researchers, systematically reducing the administrative burden and coordinating this effort across the providers of targeted support
- Improving the evaluation of R&D projects and the support programmes (ex-ante and ex-post), including greater involvement of foreign evaluators
- Developing the strategic management of research, development and innovation policy (foresighting, trend mapping) for the purposes of focussing the programmes of targeted support for R&D
- Building the institutional capacity and strategic intelligence of public administration in the area of research, development and innovation and the implementation of RIS3 at national and regional levels
- Increasing public expenditure on R&D with the aim of achieving a 1% share in GDP by 2020
- Preparing a long-term financial outlook for the R&D budget for 7 years, including the fixation of the amount for implementing the National Priorities 2030
- Updating the National roadmap of large Infrastructures up to 2020, including linking its financial requirements to the long-term financial outlook
- Introducing a new methodology for evaluating programmes of targeted support

### Key area of change C: Increasing the economic benefits of public research

In terms of the interaction of public research with partners from the application sector, Czech research organisations show significant deficiencies, which are even more apparent in international comparison. In the vast majority of areas, Czech research organisations show only a minimal level of commercial utilisation of their research results and knowledge, whether in the form of the direct commercialisation of results (the sale of licences to intellectual property or the establishment of technology companies using the intellectual property of the research organisations) or in the form of co-operation with the application sector (contract research, joint projects and joint publication activity). As a result, the growing public investment in research has translated very little into higher economic and social return, higher added value and improved competitiveness of the Czech Republic.

The causes of this unsatisfactory situation must be addressed simultaneously at three levels: (i) through changes in the regulatory conditions, which must be set in a way that stimulates greater interest in the commercial use of the results on the part of research organisations, especially while taking into account the aspect of co-operation with the application sector in evaluating the quality of research and institutional financing; (ii) through improving the preparedness of research organisations to cooperate with the application sector through changes and improvements to internal procedures and mechanisms; (iii) through implementing support tools and interventions that will ensure the highest possible level of interaction between research organisations and the application sector, including joint training of doctoral students.<sup>200</sup>

The changes in the regulatory conditions and improvements in the preparedness of research organisations to cooperate with the application sector have the nature of horizontal measures that should affect the widest group of research organisations possible, regardless of their area of interest. The implementation of support tools should mainly take the form of vertical measures, i.e. interventions aimed primarily at research teams and research and application themes that are relevant to smart specialisation.<sup>201</sup>

The target situation is the improved preparedness of research organisations for co-operation and, at the same time, the creation of stimulating conditions for cooperation between public research and the application sector. Another target is the creation of mechanisms for intensive long-term interaction between research organisations and companies, especially through supporting their co-operation on joint research in directions that are significant for strengthening the competitive advantage of companies in the Czech Republic (see the chapter on specialisations).

Key area of change C: Increasing the economic benefits of public research	
<b>Strategic objectives in key area of change C:</b> <b>C.1: Increasing the relevance of research to the needs of the application sector</b>	<b>Indicators of strategic objectives/key area of change:</b> <ul style="list-style-type: none"><li>• Number of licences to research results granted to companies by research organisations</li><li>• Number of acquired grant (i.e. co-financed by companies) research projects of research organisations and companies</li></ul>

<sup>200</sup> Another cause of the unsatisfactory situation is the low sophistication of innovation demand on the part of Czech companies. This area is addressed in key area of change *Higher innovation performance of companies*.

<sup>201</sup> For more information see the chapter on specialisation in the Czech Republic.

**Strategic objective C.1: Increasing the relevance of research**

The relevance of research activities is directly dependent on the intensity of the interaction and co-operation with the users of the results and with the application sector, which is a necessary partner for correctly defining the research problem. In order to increase the relevance of research financed from public resources, it is therefore necessary to support co-operation and mobility and to strengthen the partnership relations between research organisations and the application sector. In order to increase the economic benefits of research that is implemented by research organisations, it is essential to improve the support processes for the commercial use of R&D results.

Increasing the intensity of the interaction between research organisations and companies will translate into increased intensity of jointly prepared and implemented projects, and the volume of contract research. Improving the processes to support commercialisation will translate into an increase in the number of licences granted by research organisations for the results of their research activities, and in the number of technological companies that use the intellectual property of research organisations.

<i>Specific objectives</i>	<i>Indicators of the specific objective</i>	<i>Model activities/projects/operations</i>
<b>C.1.1: Strengthening the co-operation and interaction between research organisations and the application sector<sup>202</sup></b>	<ul style="list-style-type: none"> <li>The volume of financial resources for R&amp;D acquired by research organisations from corporate sources (contract R&amp;D + donations from donors)</li> <li>The share of specialist publications co-authored by research organisations and companies</li> </ul>	<i>Support for the preparation and implementation of joint projects of research organisations and application partners in R&amp;D and education, with an emphasis on interdisciplinary approaches and on defining the focus of the activities in co-operation with the application sector (projects such as competence centres)</i>
		<i>Long-term problem-oriented research programmes<sup>203</sup> that respond to the medium-term needs of the application sector; emphasis on the networking of leading Czech facilities and entities from the application sector (especially technologically advanced companies) in key economic sectors, and on interdisciplinary topics with the potential for the wide application of the results in practice</i>
		<i>Summer schools implemented in co-operation between research organisations and the application sector</i>
		Student mobility, joint training of PhD students under the supervision of universities and companies (Knowledge Transfer Partnerships)
		Industrial professorships (professorial positions for experienced specialists from practice)
		Innovation vouchers
		<i>The establishment of innovation platforms for the priority areas of RIS3 (the areas of vertical specialisation) at the national level, while identifying promising long-term R&amp;D themes that respond to the needs of the application sector and to identified social challenges</i>
		Providing access to the instruments of research organisations for the needs of external users – creating a central nationwide database of the instruments available at research organisations, negotiating the terms and setting the rules for access to the instruments.
Activities aimed at strengthening contacts and building up trust between research organisations and the		

<sup>202</sup> Only in the implementation of application research topics that develop smart specialisation.

<sup>203</sup> This is an analogy to the Future and Emerging Technologies (FET) programme that is implemented within the 7th EU Framework Programme.

		commercial sector (the establishment of information and cooperation platforms, networking events etc.)
<b>C.1.2: Increasing the commercial use of the R&amp;D results and knowledge of research organisations</b>	<ul style="list-style-type: none"> <li>The volume of resources obtained by research organisations from newly granted licences to research results (from 2014)</li> <li>The number of start-up companies using intellectual property from research organisations</li> </ul>	Activities aimed at strengthening the entrepreneurship of university students and researchers (student competitions, education in the basics of entrepreneurship...)
		The implementation of international incentive tools (within research organisations) to support co-operation with the application sector
		Support for the creation of academic start-ups (i.e. companies based on research results), including temporary management services to manage the establishment and development of companies
		Educating students and researchers in the area of intellectual property
		Securing internal and expert capacities for the transfer of technology (licensing, contract research) from research organisations to companies, improving the effectiveness of and professionalising the processes during commercialisation, including providing a mechanism for financing the patent protection of research organisations' results
		The presentation of results in the media as part of the commercialisation of research
<b>The strategies and national documents to which the strategic and specific objectives are related:</b> <ul style="list-style-type: none"> <li>National Research, Development and Innovation Policy of the Czech Republic for 2009–2015</li> <li>National Innovation Strategy of the Czech Republic</li> <li>International Competitiveness Strategy of the Czech Republic for 2012–2020</li> <li>The International R&amp;D Audit in the Czech Republic</li> <li>National Reform Programme of the Czech Republic 2014</li> </ul>		
<b>The conditions for and barriers to implementing interventions in this key area of change:</b> <p>The implementation of regulatory measures aimed at strengthening the aspect of co-operation with the application sector in the overall evaluation of research quality:</p> <ul style="list-style-type: none"> <li>Earmarking a portion of institutional resources for research organisations, which will be allocated in the form of an additional financial bonus based on an evaluation of co-operation with the application sector (an analogy to the system introduced for English universities)</li> <li>Revising the existing system for allocating institutional resources so that the application relevance and quality of the applied results is also taken into account (a new evaluation methodology from 2016)</li> <li>Removing systemic barriers to co-operation of research organisations and the practice, especially in the area of contract research and the commercialisation of R&amp;D results (the binding interpretation of the public support rules that will not excessively limit contract research, the use of subsidised equipment and intellectual property for commercial purposes etc.)</li> </ul>		

### 6.3. Human resources

#### **Key area of change D: Improved availability of HR, in terms of both quality and quantity, for innovative enterprise, research and development**

Human resources represent the key determinant of the competitiveness of a country, especially in terms of competitiveness in knowledge-intensive markets. From this perspective, there are three very important interconnected levels of creating and developing people's research and innovation potential.

The first level can be viewed as the general level of realistically applicable knowledge and skills that, in practice, translate mainly into the ability to create commercially usable innovations. From this perspective, it is possible to identify some skills that are above average in comparison with other OECD countries, both in the adult population and in the population of pupils aged 15. However, the application of the current, mostly average skills of the Czech population continues to be limited by the insufficient level of soft skills, such as entrepreneurship, co-operation, flexibility or customer orientation, which are essential for success in knowledge-intensive markets. Insufficient language skills also hinder the potential of the economy to benefit from market globalisation and, for example, to quickly and knowledgeably introduce new practices or benefit from innovations emerging abroad. Unless a larger portion of the population can offer a combination of expertise, soft skills and language skills, the Czech Republic will provide a poor environment for innovative companies, both domestic and foreign.

The development of the mix of competencies that support the creation of innovations and increase the potential for knowledge-intensive activities, including research and development, represents merely an initial prerequisite for success. The "building block" of the second level is to use those characteristics of individual people that can generate the greatest value. This essentially involves identifying and developing natural talents, where the entrepreneurial talent, technical talent and the talent for research and development work are the most important for the topic being discussed. Unfortunately, the Czech education system lacks the identification of personal aptitude for a career in which the individual will be the most productive, and it does not support the individual's development in this direction. In turn, this negatively affects the degree to which the potential of human resources is utilised, reduces the effectiveness of investment in education in a large part of the population (including the lack of graduates from technical disciplines) and limits the inclusive function of education. The introduction of the above system of working with talent would make it possible to identify the best talent and work with them intensively from a very young age. The acquisition of talent includes both making better use of the country's own resources and effectively attracting talent from abroad, because – regardless of the origin of these individuals – it is their presence and contribution in the Czech Republic that count.

The highest level includes working with people whose profession is research and development, because they have the best prerequisites for generating knowledge that may contribute significantly to the competitiveness of the country. It turns out that already in the initial phase of university education, knowledge from research and development is inadequately used in students' practical training and in the knowledge of students, which translates into insufficient transfer of new knowledge into practice. At the same time, however, it also turns out that researchers themselves do not have suitable conditions for their development, especially in the public sector. The competitive environment in the public sector is insufficiently open, weak (and in some cases even unhealthy) and it does not provide enough room or motivation for the development of a large portion of the employees in this sector. It is therefore necessary to specify the correct direction for the development of individual research organisations and universities and to adjust work with

human resources correspondingly. The parallel implementation of measures at all three levels will ensure a systemic change in the use of human resources for work in research, development and innovative enterprise.

The RIS3 Strategy specifies the following strategic objectives for this key area of change; for the area of regional education, these are indicative proposals for activities and indicators.

<b>Key area of change D: Improved availability of HR, in terms of both quality and quantity, for innovative enterprise, research and development</b>	
<p><b>Strategic objectives in key area of change D:</b></p> <p><b>D.1: Improving the quality of school graduates</b></p> <p><b>D.2: Identifying and making use of talent</b></p> <p><b>D.3: Improving the quality of research and development staff</b></p>	<p><b>Indicators of strategic objectives/key area of change:</b></p> <ul style="list-style-type: none"> <li>• The numbers of primary and secondary schools and universities equipped with tools for the diagnostics and development of soft skills</li> <li>• The proportion of secondary school graduates with a knowledge of English at a corresponding level according to the Common European Framework of Reference (secondary school completed without the maturita school-leaving examination – B1, secondary school completed with the maturita school-leaving examination – B2)</li> <li>• The proportion of university students who have studied at least one semester abroad</li> <li>• The number of primary and secondary schools with a borrowed (standardised) system for identifying the natural talents of pupils</li> <li>• The number of primary and secondary schools with an implemented programme for developing natural talent</li> <li>• The number of persons participating in individualised programmes for the development of individuals with exceptional talent</li> <li>• The number of foreign students at universities</li> <li>• The number of research organisations with a modernised system of strategic management</li> <li>• The proportion of doctoral students who successfully completed their studies</li> <li>• The proportion of doctoral students who have studied at least one semester abroad</li> </ul>
<p><b>Strategic goal D.1: Improving the quality of school graduates</b></p> <p>The quality of human resources in the current knowledge-oriented economy represents the key determinant of international competitiveness. Therefore, all countries</p>	

focus on the different levels of their initial education systems with the aim of improving their effectiveness. It is no coincidence that the countries with the best functioning school systems are the leaders in the area of research and innovation and that they achieve above-average rates of growth (for example, Munich and Protivínský<sup>204</sup> have documented a strong relationship between the education of the population and economic growth). From this perspective, it is absolutely essential for the Czech Republic to focus its attention on improving as quickly as possible the quality of the outputs of each level of the education system. At present, the Czech Republic admittedly achieves above-average results in the natural-science literacy of pupils, the numerical literacy of the adult population and the high level of interest in studying technical and natural science fields among doctoral students, but the long-term declining trend in the quality of the outputs of education, the inadequate development of soft skills and language skills, the high ratio of unsuccessful doctoral students and the unbalanced structure of the fields of study in relation to the needs of the labour market not only make it impossible to use the above advantages, but they also represent a threat for Czech competitiveness in the future.

<i>Specific objectives</i>	<i>Indicators of the specific objective</i>	<i>Model activities/projects/operations</i>
<b>D.1.1: Creating a functioning relationship between schools and employers</b>	<ul style="list-style-type: none"> <li>▪ The satisfaction of employers with the quality of the expertise and skills of graduates from various fields of study (it is necessary to carry out a representative survey among employers<sup>205</sup>)</li> </ul>	<ul style="list-style-type: none"> <li>▪ The definition of the expected education outputs (these can be called graduate competence models) that will not only indicate the required competencies, but also their contents and target level for each level of the system of initial education; these expected outputs will be processed for the different groups of professions and as such will represent recommendations for modifying the curricula of individual schools (the objective of this measure is the specific description of the objectives of education based on the needs of employers). The processing of the competence models can make use of, for example, the relevant outputs from the National System of Qualifications and the National System of Professions.</li> <li>▪ The introduction of a system of (preferably long-term) placements for teachers active in initial education at employers and linking the system to teachers' career paths</li> <li>▪ The implementation of activities leading to the practical orientation of teaching at universities and secondary schools, for example in the form of internships, shadowing or the setting of work topics by employers</li> </ul>
<b>D.1.2: Increasing the level of entrepreneurship and other soft competencies</b>	<ul style="list-style-type: none"> <li>▪ The satisfaction of employers with the quality of soft competencies in the graduates from various fields of study (it is necessary to carry out a representative survey among employers<sup>206</sup>)</li> <li>▪ The numbers of primary and secondary schools</li> </ul>	<ul style="list-style-type: none"> <li>▪ The general introduction of tools for the diagnostics and development of entrepreneurship and the soft skills defined by the National System of Professions at all levels of the education system, including training teachers on working with these tools</li> <li>▪ The implementation of activities leading to the practical orientation of</li> </ul>

<sup>204</sup> Munich and Protivínský (2013): The impact of education on economic growth in the light of the new PISA 2012 results

<sup>205</sup> The alternative is the introduction of a nationwide system for the evaluation of the quality of the teaching.

<sup>206</sup> The alternative is the introduction of a nationwide system for the evaluation of the quality of teaching.



	and universities equipped with tools for the diagnostics and development of soft skills	teaching (see the activity under objective D.1.1)
<b>D.1.3: Improving the active knowledge of English and another foreign language</b>	<ul style="list-style-type: none"> <li>▪ The satisfaction of employers with the level of knowledge of English and possibly another foreign language among the graduates from various fields of study (it is necessary to carry out a representative survey among employers<sup>207</sup>)</li> <li>▪ The proportion of secondary school graduates with internationally acknowledged certificates attesting to their knowledge of English at a corresponding level according to the Common European Framework of Reference (secondary school completed without the maturita school-leaving examination – B1, secondary school completed with the maturita school-leaving examination – B2)</li> <li>▪ The proportion of university students who have studied at least one semester abroad</li> <li>▪ The proportion of university students who have studied at least one subject in English during their studies</li> </ul>	<ul style="list-style-type: none"> <li>▪ The introduction of compulsory English lessons at primary and secondary school completed with an examination with requirements corresponding to the levels according the Common European Framework of Reference (primary school – A2, secondary school completed without the maturita school-leaving examinations – B1, secondary school completed with the maturita school-leaving examination – B2); other languages should be taught as a second foreign language</li> <li>▪ The development of a specialist foreign language at specialist secondary schools and universities</li> <li>▪ The involvement of native speakers in teaching English in the system of initial education</li> <li>▪ The involvement of foreign specialists in teaching at universities</li> <li>▪ The introduction of a system of foreign language courses for teachers and its links to teachers' career paths</li> <li>▪ The introduction of the obligation to actively use a foreign language during studies at all universities and secondary schools, for example in the form of the study of some subjects in English, or the implementation of a study stay abroad (except for Slovakia)</li> </ul>
<p><b>Strategic objective D.2: Identifying and making use of talent</b></p> <p>Identifying areas of activities, in which an individual will be the most productive (because they have e.g. an artistic or sports talent, an aptitude for craft, entrepreneurial skills etc.), and developing them in that direction is the essence of working with talent. Unfortunately, this is lacking in the Czech education system. Every pupil or student has a natural talent for something (this is not taken to only mean exceptional talent) and he or she should choose the type of education accordingly. However, people often discover their talents towards the end of their educational path, after its completion or not at all. These cases mean that resources are spent inefficiently on incorrectly oriented education and that the individual's productive potential will be used only partly or not at all. This also means that the individual's chances of succeeding in their personal and professional life are reduced. Therefore, the timely identification of the natural talents of each individual, their correct guidance and targeted development could help significantly reduce the inefficiency in education and improve competitiveness. According to the targeting of these tools, the Czech Republic could deliberately support the development of entrepreneurial talent, reduce the problem of insufficient workforce with a technical education and cultivate top-quality talent for research teams from their childhood. Also, this measure has an inclusive nature, because it assists in the use of individuals who show poor school results and who do not receive adequate attention in the current education system. The insufficient amount of "domestic talent" in individual areas can also be addressed through supporting the arrival of such talent from other countries.</p> <p>Binding indicators for objective D.2:</p>		

<sup>207</sup> The alternative is the introduction of a nationwide system for the evaluation of the quality of teaching.

<ul style="list-style-type: none"> <li>• The proportion of primary and secondary schools with an implemented system for identifying the natural talents of pupils</li> <li>• The proportion of primary and secondary schools with an implemented programme for developing natural talent</li> <li>• The number of persons participating in highly individualised programmes for the development of individuals with exceptional talent</li> <li>• The number of foreign students at universities</li> </ul>		
<b>Specific objectives</b>	<b>Indicators of the specific objective</b>	<b>Model activities/projects/operations</b>
<b>D.2.1: Creating a system for identifying and developing natural talent</b>	<ul style="list-style-type: none"> <li>▪ The proportion of primary and secondary schools with an implemented system for identifying the natural talents of pupils</li> <li>▪ The proportion of primary and secondary schools with an implemented programme for developing natural talent</li> </ul>	<ul style="list-style-type: none"> <li>▪ The creation and introduction of tools for identifying pupils' natural talent for entrepreneurship, technical professions and research and development</li> <li>▪ The creation and application of development programmes for the above types of natural talent, including the preparation of consultants for working with them</li> </ul>
<b>D.2.2: Preparing the next generation of innovators</b>	<ul style="list-style-type: none"> <li>▪ The number of persons participating in individualised programmes for the development of individuals with exceptional talent</li> </ul>	<ul style="list-style-type: none"> <li>▪ The implementation of highly individualised programmes for the development of individuals with an exceptional entrepreneurial talent, a technical talent or a talent for research and development work</li> </ul>
<b>D.2.3: Creating a system for attracting and adapting highly qualified people to the Czech Republic</b>	<ul style="list-style-type: none"> <li>▪ The number of foreign students at universities</li> <li>▪ The number of highly qualified foreigners with long-term residency in the Czech Republic or with granted Czech citizenship</li> </ul>	<ul style="list-style-type: none"> <li>▪ Encouraging foreign students to study at Czech universities (for example the promotion of Czech universities abroad, the introduction of English as a second official language at universities, the introduction of compulsory subjects in English, the purchase of foreign literature for libraries etc.)</li> <li>▪ Encouraging highly qualified foreigners (especially in technical professions) to work in the Czech Republic</li> </ul>
<p><b>Strategic objective D.3: Improving the quality of research and development staff</b></p> <p>The quality of research and development mainly depends on the quality of the available human resources and the effectiveness of their use. In the private sector, the presence of competitive pressures and the need to survive creates a suitable environment that gives rise to the need to intensively address both of the above factors. However, the environment in public research differs significantly from that in the private sector, especially in the intensity of the pressure on the results and effectiveness of research and development (furthermore, there are also significant differences between individual research organisations). As a result, the public research environment in the Czech Republic can be perceived as being generally less competitive and showing less pressure on performance than in the case of the private sector or in research in developed countries. The above is often reflected in the unclear development strategy of individual research organisations (including the implementation framework), the insufficient functioning of personnel processes, and also the insufficient effectiveness or the absence of tools that might help eliminate the above deficiencies of the current system. Public research organisations are therefore faced with the very demanding task of changing the culture of this sector, defining the direction of development (including identifying priority research areas), building support structures and commencing targeted work associated with the development of human resources, and improving the effectiveness of their use.</p> <p>Binding indicators for objective D.3:</p> <ul style="list-style-type: none"> <li>• The number of research organisations with a modernised system of strategic management</li> <li>• The proportion of doctoral students who successfully completed their studies</li> <li>• The proportion of doctoral students who have studied at least one semester abroad</li> </ul>		
<b>Specific objectives</b>	<b>Indicators of the specific objective</b>	<b>Model activities/projects/operations</b>

<p><b>D.3.1: Improving the level of strategic and operational management and creating the conditions for improving the competitiveness of research organisations</b></p>	<ul style="list-style-type: none"> <li>▪ The number of research organisations with a modernised system of strategic management</li> <li>▪ The number of universities with implemented transparent systems for evaluating quality</li> </ul>	<ul style="list-style-type: none"> <li>▪ Management education for executives at research institutes, universities and their faculties, especially in the area of strategic management, leadership and change management</li> <li>▪ Updating and implementing strategic development plans of faculties, universities and research institutes, which are aimed at achieving European quality in research and teaching (the aforementioned assumes a change in the culture of these organisations towards a “challenge culture”)</li> <li>▪ Optimising the internal processes of the research organisations, reducing the administrative burden, and defining the measures of quality</li> <li>▪ The introduction of English as a second language in the operations of research organisations</li> </ul>
<p><b>D.3.2: Introducing an effective system of human resource management at research institutes, universities and their faculties</b></p>	<ul style="list-style-type: none"> <li>▪ The evaluation of the satisfaction and work participation of employees</li> <li>▪ The proportion of research institutes and universities certified in human resource management</li> </ul>	<ul style="list-style-type: none"> <li>▪ A change in the existing system of human resource management according to modern trends and the specific needs of each organisation (analysis, proposal, introduction, evaluation and improvement)</li> <li>▪ Educating managers and relevant employees of research organisations on human resource management</li> </ul>
<p><b>D.3.3: Increasing the attractiveness of research careers and improving the quality of the preparation of future researchers</b></p>	<ul style="list-style-type: none"> <li>▪ The proportion of doctoral students who successfully completed their studies</li> <li>▪ The proportion of doctoral students who have studied at least one semester abroad</li> <li>▪ <i>The number of foreign internships longer than 5 months</i></li> </ul>	<ul style="list-style-type: none"> <li>▪ Activities to popularise research with the aim of increasing the interest of the young generation in research activities, including improving the infrastructure for popularisation</li> <li>▪ Programmes for talented students (master’s and doctoral level) with special preference for the priority fields of smart specialisation</li> <li>▪ Improving the quality of scientific preparation through support for the completion of a part of doctoral studies abroad, for example in the form of long-term internships at a foreign organisation engaged in research and development, or the obligation to complete an internship or shadowing of a corresponding profession in practice</li> <li>▪ Strengthening international mobility in the European Research Area (ERA)</li> <li>▪ Improving the quality of scientific preparation through support for the active participation of doctoral students in reputable international conferences</li> <li>▪ The development of relevant language skills in doctoral students at least to the C1 level</li> <li>▪ The development of the relevant soft skills in doctoral students to an above-average level, i.e. level 4 and 5 according to the classification of soft skills in the National System of Professions</li> </ul>

- Specific measures to strengthen the proportion of women in research, including measures aimed at reconciling maternity and parental leave with a career in research and development

**The strategies and national documents to which the strategic and specific objectives are related:**

- Education Policy Strategy of the Czech Republic up to 2020
- International Competitiveness Strategy of the Czech Republic for 2012–2020
- Human Resources Development Strategy for the Czech Republic
- Economic Growth Strategy of the Czech Republic
- National Innovation Strategy of the Czech Republic
- The Updated National Policy for Research, Development and Innovation of the Czech Republic for 2009 to 2015 with a view to 2020
- National Reform Programme of the Czech Republic 2014

**The conditions for and barriers to implementing interventions in this key area of change:**

- Increasing the level of entrepreneurship and other soft skills (objective D.1.2) must be supported through the introduction of a uniform methodological approach and the provision of suitable tools throughout the entire system of initial education. The current practice, where individual schools have approached the achievement of this objective in different ways based on their own solutions, shows that this approach does not guarantee the necessary results.
- The introduction of the obligation to actively use a foreign language during studies at secondary schools and universities (objective D.1.3) is conditional upon the implementation of the other proposed measures in this objective. Above all, it is crucial to increase the number of foreign specialists teaching at universities and to include native speakers in teaching at secondary schools. The limited number of Czech teachers with a corresponding knowledge of a foreign language does not need to be of fundamental importance in that it is sufficient to include 1 subject in English for each year of study, i.e. only a very limited number of teachers are needed to provide these classes. This step is also conditional upon a change in the relevant laws, which will allow the inclusion of compulsory lessons in a foreign language in Czech study programmes.
- The general introduction of a system for identifying and developing talent (objective D.2.1) at all primary and secondary schools will ensure that all pupils (given that school attendance is compulsory, this means the entire population aged 6–15) will be monitored in terms of their aptitude for entrepreneurship, technical career or career in research and development. Pupils, in whom the potential for any of those areas is identified, will be worked with in order to develop this aptitude. Given that this involves long-term work with the entire population of pupils in the area of their development, it is logical that this activity will be implemented by individual schools. To this end, it is necessary to create functioning diagnostic and development tools that will be provided to all primary and secondary schools. The uniform systems of identifying and developing talent will ensure an equal approach to all pupils across the Czech Republic.
- The successful implementation of the objectives in this key area is conditional upon improving the quality of teachers at all levels of the system of initial education (for example through implementing the Education Policy Strategy of the Czech Republic up to 2020).
- Developing the quality of teaching at primary schools and technically oriented secondary schools supports the achievement of the objectives of this key area of change. It is therefore necessary to ensure co-operation between primary schools and the business sector, which would assist in the better orientation of pupils in the labour market and lead them to a more responsible choice of secondary school (these activities support the effectiveness of the implementation of objective D.2.1), as well as improve the quality of the outputs of education (this can be roughly measured using the results of the PISA survey). At the same time, it is necessary to develop awareness of the technical fields available (including selected fields in the area of the natural sciences) and to increase their attractiveness, especially through

developing their quality. This can be achieved e.g. through changing the way in which some subjects are taught (for example mathematics), introducing elements of dual education, creating a system enabling schools to flexibly respond to the requirements of the labour market (see objective D.1.1) and so on.

- The identification and development of a natural talent for technology and science (see objective D.2.1) also requires motivating pupils and their parents to seek a career in these fields. In the 2007–2013 programming period, a basic infrastructure for the popularisation of science at the national level (science learning centres) was created using resources from the EU funds. It is advisable to ensure the further development and use of these centres.

## 6.4. Information and communication technology – digital agenda

### Key area of change E. The development of eGovernment and eBusiness for increased competitiveness

The electronisation of communication and the distribution of information represents a new phenomenon that, if used correctly, can substantially increase the effectiveness of communication both at the level of public administration, and between public administration and citizens or business entities. Thanks to that, support for the development and use of ICT constitutes a fundamental precondition for improving the competitiveness of the entire economy.

While companies continue to introduce and utilise ICT at their own initiative (due to market pressure and the need to constantly improve the effectiveness of their business activities), the use of ICT at the level of public administration is still inadequate<sup>208</sup>, which ultimately reduces the effectiveness of public administration, increases the cost of public administration, and reduces the competitiveness of the economy as a whole.

As part of the activities to date, the Czech Republic has created the foundations in the form registers that represent a very significant initial step for the development of eGovernment services. However, their use by the different services is currently at a minimal level and they need to be developed.

In order to achieve a greater degree of use of eGovernment services and to gain the trust of the clients (citizens and companies), not only the electronisation of the offered services is important, but also the electronisation of the public administration itself, both within each department and in the communication between the different departments. Only a fully and functionally equipped administration can operate effectively and be a reliable and credible partner for its clients.

Just as ICT can contribute to the effectiveness of the public administration, it also represents significant potential for the development of enterprise, i.e. both thanks to the increased use of ICT in business across all fields and due to the new possibilities in the new fields that emerge along with the rapid development of ICT. Taking advantage of this opportunity requires targeted and highly effective support for the use of ICT in enterprise, support for new companies taking the form of start-ups and spin-offs, and support for research and development in the area of ICT and for the use of ICT which can contribute to the establishment of such companies.

An essential prerequisite for the development of eGovernment and eBusiness is the existence of a sufficient-capacity, high-quality, secure and accessible infrastructure that will provide equal basic entrance conditions for all citizens and entrepreneurs, a high-quality interconnection of all institutions involved, i.e. at a level that not only corresponds to the latest requirements, but that also corresponds to the expected trends in the demand for and use of ICT at least up to 2020 or 2025.

The development of the necessary infrastructure must provide support for building new networks and modernising existing ones, but also for improving the accessibility of high-capacity connection in peripheral areas where insufficient bandwidth is a critical factor limiting the development of any use of ICT<sup>209</sup>.

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<sup>208</sup> 90% of companies use eGovernment services. On the other hand, the proportion of the population who have used eGovernment services in the past 12 months is less than a third (EU, Digital Agenda for Europe: <http://ec.europa.eu/digital-agenda/en>).

Key area of change E: Development of eGovernment and eBusiness to improve competitiveness (development of ICT and digital agenda)		
<b>Strategic objectives in key area of change E:</b> <b>E.1: The development of eGovernment</b> <b>E.2: The development of eBusiness and ICT in enterprise</b> <b>E.3: The development of infrastructure in ICT</b>		<b>Indicators of strategic objectives/key area of change:</b> <ul style="list-style-type: none"> <li>• 100% of public administration offices of municipalities with extended competence or higher (regions, ministries, financial offices, land registry offices etc.) will be offering their 20 most frequently used services for citizens and the 20 most frequently used services for companies in fully electronic form by 2020</li> <li>• More than 70% of the population will have intermediate computer skills by 2020</li> <li>• More than 70% of households in remote areas will be serviced by a high quality Internet connection</li> <li>• More than 70% of the population will use eGovernment services to communicate with the public administration at least once a year</li> </ul>
<b>Strategic objective E.1: The development of eGovernment</b> A fully electronic and effectively functioning public administration that corresponds to the trends in the current development of ICT technologies and use, as the basis of a competitive digital economy. The public administration will offer all services that are commonly used by either citizens or companies in a fully electronic form that will enable citizens and entrepreneurs to seamlessly communicate with public administration bodies at the regional and national levels.		
<i>Specific objectives</i>	<i>Indicators of the specific objective</i>	<i>Model activities/projects/operations</i>
<b>E.1.1: Improving the effectiveness of the public administration's external communication and the communication with clients</b> The offered services will be adapted in terms of their procedural, legislative and technological aspects so that their use is 100% feasible using electronic communication without the need for any personal contact with the given office. Each service will be optimised in order to maximise the effectiveness of its provision, i.e. both in relation to the client and with respect to the public administration's costs for its provision (the use of the basic registries, the mutual links between the various services including the option of automatic loading and	- 100% of public administration offices at the regional and national level (regions, ministries, financial offices, land registry offices etc.) will be offering their 20 most frequently used services/tasks for citizens' communication with public administration in a fully electronic form that will not require any personal contact between the citizen and the appropriate office - More than 20% of citizens will exclusively use electronic communication to communicate with authorities in 50% of cases	- The comprehensive modernisation/transformation of the most frequently used public administration agendas both towards citizens and towards entrepreneurs into a form that is usable for fully electronic communication – i.e. the modification of the legislative conditions, the transformation/creation of new procedural models that use electronic communication, and the transformation of competence models with the aim of enabling electronic communication with clients - The establishment or development (in terms of capacity and function) and modernisation of the information systems used for communication between public administration and clients to a level that will enable full electronic communication - The modernisation of the existing information systems in order to fully connect them to the basic registers with the aim of maximising

<sup>209</sup> The map of the Czech digital wasteland: Only 3 per cent of people have a truly fast Internet connection ([www.ihned.cz](http://www.ihned.cz)) and the Czech Telecommunication Office (<http://www.ctu.cz/ctu-online/pruzkum-nga.html>)

<p>verification of data from the registries without any need to document or specifically request additional actions on the part of the client/citizen).</p> <p>As a result, full electronisation will bring a win-win situation that generates clear benefits and savings for both parties.</p>	<ul style="list-style-type: none"> <li>- More than 70% of citizens will use at least one offered eGovernment service per year</li> <li>- More than 50% of entrepreneurs will submit their tax returns in electronic form</li> <li>- The time required for carrying out 50% of the most frequently used services/tasks by citizens and entrepreneurs will be reduced by at least 50%</li> </ul>	<p>the automatic loading and verification of data using the basic registers</p>
<p><b>E.1.2: Improving the effectiveness of internal communication of public administration</b></p> <p>In terms of their procedural, legislative and technological aspects, the various administrative agendas will be set up so that they maximise the effectiveness of both communication with clients, and communication within and between various offices.</p> <p>The electronisation of the communication within each office will bring time and financial savings to the operators, which will translate into better quality of the services provided to clients. Easier exchange of information between the employees of each office and between the different offices will have a positive effect on the effectiveness of the entire office.</p>	<ul style="list-style-type: none"> <li>- More than 50% of all internal systems in public administration that use data stored in the basic registers will be connected to the registers online and will be able to automatically load and verify data</li> <li>- More than 70% of the communication between the different offices (or within offices) will take place exclusively in electronic form</li> </ul>	<ul style="list-style-type: none"> <li>- The introduction of standardised SW information systems that will be compatible to allow the potential exchange of information between individual offices without the need to keep records in duplicate in paper form</li> </ul>
<p><b>E.1.3: Ensuring safety in the use of eGovernment</b></p> <p>Each system will be set up so that their use by the clients is safe to the maximum extent possible and does not jeopardise the development of eGovernment services due to the clients' refusal to use them.</p> <p>All new systems and services will include an adequate promotional and educational campaign, which will ensure that potential clients are sufficiently educated both in terms of the use of the given service/system and in terms of basic safety rules in using electronic</p>	<ul style="list-style-type: none"> <li>- More than 70% of citizens will be informed about the possibilities and advantages of using the new eGovernment systems and services</li> <li>- More than 80% of citizens and entrepreneurs using eGovernment services will have sufficient knowledge of the principles and rules for the safe use of electronic services and electronic communication</li> </ul>	<ul style="list-style-type: none"> <li>- The implementation of information campaigns aimed at increasing the awareness among citizens and entrepreneurs about the advantages and benefits of using eGovernment services</li> <li>- The implementation of educational seminars/the creation of an online educational programme (webinars) aimed at explaining the use of the different services, which is available to anyone, at any time and free of charge</li> <li>- Support for activities leading towards the transformation of the procedural processes and the technological modernisation of public administration offices with the aim of introducing ISO certification</li> </ul>



communications.	- More than 50% of public administration offices at the regional level and more than 80% of public administration offices at the national level will have the necessary ISO certification for information security	for information security, or other international/European security standards - The implementation of regular surveys and studies that monitor the progress of the implementation of each project and its contribution towards the achievement of the set objectives, or that serve as a basis for the regular modification of implemented activities so that the set objectives are achieved (for example regular monitoring of users' ability to effectively use the newly introduced and offered services)
<b>The strategies and national documents to which the strategic and specific objectives are related:</b> <ul style="list-style-type: none"> <li>• Digital Czech Republic v 2.0 – The Road to the Digital Economy (MIT)</li> <li>• Data source: DIGITAL AGENDA FOR EUROPE (EU)</li> </ul>		
<b>The conditions for and barriers to implementing interventions in this key area of change:</b> <ul style="list-style-type: none"> <li>• Before launching implementation, it is necessary to carry out initial surveys in order to determine the most frequently used services on the part of both citizens and entrepreneurs, to analyse their requirements in terms of time, personnel etc. as the basis for the subsequent determination of the main services that should – in accordance with the objective – be transformed into a fully electronic version</li> <li>• Information and data audits that analyse the interconnectedness of the different services and data and serve as a basis for identifying the key points that need to be addressed</li> <li>• Surveys of clients' knowledge in relation to the use of eGovernment and its safety, as a basis for the implementation of measures aiming to improve the computer literacy of the clients of eGovernment</li> <li>• The implementation of parallel/follow-up projects focusing on the targeted education and training of public administration employees so that they are all able to operate the newly-introduced eGovernment services, comply with security standards for working with information systems and provide clients with at least basic assistance and advice</li> <li>• The key prerequisite for the effective functioning of eGovernment is interoperability, which allows mutual communication between systems without any limitations. The conditions of interoperability must therefore be thoroughly monitored when awarding any public contracts for any of the systems being built.</li> </ul>		
<b>Strategic objective E.2: The development of eBusiness and ICT in enterprise</b> eBusiness and ICT in enterprise as a driver of innovation and an impulse for improving the effectiveness of enterprise and developing new fields focusing on promising areas that use ICT to increase the added value of products and, by extension, to improve the competitiveness of the economy as a whole.		
<b>Specific objectives</b>	<b>Indicators of the specific objective</b>	<b>Model activities/projects/operations</b>
<b>E.2.1: Increased use of ICT in enterprise</b> ICT will play a significant role in increasing the effectiveness and improving the economic profitability of enterprise, especially due to the growing share of the use of ICT in unrelated fields where the	- The number of joint research projects focusing on the use of ICT to increase the added value of promising fields leading to the implementation of a new ICT solution in the market - The share of SMEs using cloud computing and the	- Co-operation of SMEs and research organisations in order to jointly develop new ICT services for enterprise - Improving the access of SMEs to centres of shared services and new sophisticated solutions focusing on cloud computing

<p>automation of selected agendas may increase the effectiveness of enterprise and, in turn, the competitiveness of the given sector.</p> <p>Cooperation between ICT specialists and scientists and entrepreneurs is essential for the establishment and successful development of new high-potential areas of enterprise that involves ICT. The combination of knowledge from several fields helps further and more intensively develop the newly-created areas of enterprise that have the potential to become the driving sectors of the economy.</p>	<p>services of public or private data centres and R&amp;D organisations in ICT</p>	<ul style="list-style-type: none"> <li>- Improving the access of SMEs to data centres and their services</li> <li>- The development of cloud services for entrepreneurs</li> <li>- Co-operation of SMEs and large companies (and vice versa) in using ICT in enterprise and introducing/developing eBusiness</li> </ul>
<p><b>The strategies and national documents to which the strategic and specific objectives are related:</b></p> <ul style="list-style-type: none"> <li>• Digital Czech Republic v 2.0 – The Road to the Digital Economy (MIT)</li> <li>• Data source: DIGITAL AGENDA FOR EUROPE (EU)</li> </ul>		
<p><b>The conditions for and barriers to implementing interventions in this key area of change:</b></p> <p>The need to define fields/areas of use of ICT that can be considered promising fields with a high added value, moreover with sufficient background in the form of R&amp;D, university or private capacities in the Czech Republic</p>		
<p><b>Strategic objective E.3: The development of infrastructure in ICT</b></p> <p>A high-quality, high-capacity and high-end infrastructure corresponding to latest knowledge and technology as a basis for the development of the use of ICT across the entire society. Sufficient capacity, technological facilities and security of public data centres and networks providing the facilities both for the functioning of eGovernment and for the development of the use of ICT in all promising fields. High-capacity, technologically adequately equipped centres essential for the development, testing and further development of new possibilities for the use of ICT in public administration and the economy, with specialist personnel capacities capable of assisting in meeting the objectives for the development of eGovernment and eBusiness.</p>		
<p><b><i>Specific objectives</i></b></p>	<p><b><i>Indicators of the specific objective</i></b></p>	<p><b><i>Model activities/projects/operations</i></b></p>
<p><b>E.3.1: The development of ICT used for research and development</b></p> <p>High-quality, high-capacity, technologically adequate and regularly upgraded infrastructure for R&amp;D in the area of ICT and the use of ICT in all associated promising fields.</p> <p>A national communication network – whose capacity, reliability, security and utility correspond to the latest standards and requirements – providing the interconnection of both R&amp;D organisations in the area of ICT and all other R&amp;D organisations, including their</p>	<ul style="list-style-type: none"> <li>- Increased capacity and safety of the network interconnecting R&amp;D organisations</li> <li>- The capacity of the R&amp;D network</li> <li>- 100% of public R&amp;D organisations connected to the core network</li> </ul>	<ul style="list-style-type: none"> <li>- The building of new higher-capacity and more secure networks or the modernisation and development of the existing networks that connect R&amp;D organisations to each other and to selected public administration institutions</li> <li>- Investments in the regular maintenance, modernisation and development of the network so that it meets European standards for security and capacity</li> </ul>

connection to relevant international core networks.		
<p><b>E.3.2: Increasing the capacity and quality of public ICT infrastructure</b></p> <p>High-quality, high-capacity, secure and accessible public infrastructure serving as a basis for the eGovernment services being offered.</p>	<ul style="list-style-type: none"> <li>- More than 90% of public administration offices at the level of municipalities with extended competence or higher will be connected to a network with a minimum capacity of 100 Mbit</li> <li>- More than 50% of public administration offices will be equipped with the IPv6 protocol</li> <li>- More than 50% of public administration offices will be connected to public or private data centres offering cloud services</li> </ul>	<ul style="list-style-type: none"> <li>- The development of high-capacity and modern infrastructure (NGA, LTE)</li> <li>- The renewal of HW so that public administration can provide services at a high quality, while meeting the safety standards of public administration and any other standards, for example in the latest IPV6 protocol</li> </ul>
<p><b>E.3.3: Improving the accessibility of infrastructure</b></p> <p>High-quality, high-capacity and secure access to the Internet for the entire population as a basis for greater use of eGovernment and the development of eBusiness.</p>	<ul style="list-style-type: none"> <li>- Fulfilling the objectives of the Digital Agenda at the level of the EU, i.e. a minimum Internet connection speed of 30Mbit/s for all citizens and 100 Mbit/s for half of the citizens by 2020</li> <li>- Increased transmission capacity of Internet connection in remote areas</li> <li>- Increased share of remote areas with high-capacity Internet connection coverage</li> </ul>	<ul style="list-style-type: none"> <li>- Investments in modernising and increasing the capacity of public networks that connect public administration offices to a level that corresponds to European standards and the expected needs with a view to 2020</li> <li>- Investments in the development of high-capacity internet connection in remote areas and other locations that are not sufficiently attractive to private investors</li> </ul>
<p><b>The strategies and national documents to which the strategic and specific objectives are related:</b></p> <ul style="list-style-type: none"> <li>• Digital Czech Republic v 2.0 – The Road to the Digital Economy (MIT)</li> <li>• Roadmap for large research, experimental development and innovation infrastructures in the Czech Republic – updated in May 2011 (MEYS)</li> <li>• Data source: DIGITAL AGENDA FOR EUROPE (EU)</li> </ul>		
<p><b>The conditions for and barriers to implementing interventions in this key area of change:</b></p> <ul style="list-style-type: none"> <li>• Legislative modifications enabling the introduction of eGovernment services in full, i.e. in a form where all the communication between the office and the client will take place using electronic communication, without the need for physical contact or the need to supply any documents or any other information in written/printed form</li> </ul> <p><b>Barriers:</b></p> <ul style="list-style-type: none"> <li>• In some areas, competences were not clearly defined until recently</li> <li>• Most changes require not only investments in infrastructure, but also extensive procedural changes including legislative changes so that eGovernment services can be introduced in full – this requires a longer timeframe and a well-conceived, strategic and systematic implementation process</li> <li>• The unprofitability of some interventions (NGA in rural areas)</li> </ul>		

## 6.5. Social innovation

### **Key area of change F: Improvement and better utilisation of social capital and creativity in addressing complex social challenges**

Europe faces unprecedented problems that threaten its currency, economy and social model. More than ever it is in desperate need of social innovations that will provide new and more efficient responses to tackle social challenges, to involve local actors to find responses to complex social and community needs and to bring together different actors for joint activities using new models of co-operation. Social innovations can be defined as the development and implementation of new ideas (products, services and models) satisfying social needs and establishing new social relationships and forms of cooperation aimed at improving the quality of human life. As opposed to “common innovations”, social purpose and added value, both economic and social, is a specific driver for “social innovations”. Social innovations are part of a wider concept of innovations that is turning away from the narrow concept of technologically-based innovations. Europe is lacking not only social innovations, but also instruments to incorporate those innovations that have proven their worth into mainstream public policies. More than ever it is desirable to support new partnerships of public, private and non-profit organisations and give them an opportunity to experiment in seeking new ways and responses to social problems through social innovations. It is necessary to provide safe room for creating and testing each social innovation, whose success is in many cases dependent on local conditions and the environment of their implementation, while also acknowledging the possibility of failure or their wrong direction. Territorial Employment Pacts (European Commission, 2013) are one of the successful examples of social innovations supported in the past by the European Commission that have made their way into the mainstream policy framework.

For the Czech Republic, social innovations will be an option for improving and better utilising social capital and creativity while addressing complex social challenges. The first of these challenges is reflected in the National Priorities of Oriented Research, Experimental Development and Innovation up to 2030, the meaning and impact of which will increase over time and will have to be tackled with the same or even lower amount of public resources. The second challenge is the low quality of public administration, which is one of the major disincentives to the competitiveness of the Czech Republic, as noted by many international studies and strategic documents<sup>210</sup>.

A common prerequisite for successfully addressing complex social challenges is the direct involvement of key actors in various forms of open co-operation partnerships. The main factors demonstrating the usefulness and added value that may be achieved by co-operation, include mainly the following: (a) targeting – by collecting opinions and input from actors from various classes of society, it is possible to more effectively determine the needs and priorities and act accordingly; (b) coordination – political measures and the targeting of programmes can be synchronised based on local conditions to increase their impact and eliminate duplicities; (c) access to resources – each of the problems and obstacles may be addressed and removed more effectively thanks to the access to various technical, human, knowledge-based, physical and financial resources; (d) social capital – contacts between organisations and mutual relationships in partnerships strengthen social networks and links, and promote mutual learning and better understanding of the values and importance of

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<sup>210</sup> E.g. Global Competitiveness Index 2013-14 (WEF) where the Czech Republic ranks 146th with regard to the trust in politics and 135th with regard to negative impact of government regulations out of 148 countries rated, or the International Competitiveness Strategy of the Czech Republic for 2012 to 2020.

partners and their role in the society; (e) innovations – the sharing of different perspectives, ideas and sources encourages more creative and dynamic approaches to social issues; (f) empowerment – improved capacity and direct involvement of key actors allows partners to voice their concerns more loudly about issues that concern them within the political arena; (g) legitimacy – wider mobilisation of those whom the issues concern, provides a more democratic “mandate for action” and promotes good administration; the involvement and support of organisations with “trust” of the community may contribute to the acceptance of strategic changes by the public; (h) stability – taking into account the interests of the civil society in the process of strategic planning, joint involvement in local projects and higher level of satisfaction with public policy will contribute to the integration and cohesion of the society, and (i) sustainability – the promotion of social inclusion, joint ownership and mutual advantages and co-operation of a larger number of entities may result in positive changes and better solutions to social challenges than if they were tackled by a single sector or institution. In the Czech Republic, the building of partnership is in an early stage; therefore it is necessary to improve the professional, technical and financial capacities for building partnerships.

<b>Key area of change F: Improvement and better utilisation of social capital and creativity in addressing complex social challenges</b>		
<b>Strategic objectives in the key area of change:</b> <b>F.1: Promoting open partnership co-operation while seeking experimental solutions to address social challenges and systemically utilising successfully proven models</b> <b>F.2: Promoting and better utilising co-operation of local actors in addressing problems in the area of employment, economic development and social inclusion in regions of the Czech Republic</b>		<b>Indicators of strategic objectives/key area of change:</b> <ul style="list-style-type: none"> <li>• Number of successfully proven and used experimental solutions</li> <li>• Number of regions in which Territorial Employment Pacts (meeting key OECD and EU standards) were established and are functional</li> <li>• Number of regions that have and implement integrated employment development programmes based on the TEP platform</li> </ul>
<b>Strategic objective F.1: Promoting open partnership co-operation while seeking experimental solutions to address social challenges and systemically utilising successfully proven models</b> The strategic objective is to promote experimental solutions to address social challenges through new forms of open partnership co-operation, new technologies and new business models. Social challenges are reflected in National Priorities of Oriented Research, Experimental Development and Innovation up to 2030, i.e.: <ul style="list-style-type: none"> <li>• Competitive knowledge-based economy</li> <li>• Sustainability of the energy sector and material resources</li> <li>• Environment for quality life</li> <li>• Social and cultural challenges</li> <li>• Healthy population</li> <li>• Safe society</li> </ul>		
<b>Specific objectives</b>	<b>Indicators of the specific objective</b>	<b>Model activities/projects/operations</b>
<b>F.1.1: Promoting open partnership co-operation while seeking experimental solutions to address social challenges and systemically utilising successfully proven models</b>	<ul style="list-style-type: none"> <li>▪ Number of successfully proven and used experimental solutions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Creation and application of the system for testing (accelerator) and evaluating social innovations and subsequently disseminating and systemically using successful solutions</li> </ul>
<b>Strategic objective F.2: Promoting and better utilising co-operation of local actors in addressing problems in the area of employment, economic development and social</b>		

### **inclusion in regions of the Czech Republic**

The strategic objective is to change current models of good administration in the area of employment, economic development and social inclusion. In particular, in this area it is important to promote elements of multi-level administration with active involvement of partnership in creating and implementing relevant strategies and policies. There is already an involvement of social partners in this area at the highest political level, with well-established tripartite negotiations at the national and regional levels. These partners can also mobilise ad-hoc working teams and specific solutions in case of crisis development of the economy as witnessed in recent years. However, employment, economic development and social inclusion are topics with permanent relevance and they require continuous activities of a wide range of partners in different sectors and at all levels of government. Therefore, the use of long-term functional partnerships and employment pacts, which is recommended by both OECD and the European Commission, is an important tool<sup>211</sup>. The most suitable and best available example of the systemic use of such partnership is Austria and its TEPs (Territorial Employment Pacts) in all federal countries, which are methodically supported by a Coordination Unit. It is even more important, as this example of good practice is slowly finding its way into the Czech Republic where the first Employment Pact was created in the Moravian-Silesian Region in 2011, as a result of direct inspiration by the Austrian model, which is gradually sharing its experience with interested parties in all regions of the Czech Republic. The strategic objective will be achieved through transferring these activities, which were initiated from the bottom-up, into the system of partnership co-operation in employment, economic development and social inclusion that is supported and used by the state.

<i>Specific objectives</i>	<i>Indicators of the specific objective</i>	<i>Model activities/projects/operations</i>
<b>F.2.1: Promoting and better utilising co-operation of local actors in addressing problems in the area of employment, economic development and social inclusion in regions of the Czech Republic</b>	<ul style="list-style-type: none"> <li>▪ Number of regions, in which TEP – Territorial Employment Pacts (meeting key OECD and EU standards ) were established and are functional</li> <li>▪ Number of regions that have and implement integrated employment development programmes based on the TEP platform</li> <li>▪ 100% involvement of TEPs in creating and implementing relevant EU and Czech strategies and policies at regional and local levels up to 2015</li> </ul>	<ul style="list-style-type: none"> <li>▪ The creation of the standard for the activities of TEPs in the Czech Republic and an evaluation system for their evaluation</li> <li>▪ The establishment and development of TEPs in regions of the Czech Republic as “bottom-up” initiatives with defined parameters of the required services (single model – regionally adapted solutions)</li> <li>▪ Integrated employment development programmes in the regions prepared based on the TEP platform</li> <li>▪ Regional observatories of the labour market and competitiveness</li> <li>▪ Coordination Unit for methodological and organisational support of TEP</li> <li>▪ Leadership Academy – a training programme for key TEP representatives and high-ranking officials from co-operating ministries and other central institutions</li> <li>▪ Sharing and mainstreaming of good practice examples</li> </ul>

#### **The strategies and national documents to which the strategic and specific objectives are related:**

- International Competitiveness Strategy of the Czech Republic for 2012–2020

<sup>211</sup> See the Vienna Action Statement on Partnerships (OECD LEED Forum on Partnerships, Vienna 2007) and the identification of key roles of partnerships in implementing the Europe 2020 strategy.

- National Priorities of Oriented Research, Experimental Development and Innovations
- The conditions for and barriers to implementing interventions in this key area of change:**
- Full understanding of and effective support for social innovations in the Czech Republic
  - Correct programming of social innovations into ESIF in the Czech Republic, using both the ESF (especially in OP E and OP RDE) and the ERDF (especially in OP EIC and IROP)
  - Promotion of partnerships as a fundamental form for social innovations
  - Simplification of administration for better access of partnerships to financing
  - Allowing for integrated approaches and tools to address complex social challenges
  - Possibility to experiment in the area of social innovations
  - Creating the conditions for the testing/verification/measurement of experimental solutions
  - Creating the conditions for systemic use of well-proven and tested experimental solutions

## 6.6. Responsibility for the implementation of strategic objectives in each key area of change:

Title of key area of change and strategic objective	Responsibility for implementing interventions pursuant to government resolution	Recommendation to implement interventions pursuant to government resolution
<b>Key area of change A: Higher innovation performance of companies</b>		
Strategic objective A.1: Increasing the innovation demand in companies (and in the public sector)	MIT	Prague
Strategic objective A.2: Increasing the level of enterprise in the society, with emphasis on the establishment of new, fast growing companies	MIT	Prague
Strategic objective A.3: Increasing the internationalisation of SMEs	MIT	Prague
<b>Key area of changes B: Improved quality of public research</b>		
Strategic objective 1: Improving the quality and problem-orientation of research in knowledge domains that are relevant for intelligent specialisation	MEYS	Prague
<b>Key area of change C: Increasing the economic benefits of public research</b>		
Strategic objective C.1: Increasing the relevance of research to the needs of the application sector	MEYS	
<b>Key area of change D: Improved availability of HR, in terms of both quality and quantity, for innovative enterprise, research and development</b>		
Strategic objective D.1: Improving the quality of school graduates	MEYS	Prague

Strategic objective D.2: Identifying and making use of talent	MEYS	Prague
Strategic objective D.3: Improving the quality of research and development staff	MEYS	Prague
<b>Key area of change E: Development of eGovernment and eBusiness to improve competitiveness (development of ICT and digital agenda)</b>		
Strategic objective E.1: <b>The development of eGovernment</b>		MLSA, MI
Strategic objective E.2: <b>The development of eBusiness and ICT in enterprise</b>	MIT	
Strategic objective E.3: <b>The development of infrastructure in ICT</b>	MEYS, MIT	MI
<b>Key area of change F: Improvement and better utilisation of social capital and creativity in addressing complex social challenges</b>		
Strategic objective F.1: Promoting open partnership co-operation while seeking experimental solutions to address social challenges and systemically utilising successfully proven models		MLSA
Strategic objective F.2: Promoting and better utilising co-operation of local actors in addressing problems in the area of employment, economic development and social inclusion in regions of the Czech Republic		MLSA



## 7 Institutional management and implementation of the National RIS3 Strategy

The main method for identifying smart specialisation domains is the entrepreneurial discovery process, i.e. deriving priority R&D&I areas from entrepreneurial opportunities and needs. The discussion involves representatives of the business sector, research organisations, universities and Managing Authorities of Operational Programmes, persons responsible for national programmes and representatives of regions. This is an application of the triple/quadruple helix approach, which is closely associated with the concept of smart specialisation.

A debate organised during the National Innovation Platforms resulted in more refined and more focused topics of applied research and innovation topics, as proposed in the previous stages of preparation of the RIS3 concept (see Chapters 4–6 of the National RIS3 Strategy). The debate also reflected proposals identified in regional annexes to the National RIS3 and established links to specialisation domains identified at regional level – see Table 10.

Linking the national and regional perspectives will help to efficiently focus the smart specialisation concept with respect to the needs of the business sector in the area.

The entrepreneurial discovery process represents continuous strategic collaboration between members of the triple/quadruple helix with the aim of:

1. updating smart specialisation domains (specific R&D&I) topics with a view to changes in economy,
2. identifying and setting up paths to an efficient implementation of the smart specialisation concept through ESIF-funded programmes and national programmes (participation in call targeting and verticalisation),
3. evaluating and directing the evaluations of the National RIS3 Strategy.

### 7.1 RIS3 Strategy in the Czech Republic

The following areas of smart specialisation have been identified for the Czech Republic based on the entrepreneurial discovery process.

#### 7.1.1. Advanced machinery/technology for strong and globally competitive industry<sup>212</sup>

##### 7.1.1.1 Mechanical engineering – mechatronics

###### **Background**

The manufacture of machinery, equipment and precision components constitutes a significant portion of the Czech manufacturing industry. This division includes a very wide range of equipment that acts independently on materials either mechanically or thermally or performs operations on materials, including its mechanical components that produce and apply force. It also includes any

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<sup>212</sup> This is an EDP output from National Innovation Platform I – Mechanical Engineering, Energy Industry and Metallurgy.

specially manufactured parts for such machinery and equipment. The most technologically demanding branches of engineering, combining **high or extremely high demands on manufacturing precision, quality and surface integrity parameters, the highest demands on production capacity and productivity, as well as demands on reliability**, are Machine Tools and Precision Engineering, whose products make use of advanced electronics, data processing, communication and control (mechatronic products). This is usually primary production whose products (machinery, equipment, components) are used by related branches of engineering and/or non-engineering branches of the manufacturing industry.

The set of strategically significant products of the Machine Tools and Precision Engineering industries includes, in particular: **machine tools; forming machinery; machinery for additive manufacturing, related automation and tools; precision engineering components** (bearings, clutches, gear units and other constructional elements for torque and power transmission, including hydraulics, which are the basic elements for the construction of most industrial and consumer products and allow constructing secondary manufacturing machinery, i.e. machinery and equipment for other manufacturing industries). The group also includes **complex machinery** for handling, transportation, in-process storage, cleaning, measuring, packing, printing, cooling, drying, air conditioning, media compression and other operations that allow making specific machines, equipment, machine cells, production lines and manufacturing plants. The area of precision engineering in question also includes the manufacture of weapons, manufacture of instruments and measuring equipment, manufacture of moulds and manufacture of forming and injection moulding tools. The area of precision engineering in question also includes the manufacture of weapons, manufacture of instruments and measuring equipment, manufacture of moulds and manufacture of forming and injection moulding tools. This also includes research topics concerning the production of: construction machinery, agricultural and forestry machinery, food processing machinery, mining and quarrying machinery and technological systems for all types of industries, but these must be high-technology products that require research and development for their innovation as standard.

As stated by the CSO and the MIT, machinery, equipment and components from the Machine Tools and Precision Engineering industries are the main indicator of the condition and future development of the Czech Republic's economy. These industries accounted for almost 8% of revenue for the sale of products and services of the Czech Republic's manufacturing industry in 2014, ranking second within the manufacturing industry, behind only the automotive industry. As shown by long-term statistics, the Machine Tools and Precision Engineering industries in question represent industries with high value added, a stable majority share of exports and high technology demands, classified into the hi-tech and medium hi-tech sector. The industries' products (excluding automotive, transport technology and aerospace-related products, which are assessed separately) generate combined average annual revenue for the sale of products and services of approximately CZK 60 billion and the industries give employment to approximately 27,000 people. The industries have long shown a positive external balance of approximately CZK 19 billion and export more than 80% of their production. Products in the group in question face direct competition in the global market and must stand up to any global competition. Average value added per employee is approximately CZK 820,000. The territory that has traditionally been the destination for the largest share of exports is Germany. Exports to it accounted for more than 32% of total exports in 2014. Gradually increasing exports demonstrate continuously improving product quality, technical level and competitiveness. Export performance keeps developing positively but is conditional on investments in research and

development, improvement in personnel qualifications and enterprises' adaptation to an ever more competitive environment.

In the commodity structure of both exports and imports, the most successful products include power engineering products (components and equipment for the power sector), air-conditioning and cooling products, machine tools and forming machinery, other manufacturing machinery and other engineering products with high value added such as weapons and measuring and testing instruments.

Industries that have the highest demands and determine the top-level parameters of machinery, equipment and components as required by customers include, in particular, power engineering, car manufacture, manufacture of aircraft, heavy transportation technology and instrumentation.

### **Identification of needs and opportunities, aid targeting**

A global expert strategy for the Machine Tools and Precision Engineering industries that allows strengthening competitiveness consists in:

1. Increasing precision – especially increasing geometric and dimensional precision in both small and large dimensions of parts, components, machines and methods.
2. Increasing quality – especially increasing the quality of surfaces, purposefully positively affecting surface integrity characteristics.
3. Increasing manufacturing performance – increasing the short-term and long-term manufacturing performance of machinery and equipment as well as the performance characteristics of parts and components.
4. Increasing reliability – increasing the reliability of products, functions and processes.
5. Increasing economy – minimising the unit costs of products, minimising running costs and costs of operation and minimising product acquisition costs.
6. Reducing negative environmental impacts – minimising the negative environmental impacts of products throughout their life cycle.

The manufacture and development of high-tech products in the Machine Tools and Precision Engineering industries and in mechanical engineering in general is associated with high costs of innovation and/or research and development. Targeted state and EU aid in relation to the RIS3 Strategy may result in partial sharing of such costs with the aim of accelerating promising topics of research and development and innovation and their application in manufacture and production.

Listed below are promising areas and directions of research and development and innovation that should be supported by the national budget and the EU through targeted subsidies for research and development and innovation at the level of improved institutional and special-purpose aid. The promising areas and topics whose implementation helps to fulfil the sector's strategy and main R&D&I objectives are as follows:

In the context of **product optimisation**, it is necessary to undertake research and development and prepare industrially applicable methods, techniques, procedures and especially software tools for the

optimisation of engineering product designing and usage. Optimisation tools are intended to improve the key end-use properties of products while minimising the cost of development, manufacture and use and minimising risks for the manufacturer, user and surroundings.

**New product conception and execution** requires carrying out research and development of new conceptual, structural, constructional and executional forms of engineering products that eliminate shortcomings and extend the frontiers in achieved precision, quality, performance, reliability and economy, including bionics and bio-inspired approaches in mechanical engineering.

As regards **new and progressive technologies**, it is necessary to carry out research and development of improved and new technological procedures, principles and process parameters for all fundamental manufacturing technologies in mechanical engineering: machining, forming (including injection moulding), additive manufacturing and hybrid manufacturing (combining subtractive and additive technologies), which result in more efficient, more precise and higher-quality process results.

**Virtualisation of products and technologies** requires carrying out research and development of experimentally verified and industrially applicable techniques and tools for virtual production design, virtual product design, virtual technological processing, virtual measurement and diagnostics.

As regards **components, systems and management**, it is necessary to carry out research and development of components, principles, systems and algorithms for product measurement and management during product manufacture and use and to design techniques for active feedback affecting product properties, behaviour, shape, position, temperature, etc.

In the context of **SW features and digitisation**, it is necessary to carry out research and development of hardware but especially software techniques and applications that extend and increase the added value of mechanical engineering products for the user.

**Improvement of known materials** requires carrying out research and development of the detailed properties of and processing technologies for existing (known) metallic and non-metallic (especially plastic and composite) materials used in mechanical engineering with the aim of increasing efficiency and performance in their processing (machining, forming, injection moulding, deposition, 3D printing).

For **new materials**, it is necessary to carry out research and development of new or innovated metallic and non-metallic (especially plastic and composite) materials and material structures (hybrid materials) with improved anti-wear properties, minimised friction in combination with conventional materials, reduced weight, increased specific modulus, specific strength and other specific quantities in relation to cost and price aspects for key engineering applications (machining, forming, injection moulding, deposition, 3D printing). This also includes materials and technologies for additive and environmentally friendly manufacturing and integration of conventional (subtractive) and additive technologies.

To **expand the use of composite materials**, it is necessary to carry out research and development of cheaper fibre- and particle-reinforced composites with properties approximating those of top-level fibre-reinforced composites.

In the field of **materials for additive technologies**, it is necessary to carry out research and development of materials, material forms (powders, wires, pellets, etc.) and process parameters for

processing using additive technologies (both thermal fusion processes and low-temperature kinetic deposition) and hybrid technologies.

In **surface improvement**, it is necessary to carry out research and development of advanced finishing and surface modification of parts and components with focus on improving their end-use properties. A generic area with a wide range of **nanotechnology** applications is surface protection, where mechanical engineering can take advantage of the anti-corrosive, self-cleaning, wear-resistant and other properties of nanomaterials.

In the **context of repair and recycling**, it is necessary to carry out research and development of methods for reconstructing the shape of worn-out parts, reconstructing the working surfaces of parts and material structures and methods for efficient recycling of engineering products.

### 7.1.1.2 Energy industry

#### **Background**

The energy industry is a major segment of the national economy, providing a basis for the performance of many other activities in the economy (manufacturing industry, agriculture, functioning of services, transportation of people and materials, etc.). It creates a prerequisite for the further development of Czech industry – mechanical engineering, manufacture of transport means, etc. The energy industry is defined here in a broad sense as the production, distribution and utilisation of energy (in industry, services, agriculture and the housing sector).

Due to objective conditions and political objectives, the energy industry is undergoing a fundamental transformation until 2040, consisting in renewing the production basis (replacing units with generating facilities of higher efficiency, with a significant share of decentralised facilities), changing the use of primary energy sources, advancing the use of electricity in transport and achieving significant savings in consumption.<sup>213</sup> Značným způsobem bude ČR ovlivněna rychlou přeměnou energetiky v sousedním Německu – Energiewende.

As is assumed by the updated state energy policy (2015), electricity generation in the Czech Republic should be based on the use of nuclear energy and natural gas, complemented by cost-effective renewable energy sources, with the necessary infrastructure. Electricity generation will continue to be complemented by electricity from the heat sector (combined heat and power generation). However, the installed capacity of coal-fired power plants, whose share is to be reduced in a controlled manner, may still play a significant role in the transitional period (until 2030). The trend will be a growing amount of electricity generated by decentralised facilities, whether based on non-renewable (natural gas) or renewable energy (primarily solar energy and biomass, complemented by biogas and wind energy).

The transmission system is interconnected with neighbouring systems with sufficient capacity; recently, however, it has faced risks posed by uncontrolled flows of electricity from Germany.

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<sup>213</sup> Fundamental goals are defined mainly by climate and energy packages (commitments arising out of agreements at EU level) – the Czech Republic's commitment for 2020 is to cut greenhouse gas emissions in sectors included in the EU ETS (approx. 360 enterprises) by 21% from 2005 levels and to increase greenhouse gas emissions outside the EU ETS sector by no more than 9%, to raise the share of renewables in the total gross final consumption to 13% (the commitment involves supplies of electricity, heat and liquid biofuels) and to reduce final consumption of energy by 20%; EU-wide commitments for 2030 include increasing the share of renewables in energy consumption to at least 27%, cutting greenhouse gas emissions by 40% from 1990 levels and there is an indicative target defined for energy efficiency.

Distribution systems, especially low-voltage ones, are undergoing fundamental changes due to the fact that decentralised generating facilities are connected to them and new types of consumption arise. Market-motivated cooperation between the production side and the consumption side will therefore be important, with the application of “Smart Grid” systems and technologies.

The heat supply segment, including cogeneration and heat distribution, will undergo major changes and its future development will be affected by conditions set by the state, entrepreneurs’ capacities, as well as consumers’ behaviour. Today, approximately 50% of heat is supplied by district heating systems. More and more heat is gradually produced from renewable energy sources (especially biomass, biogas, solar water heating collectors, heat pumps) but also usable energy by-products and in the future maybe also hydrogen or synthetic fuels (as a possible replacement of gas). Considering the anticipated developments in electricity production, the heat sector has a great opportunity for the regulation of electricity utilisation, both using a district heating system and in the decentralised area (mini- and micro-cogeneration). The objective will be to define priorities for the verification of individual technologies so that they can be deployed as soon as possible or to help resolve the problem of electric power (transmission and distribution) system management with a high increase in the capacity of renewable sources supplying electricity to system networks.

Efficiency and savings in the energy industry and energy consumption concern the whole chain, from the extraction of primary sources to their transformation and energy distribution to final consumption.

#### **Identification of needs and opportunities, aid targeting**

In the field of **technologies for electricity and heat production by nuclear facilities**, a particularly important task of research and development will be to continuously ensure a high level of safety, including the acquisition of knowledge and required tools and data in all areas necessary for ensuring high-quality legislation, SUJB’s oversight activities (including expert support for the regulator) and operators’ purposes, all of that synergistically serving to keep and improve the quality of necessary experts. This includes models for the improvement of deterministic and probabilistic safety analyses (including the role of the human factor) and new technologies and approaches to the prevention of and response to severe accidents. An important area of research is the utilisation of design reserves, whether capacity reserves (including fuel cycle optimisation) or life-cycle reserves (related to deducing the behaviour and ageing of materials, components and equipment). There is potential in the preparation of superior methods for the processing and treatment of radioactive waste and the decontamination and disassembly of nuclear power plants after decommissioning (including the application of robots). Another important topic of research is Generation IV reactors and small and medium-sized reactors (SMRs).

In the **generation of energy from fossil fuels**, research and development must provide the necessary tools to allow operation with greater flexibility, including increased facility control ranges (with knowledge of impacts on the service life and maintenance of materials and equipment), and technologies for ongoing compliance with the lowering emission limits for operated facilities (especially coal-fired) and for improvement in facility efficiency (techniques, advanced control models). Research should also focus on the utilisation of coal combustion products from combustion processes in coal-fired facilities (ash, fly ash, FGD gypsum, etc.), especially for the production of building and construction materials, including the deduction of conditions for use of new materials (assessment of pollutant impacts, designs of testing methods, ecotoxicology, etc.). Another possible

direction of development is value enhancement of hard and brown coal through use other than combustion.

In **heat generation and distribution**, a real challenge for the future is enhancing the efficiency of systems, based on specific conditions on the site (boiler capacity ranges; optimum solutions for the removal of sulphur oxides, nitrogen oxides and dust; reduction of minimum required condensing power generation; solutions for multi-fuel applications; etc.) or in the heat distribution system (technical possibilities for loss reduction, modern systems for distribution system management). More attention should also be paid to the cooling process, or research into suitable coolants, which is also of great importance for the environment. Crucial research topics are also the storage of energy (heat or surplus electricity in the electricity system) and “hybridisation” of systems – efficient partial decentralisation of systems (synergy between centralised and decentralised equipment). Attention must be paid to the development of innovative technologies for small cogeneration and microgeneration (improved motors, fuel cells, ORC systems, etc.), trigeneration and cold generation and distribution, and their verification in practice.

Cost-effective **use of renewable energy sources** requires developing and testing such technologies that correspond to conditions in the Czech Republic. Biomass-using systems have considerable potential – future solutions consist mainly in heat production on a local (regional) scale. Research and development must focus on sustainable biomass procurement (forestry and agricultural residues and waste), dedicated biomass production and biomass transformation into a form suitable for transportation and final use. Boilers must be available in all necessary capacity ranges meeting future requirements (ecodesign for small boilers). The subject matter must include adequate biomass transformation processes showing the most efficient solutions for the future. Topics concerning biogas stations are fuel basis expansion and heat utilisation.

The use of larger-capacity hydropower will involve improving the efficiency of facility operation (innovative machines and their control) and reducing environmental impacts during facility construction and operation. It is important to have comprehensive system management models taking account of energy, water management and other functions. There is certain potential in small hydroelectric power plants for low heads and low flow rates requiring innovative technologies (low component count systems, new types of turbines, simple regulation, etc.). Development areas in the use of wind energy are solutions for loss reduction (gearing, etc.) and trouble-free connection to the electricity system.

The use of solar energy should focus on increasing the number of rooftop photovoltaic installations in combination with adequate storage to maximise domestic consumption (residential sector, services); innovative solutions for solar thermal systems (lower costs, combination with unconventional solutions for heat storage, etc.). Development must also focus on the use of heat pumps – increase in SOC, gas pumps, combination with other technologies at house or local level.

Decentralised facilities must not only be prepared as isolated technologies but their synergistic operation must also be explored – e.g. integration into virtual power plants and heat supply sources. Development will also focus on power-to-gas technology, i.e., the conversion of power into hydrogen or methane for energy storage.

In the field of **electric networks**, research and development will be oriented towards ensuring a reliable and safe (and secured) operation of the electricity system under the changing conditions on the supply and consumer sides. For transmission, the important topics are management models, new

technical elements to enhance system robustness, efficiency and reliability, and work on the vision of grid integration and electricity system balancing in the European context. For distribution grids, the important topics are R&D and demonstration topics ensuring a reliable and safe operation – new automation (remotely controlled) elements; advanced approaches in diagnostics and monitoring (predictive diagnostics, etc.); smart metering and integration of renewables, distributed generation and electric mobility. A fundamental topic is generation and consumption optimisation – advanced load management (development in ripple control) and consumption management based on price and other incentives (demand side management / demand response).

**Energy storage** will be a crucial element between generation and consumption in the future. It is therefore important to develop and test energy storage systems of various physical and chemical natures potentially suitable for a given functionality (energy and capacity; connected to the grid or designed for island operation; etc.), taking account of their potential to become cheaper.

In energy **savings**, it is crucial to develop and demonstrate practically applicable solutions for final consumption – the residential sector, industry, services and agriculture. A complex area is the preparation and demonstration of integral solutions for cities and urban agglomerations (smart cities and regions) in relation to European initiatives but taking account of the Czech Republic's specifics. The basis is synergistically integrating energy generation and transmission, energy use in buildings and energy demands in transport, all of that with the application of ICT technologies. In the residential sector, the concept of smart buildings and homes should be developed, which is an intersection of the construction industry, local energy generation, smart appliances as well as other elements for a safe and happy life. Energy savings must focus on not only engineering solutions but also business and financing models. Improving the energy performance of buildings, including external wall insulation, is also crucial. Passive houses bring about improvement in the internal and external environment due to lower levels of harmful substances in the interior and lower emissions of local pollutants to the exterior.

The field of **energy for transport** should focus on the preparation and demonstration of solutions for the wider adoption of electric mobility (integration of charging stations into a network, control systems, integration with energy storage and recovery, hybrid solutions, inductive charging, etc.), hybrid vehicles and the development and verification of key elements for drives and transportation based on fuel cells. Another important area is the development of new types of biofuels or use of coal combustion products for the construction of road networks and infrastructure.

In the field of **promising energy technologies** that will be applicable within a longer time frame, research and development will focus e.g. on small modular reactors operating at high temperatures with a high level of safety and Generation IV reactors, hydrogen technologies especially for energy storage, nuclear fusion, advanced energy storage and transformation technologies and thermodynamic cycles.

To be able to support energy-related decision-making, it is necessary to have high-quality **supporting analytical documents**, which may concern any of the above-mentioned fields individually or several of them jointly. Conventional and larger renewable energy sources as well as energy distribution share the development of risk-oriented decision-making models (operation models, maintenance) based on advanced mathematical solutions and treatment of data. Another topic is analysis of opportunities and limits for the development of the energy industry in the Czech Republic in different



time frames or models of ensuring energy security and increasing the economy's energy and material efficiency.

Account must also be taken of **cross-sectoral research and development topics**, namely the application of ICT technologies (digitisation, big data), new materials and manufacturing technologies (rapid prototyping, customised manufacturing, etc.).

In the field of **nanotechnology**, it is necessary to focus research on possible applications of graphene (graphene supercapacitor) and the use of nanomaterials in battery construction (3D batteries).

### 7.1.1.3 Metallurgy

#### **Background**

Iron metallurgy is a material-intensive and energy-intensive industry with a high capital-labour ratio, especially concerning fixed assets. Crucial production facilities have a long service life and long renewal cycle. From this point of view (the industry's low flexibility concerning product changes), the industry's future development must be addressed with a high degree of accuracy.

Manufacture of metals is highly material- and energy-intensive. Metallurgy in the Czech Republic as well as in Europe is undergoing a structural development initiated simultaneously with the onset of a worldwide crisis. However, there was an upturn towards growth in 2013 and although steel production is highly unlikely to get back to pre-crisis levels, both production and consumption have been and should keep growing. Metallurgy forms the basis for supplies to other manufacturing industries.

Metallurgy in the Czech Republic has profoundly changed in its nature over the past twenty years. The operational flexibility of commercially-oriented foundries resulted in significant diversification of manufactured materials.

#### **Identification of needs and opportunities, aid targeting**

Ensuring production at industrial companies and marketability of their products requires continuous research and development activity resulting in **new sophisticated products** in response to the customer sectors' requirements in order to meet the ever stricter quality criteria and respond to demand for new products, innovation and supply options, such as lighter materials with the same mechanical properties as original materials. This process will help the Czech Republic compete with global businesses in product quality. Other subtopics of applied research in metallurgy leading to the development of new products are: light alloys; cellular materials and composites; extreme alloys and composites; new and improved steels; advanced superconductors; development of combination alloys, including material bonding technologies (e.g., aluminium/plastic); biocompatible metallurgy; metal structures and technology units; intermediary metallurgical products of copper and alloys; development of new and enhancement of existing auxiliary materials (chemicals, oils, etc.); new types of refractory materials, including coatings of such materials for casting new types of alloys.

Another topic is the development of **new technologies** in metallurgy. There is a global trend towards the use of new resources, technological processes and manufacturing equipment allowing increasing production capacity, reducing manufacturing costs or reducing the consumption of energy and materials in production. It is therefore advisable to focus on the application of new technologies through R&D, acquisition and installation of new equipment, machinery, etc. with subsequent development and optimisation of processes to fulfil the above-mentioned objectives. The

metallurgical and foundry industry thus requires constant improvement in process efficiency through a combination of feed materials, energy consumption in production, etc. This process will help the Czech Republic compete with global businesses in price per product. Other subtopics in the development of new technologies are thermoelectrics with a high ZT value, scalable thermoelectrics, coating and surface protection, and powder metallurgy.

R&D topics concerning **production management** will focus on the optimisation of manufacturing costs and energy and material intensity, qualitative parameters or increases in production capacity in the manufacture of products. This includes 3D microparticles and sensors, automated additive manufacturing, predictive modelling, metrology and advanced characterisation, recycling, refining and recovery of critical and high-value metals, optimisation of the qualitative parameters of metal products and improvement in the control and management of manufacturing processes (mechatronics). Other topics having an impact on the reduction of dust nuisance and environmental burdens are: heat recovery in steel and iron production; processing (recycling) of metal-bearing waste, usable by-products and waste dust for reuse in manufacture; use of metallurgical, steel-making and foundry by-products (blast-furnace slag, cinder, etc.).

## 7.1.2 Digital market technologies and electrical engineering<sup>214</sup>

### 7.1.2.1 Electronics and electrical engineering in the digital era

#### **Background**

In general, the electrical and electronics industry can be considered to be well established, in both its electrical and electronics parts, and historically having capacities for both basic and applied research. Thanks to their innovation potential, a number of even small businesses have become competitive and carved out their position within the highly globalised industry, which is subject to many influences that we cannot affect and often even predict from the Czech Republic. This applies especially to ICT and to a considerable degree to consumer electronics. The most important branch of the electrical and electronics industry has been the manufacture of electric motors, generators, transformers and electricity distribution and control apparatus. The branch is completely dominant, whether in value added, revenues, profits or, for instance, the number of employees, accounting for approximately half of the whole division of manufacture of electrical equipment. The branch is crucial not only for the electrical and electronics industry and the manufacturing industry, but also for the entire performance of the Czech Republic's economy. Electric rotating machinery, considering its wide range of applications, sizes and required performance characteristics, must be developed with regard to such required functionality. Industry 4.0 generates new requirements for servomotors, actuators and similar drives; manufacturing technologies require specific motors, often as embedded solutions. Requirements for new designs of traction motors are formed. Specific requirements for rotating machinery are defined by the energy industry; it is necessary to develop a series of high-efficiency, 5–500kW permanent magnet synchronous generators for obtaining “clean” energy and, in relation to this, also a series of corresponding turbines. Another necessary task is to identify materials and technologies to be used for the application of permanent magnets based on

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<sup>214</sup>This is an EDP output from National Innovation Platform II – Electronics and Electrical Engineering and ICT.

rare earths in electric machinery in order to provide a long-term guarantee of magnetic and mechanical parameters.

CHP requires sources of thermal and electrical energy capable of more efficient acquisition of energy from biomass or waste heat from technological processes. These are based on microturbines directly coupled with a high-speed electric generator, which is connected to a frequency converter providing mains voltage output.

Considering the size of the industry, experience and available researcher capacity, what must not be left aside is drives for tough outdoor conditions, for dusty environments (deserts, mines, etc.), for chemical applications and aggressive conditions, for seismic areas, for radioactive environments, for seaside areas with aggressive seawater mist, etc.

The development of traction drives is closely related to another priority area, namely drive solutions for electric and hybrid vehicles with regard to compact dimensions, high efficiency and reliability.

In view of newly defined requirements for PDIV (partial discharges), attention is focused on new insulation materials and technologies for electric machinery windings.

Companies that are active in the manufacture of other electrical equipment and manufacture of fibre optic and electric cables, electric wires and wiring devices are also capable of delivering turn-key industrial plants. The industry has been growing linearly without major fluctuations. There is a positive external balance, whose high value was not aggrieved even by disruptions in Russia's market, although they were serious for some companies. This shows that most companies had already diversified their export activities before the Russian market's slump. Although many enterprises have business relations with Germany, the country is not always the final destination for products; such products are often re-exported from Germany after assembly in higher-level products. The electrical and electronics industry is an extremely globalised field; Czech companies compete for contracts all over the world but also have competitors from all over the world.

### **Identification of needs and opportunities, aid targeting**

Electronics and electrical engineering are fields that intertwine with or are closely related to all industries. Identified opportunities can be divided into three areas – New Materials and Technologies, Electrical Engineering for Industry 4.0 and Electrical Engineering for Individual Industries.

**New materials and technologies** include a wide range of topics, especially new materials for soldering, insulation and to replace rare-earth permanent magnets; and micro-nanoelectronic technologies. This should produce intruder detection systems, probes, sensors, measuring instruments, new methods for measuring physical quantities, control systems and instrumentation, microscopes, calibrators, camera systems for pipelines, monitoring systems in geodynamics, measuring technologies for geological sciences and meteorology, electrical terminations, printed circuits, switchgear, cables and solutions for electrical engineering infrastructure, electrical wiring materials, contact and connector systems, fibre optic technologies, superconducting materials (including plastics), valves, storage batteries, microwave links for data transmission, LED lamps, luminous paving stones, and warning light equipment.

This area also includes development of new technologies for ultra-precision machining (in the order of nanometres) and development of technologies and processes for the manufacture of precision

aspheric and free-form optical elements (lenses and mirrors) as well as design of optical illumination and display systems that can take advantage of the unique properties of precision aspheric and free-form elements.

New manufacturing technologies require an increasing amount of sensors – as the enhanced senses of not just robots but all new sophisticated products. A key requirement for further research is related to the need for developing new technologies with a certain degree of interaction with the surroundings based on advanced sensors and smart end effectors, namely to mediate “human” skills on the basis of advanced force control or advanced techniques for 2D/3D machine vision and the processing of speech and other sensory inputs. Another requirement is scalability – independence of the size and complexity of a process and need for designing advanced simulation and optimisation tools.

The above is already closely related to technologies for the evolving concept of **Industry 4.0**, which includes the field of sensors (advanced sensors, actuators, data aggregators, new system parts and components, embedded systems, fibre-optic technologies and sensors and methods for the processing of sensor data) as well as the field of automation, robotics, mechatronics, measurement and simplified application of industrial automation and robotisation to new industrial processes, especially to human–robot/machine collaboration and virtual and augmented reality (development of glasses). Industry 4.0 also inherently includes industrial process automation, diagnostic systems, control and information systems, systems controlling technological processes, industrial transfer arms or equipment for intelligent transport systems.

Digitisation cannot go without new methods and simulation tools for the control of units, production plants and parent systems and without technical and SW support for the control of manufacturing technologies, solutions for data collection, transfer, storage, processing and archiving and creation of information for complete life-cycle management, for quality assurance, environmental friendliness and safety of people and things, which is also closely connected with the development of tools for IoT (Internet of Things), IoS (Internet of Services) and IoP (Internet of People) support and for development and design of embedded processor systems. Prerequisites of robotisation include the development of artificial intelligence tools and their implementation in the manufacturing industry; identification systems, including related services; and control elements and systems for units, machines, production lines and buildings, including software support. Special robots for the inspection of distribution networks and other linear structures and tools for the integration of Smart Systems will also be created. An increasingly high number of industrial ICT applications, such as autonomous systems and equipment and complex simulations, are very computationally intensive and necessitate the **development of supercomputers**.

**The electrical and electronics industry supplies many other branches** of the economy. Interdisciplinary solutions are of particular importance for the creation of innovations, with a focus on solutions for the automotive industry, chemical industry, transport, construction and health care. Automotive and industrial electronics, electric motors for the automotive industry and replacement of batteries in electric vehicles are particularly crucial for the Czech Republic’s economy. Specific emphasis can also be placed on the field of drives (drives and control of drives, specific drives, increasing the energy efficiency of drives, new materials for the construction of drives – permanent magnets, insulation).

Other fields for which electronics and electrical engineering and their outputs are a necessity include consumer and medical robotics, electrical engineering for medical applications, electrical engineering for the defence industry and special applications (passive and active radiolocation, especially for civil aviation, meteorology and security applications), semiconductor industry, imaging technology and digital projections (including technical provisions for analogue and digital transmissions in respect of increasing transfer rates and quality and reducing transmission energy demands).

Electrical engineering is also an input for Smart Society and smart buildings. In this context, it is also necessary to emphasise the need for security and reliability in all of the above-mentioned topics.

The last branch that supplies important intermediary products to other industries in the Czech Republic and worldwide is electron microscopy, nanotechnology for electronic components and the field of automated identification (RFID).

Manufacture of computer, electronic and optical products is one of the most significant divisions of the manufacturing industry. It is an important supplier for other industries, especially the automotive and machine-building industries. The products of the electrical and electronics industry are used in virtually all branches of human activity and their life cycle is getting shorter all the time. The production is classified as high technology and medium high technology. The division includes both labour-intensive manufacture and highly productive automated manufacture. It has the highest level of integration into multinational corporations' global value chains. Those chains feature varied segmentation of activities, with the parent companies usually keeping control over initial production activities such as research and development, innovation, design and post-production activities (logistics, marketing, after-sales customer service) with a higher level of employees' knowledge and higher value added, while the actual production (assembly) is located in less economically developed countries with a lower level of employees' knowledge and lower value added. This division's production is mostly intended for export but it also requires a great amount of imported components. Each koruna (Czech crown) of exports represents 0.789 korunas of imports, and this import intensity of exports is the highest among all divisions of the manufacturing industry. This great openness and strong integration into the world economy also make the industry highly susceptible to the global economy's business cycles.

In 2014, there were a total of 3,325 businesses involved in the *manufacture of computer, electronic and optical products*, with revenue amounting to almost CZK 292 billion, employing 57,509 people and generating book value added of almost CZK 36 billion. It ranks fourth in terms of revenue in the manufacturing industry.

#### **7.1.2.2 Digital economy and digital content<sup>215</sup>**

##### **Background**

The digital economy uses digital technologies to make products and provide services. Digital economy development is related to the development of information society and depends on technological development in hardware and software, on the availability of functional ICT infrastructure and especially on human resources. Individuals' and organisations' ability to creatively, meaningfully and efficiently use digital technologies is crucial for national economy development in a digitised society.

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<sup>215</sup> This part also makes use of outputs from the Cultural and Creative Industries NIP – New CCIs.

The emergence of digital technologies manifests itself in all sectors of the national economy with unprecedented speed and extent. More and more existing activities are standardised and automated by means of digital technologies, which contributes to further development of technological concepts such as cloud computing<sup>216</sup> and aids comprehensive initiatives such as Industry 4.0. Simultaneously, new processes and services emerge that are already founded on digital technologies and bring about considerable changes in existing sectors. Examples are models based on the principles of the sharing economy such as Uber, Zonky, Upwork, Airbnb or TaskRabbit. Dramatic development continues in e-commerce, including related logistic services. Digital technologies also change how businesses work internally, which allows, for example, expanding opportunities for teleworking and telecommuting. Transformation is under way in the entertainment industry and the creative industry in general, which, as the provider of attractive content, is a major driver of technological development. Digital technologies affect the operation of traditional cultural and creative industries, leading to the creation of completely new forms of creative industries and culture.

One of a fast-growing digital areas is the “Internet of Things”. It is primarily the interconnection and collaboration of things over the Internet. The boom expected in this segment will imply a high increase in the amount of data, which will be hard to process and analyse using common methods. Processing and analysis of large amounts of data are dealt with by a technological concept called big data. The increase in the amount of data not only creates technological pressure on data processing and storage but also dramatically increases the need for high-quality analysts that can work with large quantities of data. Such data is processed using new tools based on artificial intelligence; the biggest players in artificial intelligence have been releasing their technologies to the public under a free licence over time, so further development and much wider adoption can be expected in this area.

As a prerequisite for digital economy development, it is necessary to support the development of high-quality ICT infrastructure providing fast or superfast Internet access with faultless data transfer throughout the Czech Republic, including mobile Internet to allow connection out of doors.

Easy connection to the Internet thus allows higher flexibility of the labour market for people who use the Internet for their work. Greater penetration of the Internet and next-generation high-speed networks and, generally, development of the necessary infrastructure outside large cities will make telecommuting and work in the open a much more common occurrence (both within and outside the ICT sector).

Especially with the development of additional trends such as the Internet of Things, big data, video over the Internet, etc., growing demands will be made on the capacity and security of clouds, which will probably play an increasingly important role.

Transformation is also under way in the entertainment industry and the creative industry in general, which, as the provider of attractive content, is a major driver of technological development. Mixing advanced technologies with traditional technologies creates stimuli for the formation of new cultural

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<sup>216</sup> Cloud computing is an Internet-based model of development and use of computer technology. The offer of applications ranges from office applications to distributed computing systems to operating systems running in browsers, such as eyeOS, Cloud or iCloud. Services such as Software as a Service, Platform as a Service, Infrastructure as a Service or Hardware as a Service enable businesses to switch over from administrating their own information systems or outsourcing information services completely.

and creative industries, including a new type of culture where creators and users blend together. Moreover, according to the latest EU studies, a direct correlation has been demonstrated between lively cultural activity and innovation capability. And the cultural and creative industry (CCI) is experiencing distinct amalgamation of creation, digital technologies and innovations, establishing a new type of economy based on strategic utilisation of immaterial, cultural resources and intellectual property rights.

Art is conjoining with business, forming new dynamic industries that have great potential to help increase the Czech Republic's competitiveness, gain economic advantages in newly emerging markets, increase the GDP and create high-value-added products and services and new jobs.<sup>217</sup>

Conclusions from existing surveys of links between CCIs and research and development and innovation show that the dominant position in applied research and development in the sector is held by information and communications technology industries, especially information technology services (most importantly the creation of software and specialised applications, programming and web portal activities).

Domestic businesses engaged in New CCIs and using digital technologies and their products enter global competition disadvantaged by the size of the market they operate in, whose potential profits do not allow sufficient investment in basic and applied research. The Czech Republic still lacks a coherent government policy focusing on digital economy development. Based on requests made by stakeholders participating in the Cultural and Creative Industries NIP, the Ministry of Culture decided to draft a new government policy for this area – the Cultural and Creative Industries Development and Support Strategy.

The trends described above will also be exploited in the development of eGovernment. Gradual infrastructure expansion will allow incorporating additional areas into this form of administration, such as the social and health sector (eHealth, remotely aided seniors at home), transport (opportunities for line construction during the construction or reconstruction of parts of the transport infrastructure and its use, collection of information), education and culture (interconnecting subsidised organisations, providing means of communication, centralised services, access to cultural heritage), etc. The above-mentioned possibilities are in line with the concept of "Smart Administration", whose goal is efficient public administration and friendly public services. In addition, ICT has high innovation potential capable of changing both the internal and the external workings of processes in public administration.

A related step is broadening the base of competent ICT users, i.e. supporting the development of digital literacy. It is therefore necessary, besides strengthening the competences of educational professionals, to set up education curricula accordingly (with emphasis on a systemic and interdisciplinary approach) from the primary education level up, and to reflect ICT competences in the systems of further education and lifelong learning. It is necessary to provide institutional

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<sup>217</sup> Culture in general constitutes a considerable part of the Czech Republic's economy. The results of the culture satellite account show that the culture sector's weight/share in the economy as a whole oscillates over a relatively wide range around 3.7% in several significant indicators. However, creative industries are estimated to account for 5–7% of the GDP, starting to play an important role in, for example, Prague's economy. The Czech Republic's CCI sector is highly fragmented, consisting largely of dynamically developing small and micro enterprises.

opportunities for knowledge expansion over the course of life in order to reduce risks associated with exclusion in the labour market resulting from digital illiteracy or knowledge obsolescence due to fast technology changes. Besides ensuring a sufficient level of digital literacy among the Czech Republic's population, it is also necessary to specifically strengthen the professional competences of programmers and other IT specialists by means of professional and further education, as well as to set up the education system adequately to prevent a shortage of highly qualified and professionally specialised IT experts in the labour market.

### **Identification of needs and opportunities, aid targeting**

The first domain on which research and development should focus is **technical provisions and support for the administration of infrastructure providing fast or superfast Internet access** with faultless data transfer throughout the Czech Republic, including mobile Internet to allow connection out of doors.

Aid targeted at the **area of development in digital content industries, introduction and utilisation of new technological concepts**. This concerns, in particular, support for the IT services sector and development of CCIs using a digital platform. The goal is to aid the deployment of new applications (including streaming) on the Internet, development of e-commerce, support for communication with customers in geographically distant markets, deployment of digital technologies in culture, sophisticated services in exports (see the Czech EcoSystem programme) and provision of access to the public administration's open data. The aid to research and development and innovation should support the introduction and utilisation of new technological concepts such as the cloud, Internet of Things, big data, artificial intelligence and others.

Digital technologies are a key factor for preserving the competitiveness of traditional, especially industrial sectors and branches, which drive the Czech Republic's economy. There is still a lack of a **coherent approach to providing** this dynamic sector with **access to loans, borrowings and/or guarantees for loans. Venture capital financing**, i.e. financing using seed fund or pre-seed fund tools, is not developed.

Digital economy development requires supporting the development of technological concepts and their application in national economy sectors. **Vertical integration of information and knowledge systems and processes**, affecting real-time management, ERP systems and systems of strategic decision-making at the top management level, is important especially in industrial enterprises. **Horizontal integration of information and knowledge systems and processes** then concerns contact with suppliers, engineering activities, actual manufacture and distribution.

From the perspective of production, it is necessary to develop computer/digital integration of all engineering activities within an enterprise: from digitisation in the pre-manufacturing stage (modelling, virtual prototyping and 3D printing, simulation, visualisation, analysis of big data for production, prediction of material and system properties, testing) and in the manufacturing stage using robotics, cybernetics, cyber-physical objects or adaptive systems (automation and control of technological processes, integrated intelligence for operation productivity enhancement, human-machine interaction, robotic solutions leading to automatic self-learning operations) to the maintenance of data and the entire life cycle of a product or service.



From the perspective of research and development and innovation, digital economy development requires continued focus on the **development of the Internet of Things and cyber-physical systems, robotics, methods and techniques for cybernetics and artificial intelligence** (agent systems, service-oriented architectures, learning and self-organising systems, machine perception systems, intelligent robotics), **development of new algorithms and analytical tools for working with large quantities of data, tools for working with the Czech language and/or other languages in ICT, digitisation of the distribution system.**

**ICT technological concepts need to be adapted to the needs of national economy sectors.** To this end, it is necessary to support innovations that will allow taking advantage of the potential of ICT technological concepts under the specific conditions of national economy sectors. These are various solutions based on the principles of the sharing economy, e-commerce, technological interconnection of digital content, the Internet of Things, assistive technology, or specific tasks such as the digitisation of the distribution / transmission system, distribution network – smart grids. New solutions for electronic communications systems need to be developed. A significant application of ICT technological concepts in the automotive industry / transport is self-driving car technology. This requires supporting the development and application of sensors and algorithmic control technologies. Unmanned aircraft systems, including their autonomous operation, need to be developed for industrial application or consumer and other purposes.

Increasing **cybersecurity** is a prerequisite for digital economy development. It is therefore necessary to ensure the protection of both ICT infrastructure and data against attacks especially by securing data and networks, to secure data storage and backups and modern but secure digital communications, and to prevent malware propagation and not only fight but also prevent cybercrime.

**Digital economy development also brings about the risks of negative phenomena in society.** The most significant phenomena include fear of possible increase in unemployment, which may be caused by the high level of automation in the digital economy; inhibiting innovation for fear of change or competition; digital exclusion or social pathologies such as addiction to playing Internet games; etc. It is necessary to monitor key indicators of such social phenomena, which may in effect prevent further digital economy development, and participate in the preparation of measures to eliminate their impacts. It is therefore necessary to look into socially sustainable digital economy development and monitor related negative social phenomena and develop measures to eliminate them (sociology, psychology, law, media studies, political science, area studies, ethnology, anthropology, etc.), including forming requirements for education, research, development and innovation.

In the above context, **digital humanities** are becoming new areas of research, e.g., the area of extraction of information from text sources and combined structured and unstructured data (“text and data mining”, including quickly developing corpus linguistics). A conspicuous area in this regard is research into copyright and intellectual property in relation to new technologies.

An area in which digital technologies find massive application is **media production** – film<sup>218</sup>, video, television, radio, animations, games, intermedia, visual art, lighting design, photography, advertising, publication (printed and digital), digital platforms (web, mobile apps).

The segment's growth is conditional upon growth in both the creative (artistic) and the technological part of the creative process. Research topics thus cover areas whose development opens up opportunities for new forms of communication within society or between an individual and technology. This also takes advantage of the potential of all creative industries (including non-technical) and involves them in a number of innovative processes within the meaning of development of both engineering and artistic disciplines. In the field of media, development focuses on new techniques for the creation of media content, development of presentation techniques, innovation in archiving and development of media content applications.

Development of **architecture and performing arts** is based on bonds with other fields and on the ability to make use of those fields' results. This includes, in particular, the application of digital technologies, media and advanced materials in work with space – virtual and mixed reality.

**Memory institutions** are concerned with maintaining a repository of information and cultural heritage and making them accessible using current technology and a form comprehensible for current society. This demands adequate technological equipment for transferring the results of activities in varied fields to the process of archiving and presenting stored contents. The key topics of research and development are seeking new methods for the restoration and archiving of memory collections, archiving and searching of media content and innovative use of memory collections for the purposes of cultural and creative industries' development, among other things.

### 7.1.3 Transport means for the 21st century<sup>219</sup>

#### 7.1.3.1 Automotive

##### **Background**

The automotive industry contributes significantly to the Czech Republic's total economic performance. The industry covers the following product structure: passenger cars, light utility vehicles and lorries, trailers and semi-trailers, buses and trolleybuses, snowmobiles, golf carts, amphibious vehicles, fire engines and the manufacture of their parts.

In 2014, the industry had a 7.4% share in the Czech Republic's gross value added, accounted for about a quarter of the total revenue of the manufacturing industry, and exported goods worth CZK 727 billion, i.e. approximately 23% of total exports. The industry employs 155,500 people, i.e. almost 2.5% of the total number of people employed, with a year-on-year growth of over 3%.

Internationally, the Czech Republic is an automotive superpower with a solid background of technical knowledge and people's skills. In 2014, the Czech Republic ranked fifth in the EU (behind Germany,

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<sup>218</sup> The film industry will undoubtedly be able to take advantage of the Czech Republic's unique locations.

<sup>219</sup> This is an EDP output from National Innovation Platform III – Manufacture of Transport Means.

France, Spain and the United Kingdom) and thirteenth worldwide in terms of passenger cars manufactured. Czech automotive parts are used by virtually all car makers manufacturing their cars in Europe.

In terms of research and development, the automotive industry is one of the most significant industries in the Czech Republic. It employs over 2,000 researchers, which is 11% of researchers in the entire entrepreneurial sector. Its research and development expenditure accounts for more than 13.5% of the entire entrepreneurial sector's R&D expenditure, growing by more than 8% annually in the past five years. Many companies of international importance have built their technology centres in the Czech Republic.

### **Identification of needs and opportunities, aid targeting**

Research objectives focus on innovation in vehicle design (chassis systems, overall lightweight construction, better aerodynamics). Innovation in **chassis systems** involves new conceptions with advanced powertrains and integrated control with respect to vehicle dynamics, active safety and comfort and noise, application of intelligent power elements, lightweight body and frame construction, vehicle exterior and interior aerodynamics.

Innovation in **powertrains and fuels** will make them more compact and efficient while reducing the consumption of fossil fuels and biofuels and the emissions of CO<sub>2</sub> and other pollutants (PM<sub>x</sub>, NO<sub>x</sub>, aromatic hydrocarbons). This involves internal combustion engines with improved efficiency using fossil fuels, second-generation biofuels, later-generation biofuels, materials and components for alternative powertrains, alternative fuels and vehicle fluids. This also includes alternative-fuel power units, hybrid drives (power electronics, electric motors, generators, batteries, flexible-fuel internal combustion engines for innovative powertrains using synthetic fuels, etc.) and electric drives (power electronics, electric motors, generators, batteries, flexible-fuel internal combustion engines for innovative powertrains using synthetic fuels, etc.). Reduction in CO<sub>2</sub> emissions can be achieved in part by innovating powertrains with both conventional and flexible-fuel engines and reducing vehicle weight. A key role is played by the introduction of fuels with recycled carbon and vehicle electrification while also reducing CO<sub>2</sub> emissions in electricity generation. Reduction in the consumption of fuels with fossil carbon can also be achieved by improvement in vehicle driving and vehicle management in traffic flows. Research objectives also focus on emission parameters (EURO 6+). The described innovations in vehicle powertrains and construction will also generally result in noise reduction.

The field of **vehicle electrics and electronics** concerns vehicle communication networks, adaptive and predictive control of powertrain parameters, integrated and hierarchical vehicle control systems, including the automation of routine processes, electrics components aimed at reducing power input and price, ensuring robustness and high operating reliability to enhance safety, reducing energy demands, resolving EMC issues and reducing noise, and diagnostic means to ensure the reliability of integrated control systems with new appliances.

We also must not forget **ecology**, with research objectives integrally including the environmental friendliness of manufacture within the meaning of using a set of input materials based on recycled materials or materials from renewable sources and research into efficient recovery of materials from transport equipment after its useful life.

Emphasis will also be put on maximum **safety**, involving innovation in active and passive vehicle safety (lighter and stronger materials with deformation capacity, impact energy absorption capacity, etc.) as well as measures supporting the safety of the whole transport system, such as cooperative systems for sharing information among users and other transport system elements.

The area of **ITS, mobility and infrastructure** concerns cooperative systems for online information sharing among vehicles and other types of transport, and between a vehicle and its surroundings, systems for optimum utilisation of data on the road network, traffic and travelling, as well as data on recharging facilities for electric and hybrid vehicles. It also includes research, development and implementation of driver assistance systems, as well as research, development, legalisation and implementation of autonomous driving systems, including car-to-car communication systems. Besides design innovations, vehicle comfort and reliability will also be increased by integrated predictive and adaptive control. There is a trend towards increasing the proportion of information technologies even in cheaper vehicles.

Some of the innovations described above (e.g., weight reduction, safety enhancement, manufacture of new types of engines and motors) will be implemented using new advanced materials (plastics, composites, using nanotechnology, etc.). New **material processing** also includes nanotechnology (e.g., in surface protection, which can take advantage of the anti-corrosive, self-cleaning, wear-resistant and other properties of nanomaterials) for multifunctional materials, advanced metal, plastic and composite materials, application of modern methods for material machining, parting and joining, productivity enhancement methods including Design4x, R&D of manufacturing process optimisation and flexibility enhancement and disposal methods.

The basis for tackling the above-described challenges efficiently is simultaneous engineering (based on integrated utilisation of simulation and experiment modelling), connected with systematic use of prior experience preserved in knowledge databases. It is therefore necessary to create R&D tools (simulation methods of various levels, including virtual reality or knowledge and data storage methods) and to verify such tools in short-term-oriented experimental development and use them for strategic applied research on innovative concepts. A shared data and knowledge base supports smooth collaboration between experts from the fields of mechanics, thermodynamics, electric traction engineering, management, information and communications technology, microelectronics, mechatronics and transport engineering. **Virtual development** includes research into simulation techniques and virtual reality (VR) techniques for parametric optimisation of products, for conceptual optimisation of higher-order innovation, VR for faster preparation of the manufacturing stage in the production chain, use of VR in manufacturing line design, and applications for designs usable during possible implementation of the Industry 4.0 conception.

Manufacture will thus see an increasing level of robotisation and automation, with even those components of the manufacturing processes of the most progressive producers being designed using virtual development means, which will allow accelerating the preparation of the manufacturing stage in the production chain. Flexibilisation of all production stages will also allow flexible adaptation to the variable requirements of customers of different ages and customs; additionally, it will strengthen the Czech automotive industry's competitiveness, including competitiveness in emerging markets. **Manufacturing processes** should then link the virtual cyber world with the world of physical reality while developing industrial and operating intelligence based on information and cybernetic technology.

In the field of **energy**, it is necessary to create an infrastructure and transport systems for electric mobility, as well as an infrastructure for advanced transport – Smart Grids, hydrogen infrastructure and vehicle power management for the management of electric and hybrid buses.

Naturally, research and development also concerns **related components**.

### 7.1.3.2 Aircraft and spacecraft industry

#### **Background**

The aircraft industry, which has an almost 100-year tradition in the Czech Republic and whose strongest aspect is expertise continuity and internalisation, has annual revenue of more than CZK 25 billion. The manufacture of aircraft and aircraft engines is a technology-intensive (hi-tech) industry.

The Czech aircraft industry systematically aligns its research and development activities with the EU aircraft industry's updated strategic goals and wants to participate through its activities in the fulfilment of objectives defined in ACARE's European strategic documents and Strategic Research & Innovation Agenda (SRIA). This applies especially to increasing air transport quality and affordability, improving flight safety and reducing the number of aircraft accidents, enhancing air transport safety as well as reducing the negative environmental impacts of air transport (reducing fuel consumption and CO<sub>2</sub> emissions, reducing perceived noise, etc.). In the field of research and development, Czech companies and research organisations have been part of the European Research Space for many years, participating in the development of new technologies and elements for large transport aircraft and helicopters alongside such companies as Airbus, Dassault Aviation, BAE or Leonardo-Finmeccanica.

From the international perspective, the Czech Republic is seen to be competitive especially in the production of small transport aircraft (up to 19 passengers) and sports aircraft. The Czech Republic is Europe's second largest producer and exporter of light sport aircraft. Ultralight aircraft manufactured in the Czech Republic cover more than a quarter of the world's market. Therefore, the Czech aircraft industry's strategic goal is to maintain the position of a major European producer and exporter of light sport aircraft and become a major European centre for the development and manufacture of small transport aircraft, their parts, systems and components. In addition, the Czech Republic wants to be a respected supplier of assemblies, units, components and services for transport aircraft and helicopters under both civil and military aircraft programmes.

#### **Identification of needs and opportunities, aid targeting**

Research and development in **aerodynamics, thermomechanics and flight mechanics** will focus on aerodynamic profiles, boundary layer control, efficient high-lift devices, active elements for aircraft aerodynamic controls, flight dynamics analysis, flight characteristics and performance, simulation of icing impacts and elimination, prediction of cabin interior environments, optimum aerodynamic design of VTOL/STOL aircraft, hydrodynamics optimisation in floatplanes and flying boats, thermodynamics of suborbital aircraft, optimisation of flow paths in turbine engines, optimisation of bladed parts for turbine engines and optimisation of the aerodynamic design of propellers. Research will also be conducted on aeroelasticity (simulation of aeroelastic effects with the influence of the environment) and aeroacoustics.

The field of **modern designs and technologies** will cover progressive structural designs reflecting new technologies and materials, optimisation tools for progressive design reflecting manufacturing

technology, aircraft structure assessment in terms of load capacity, fatigue and durability, limit states and modes of failure in aircraft structures, fatigue failures, and more precise residual life prediction. Research will also be conducted into the impact of structural, material or technological changes on structural failures in aircraft and increasing aircraft service life. The field of advanced manufacturing technology requires research into efficient and safe uses, e.g. of various modifications of new composite technology, joining of structural parts or manufacture of integral structures. It is necessary to seek alternative methods for assembly and installation (3D metrology, augmented/virtual reality), casting of aircraft structural parts from aluminium and magnesium alloys, including computer simulations, bulk and sheet metal forming and machining of unconventional materials, high-strength steels and non-ferrous alloys, ADM (Additive Layer Manufacturing) and means to reduce external and internal noise.

In the field of **materials**, it is necessary to seek materials with new properties, which should feature an excellently favourable ratio between properties and specific weight. What is needed are materials resistant to corrosion (airframe) and high temperatures (engine parts), fireproof materials (interior), materials with sliding properties (moving parts), materials with anti-icing properties, materials reducing surface friction, materials capable of absorbing high energies (landing gear), materials with programmable and smart properties, etc. Another direction of development is the use of materials with nanofibres and nanofillers. Simultaneously, it is necessary to seek opportunities for the application of (existing) advanced materials in aviation.

Development in **propulsion units** will focus on alternative fuels, new propulsion systems (propulsion for small aircraft, powertrains for gliders, restartable rocket propulsion, electric and hybrid powertrains, hydrogen fuel cells), combustion chambers, diagnostic systems for propulsion units, design and modelling of aircraft engines and their components, optimisation of lightweight propeller and fan designs, dynamic simulations of turbine engine regulation and control systems, modelling and optimisation of thermodynamic processes in combustion chambers, design and optimisation of high-speed gearboxes.

Development in **aircraft on-board systems** will focus on the integration of operating (hydraulic, fuel, air-conditioning) systems, the optimisation of automatic movement control (autopilot function), secure data communications, integrated electric supply distribution system, increase in the precision of low-cost aircraft inertial measurement units using GPS and magnetometers, particle filters, identification and control algorithms of dynamic systems, integrated satellite navigation receivers, automated control system and integrated stabilised aircraft optical systems.

The development of **unmanned aerial vehicles** will focus on drones for security purposes (protection of critical infrastructures and airports, perimeter security, bird and animal control) and research into possible use of drones in various fields (agricultural and forestry – fire protection, forest damage monitoring, linear structures, orthophoto mapping). It is also necessary to research the possibility of using multiple UAVs in a single area – this includes tactical, planning and collision avoidance, ability to carry out various tasks – tracking, surveillance, monitoring, patrolling, etc. and using GT for multiple UAVs.

In **space activities**, research and development will concern especially sensorics, instrumentation and space transportation technologies and components<sup>220</sup>, satellite communications, Earth observation

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<sup>220</sup> E.g., space activities for Ariane or Vega.

and satellite navigation. This includes, in particular, the development of optical components and related precision mechanisms and 3D printing, technologies for on-board electronics, HW platforms for data processing, satellite on-board and SW systems (e.g. on-board software, power management), automatic and robotic systems (including vibration-damping systems and launching equipment), MEMS (microelectromechanical system) technology and parts of stabilisation equipment (gyroscopes, reaction wheels), materials with enhanced characteristics for use in space, composite and glued laminated materials, adhesives and coatings, structural and thermal analysis, thermal management, simulation of aerothermoelastic effects. Attention should also be paid to trends in processes, such as Industry 4.0, IoT (Internet of Things), model-based enterprise, advanced simulation and testing. In the use of data from space systems, research and development will focus on open and secure communication protocols, compression algorithms for data transmissions, algorithms for the processing of Earth observation data (including big-data algorithms), advanced methods for GNSS (global navigation satellite system) signal processing, development and application of GNSS-based correction systems and position finding algorithms, increasing GNSS receiver resilience in combination with suitable anti-jamming and anti-interference technology, autonomous driving algorithms. Businesses should aim their space activities especially at creating products applicable in supplier chains, ideally as integral components (rather than individual parts) in more complex products.

Optical and optical/photonic systems for space research, modelling of space research objectives, and supporting ground observations.

From the social point of view, the aircraft industry addresses the issues of energetically and environmentally sustainable transport and ensuring transport **safety and security**. Safety and security concerns, on the one hand, the reliability and durability of aircraft and aircraft components (operating reliability of aircraft structures, civil applications of unmanned aerial vehicles, enhancing the durability of aircraft structures, aircraft damage evaluation, experimental equipment for monitoring, measuring and evaluating the load and deformation of aircraft structural parts in operation, advanced cockpits, low-cost aircraft structural elements, efficient use of aircraft interior) and, on the other hand, ensuring air traffic safety and continuity (technical systems for the provision of air traffic services, including remote provision technology, aviation information and communications technology, drone detection in the vicinity of big airports). Safety and security also include antiterrorist features, reduced-crew aircraft, passive safety of crews and passengers and pilot stress reduction, transmitting and sharing large quantities of structural data between remote users, virtual reality in designing activities, advanced deicing systems, protection from the effects of lightning, aircraft rescue systems or ejection seats.

### 7.1.3.3 Railway and rail vehicles

#### **Background**

In terms of production characteristics, the manufacture of railway locomotives and rolling stock is the most significant group in the manufacture of other transport equipment in the Czech Republic (accounting for more than 50% of employment, more than 56% of gross value added and almost 60% of revenue, while the whole division accounts for approximately 0.5% of total employment and gross value added). Its five-year trend is slightly rising in revenue, and is level in value added and employment. The manufacture of railway and rail vehicles classifies as a medium hi-tech sector. In

line with the European strategy of constructing high-speed railway corridors, enhancing the significance of urban and regional rail transport, especially in agglomerations and their vicinity, and in line with the preference for railway in medium- and long-distance freight transport, carriers can be expected to be increasingly interested in modern, fast, reliable, safe and energy-efficient trains and related equipment. With their quality and competitive prices, Czech manufacturers in the railway industry are valued suppliers of products to not only the domestic market but also other EU member states' and other countries' markets. In Western Europe, products from this group are exported mostly to Germany and France; exports of Czech rolling stock manufacturers are, to a very great extent, oriented towards Central and Eastern European countries and Asia.

In terms of research and development, the manufacture of other transport equipment is important to the Czech Republic for its share in the business sector's R&D expenditure (over 4%), which, in addition, has been growing year-on-year (the average year-on-year growth in the past 5 years has been over 6%). It employs almost 3% of the business sector's researchers.

### **Identification of needs and opportunities, aid targeting**

Basic directions of research and development in the field of rolling stock concern harmonisation with the environment (reducing energy consumption, developing components and systems for noise reduction, new environmentally friendly propulsion systems).

Another area concerns increasing interoperability, safety and reliability, where the major challenge is developing new rolling stock and components meeting the requirements of the latest EU legislation, trends in passenger and freight transport, including the use of smart systems.

In the field of **advanced materials**, it is necessary, in general, to develop materials with new properties for longer durability, higher safety in railway service and/or greater environmental friendliness. This includes, in particular, new metal materials (steels of higher strength, steels with better corrosion resistance) as well as non-metal materials (e.g. laminated structures, composite materials and rubber applications). Such new materials can find application, e.g., in the construction of bodies and chassis, in rail vehicle interiors. Such materials should provide advancement in the reduction of emissions and noise and vibration propagation in railway operations. Development in materials with new properties is applicable, e.g., to materials for railway wheels and axles with higher durability and safety in operation, including heat treatment technology, or in the research and verification of new metal and non-metal materials and the development of new designs of rubber-cushioned wheels for urban and suburban rail transport.

In **advanced manufacturing technology**, it is necessary to research the fields listed below (**products; emissions/noise/energy; control systems/electronics; test engineering**).

In the field of **products**, it is necessary to focus on interoperability and higher safety, where more product prototypes need to be produced during research and development due to the necessity to implement new EU legislation's requirements for rolling stock, especially those targeted at interoperability, maximum safety and operational efficiency with emphasis on demonstrating compliance with such requirements (i.e. reaching the required level). Without producing such product prototypes to verify research and development results, it is impossible to reliably demonstrate that defined development goals have been accomplished. Since prototype production costs comprise a considerable percentage of development costs, and verification, testing, certification and homologation alone account for up to 50% of a product's total costs, this



discourages the sector from developing products in advance, in connection with market and legislative requirements, which has a negative impact on the sector's competitiveness.

Another field is the design of railway vehicle interiors, to achieve maximum energy savings in operation (heating, etc.), together with minimum noise emissions and enhanced functional and fire safety of the rail vehicle interior as a whole.

Another necessary area of research and development is the design and optimisation of new wheels and axles for high speeds above 300 km/h, as increasing the speeds of this type of transport over time will result in its increased competitiveness. In relation to this, it is then necessary to enhance the technical parameters of related components and assemblies (e.g., anti-friction bearings). Another necessary area of research and development is new designs of tram-train systems.

An area related to both interoperability and the development of high-speed rail transport is aerodynamics. Rolling stock aerodynamics, including the effect of crosswinds, and the preparation of a wind map of the Czech Republic's areas covered by the TEN-T network and considered for the construction of high-speed lines are necessary for stock and infrastructure design.

Concerning the related infrastructure, it is necessary to focus on development in the field of increasing the service life of the infrastructure and its components, as well as the development of diagnostic methods for the railway infrastructure and rolling stock.

In the environmental area of **emissions/noise/energy**, i.e. support for zero-emission rail transport and decrease in the consumption of fossil fuels by this type of transport, it is necessary to concentrate on future environmentally friendly propulsion applied to railway transport, focusing on a shift towards a railway that will be as low-emission and as energy-efficient as possible. Such development should focus on battery power supply technology, combined overhead/battery power supply, fuel cells (hydrogen), solar energy and hybrid propulsion, including corresponding related technologies in the railway infrastructure. Following on from the above, focus should also be on the research and development of advanced energy recovery systems for rail transport, powertrain structure interaction, auxiliary consumption and systems for automatic control of rolling stock and traffic with respect to energy use optimisation. Also related to this area is improvement in the energy and traction parameters of components, traction equipment of railway vehicles together with improvement in the efficiency and effectiveness of component usage, as well as powertrain control methods aimed at energy consumption reduction and optimum utilisation of adhesion conditions.

In the field of **control systems/electronics**, it is necessary to focus on the development of full traffic control automation, including integration with rolling stock (SW, HW). Integration with other technological systems in rail vehicles. Optimisation of automatic railway traffic control in terms of efficient management of energy sources. Development of the fixed infrastructure for automation of vehicle operation control, including online data transmissions. These activities should consist in, e.g., the application of satellite positioning to safety systems with particular focus on ETCS, enhancement of safety on regional lines, telematic applications, including diagnostics.

To support interoperability, this would include development of the European train protection system (ERTMS – ERTMS/ETCS and ERTMS/GSM-R), especially in the adaptation and consolidation of properties of the two systems with focus on introducing functional key online management, ETCS implementation in railway vehicles, including integration of sophisticated solutions for automatic train control linked to traffic control systems, development of ETCS mobile parts according to new

specifications, and finding an optimum engineering and financial compromise for application to regional lines.

Furthermore, in the development of detection means for identifying clear/occupied track sections in accordance with the development of locomotive traction drives, development of jointless track circuits allowing wider application of continuous welded rails and the development of secure radio transmission systems, which are already obsolete in the Czech Republic.

Last but not least, also the development of information systems for passengers – providing visual and audio information, including multimedia, to both passengers and train staff, or the development of centralised data management and data distribution to operators' vehicles or solutions for safer railway crossings.

The field of **test engineering** is an inseparable and very important part of product research and development. Creating methodologies and conducting necessary technical tests, analyses, simulations, evaluations, verification by independent entities, certification (demonstration of compliance with legal requirements) or at least reviews of a product's ability to get certification necessary for placing the product on the market and the related engineering consultancy by highly specialised entities (laboratories, universities, accredited testing laboratories, recognised bodies, etc.) are absolutely necessary for the verification of research results and their applicability, i.e. product marketability.

Another area is **standardisation and standard making**, where research and development will focus on the development and support of the standard-making process and accompanying activities in relation to the state of the art and research results.

Under the topic of **safety and ecology**, research and development will focus on the development and support of the system of rolling stock maintenance and modernisation with a view to enhancing operation safety and environmental friendliness.

## 7.1.4 Health care, advanced medicine<sup>221</sup>

### 7.1.4.1 Medicinal Products, Biotechnologies, Medical Devices and Life Sciences

#### **Background**

The pharmaceutical industry classifies as a high-tech manufacturing division with high demands on research and development activities (15% to 20% of annual revenue).

The production portfolio of the pharmaceutical industry is very broad, consisting of original drugs that are protected by patents as well as generic drugs that are no longer covered by patents. Key manufacturers in the Czech Republic, mainly for reasons of high costs, focus mostly on generic drugs, where the Czech Republic is at the world's absolutely top level. The pharmaceutical sector in the Czech Republic is mostly represented by businesses with foreign participation, accounting for about

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<sup>221</sup> This is an EDP output from National Innovation Platform IV – Medicinal Products, Biotechnologies, Medical Devices, Life Sciences.

four-fifths of total revenue. Investment activity in the pharmaceutical industry continues. There are indications of foreign companies' interest in future projects, so the sector can be expected to grow. There is similar dynamic development in the diagnostic segment, which is one of the fastest-growing segments in the field of health care. Progress in personalized medicine increases the importance of in vitro diagnostics, while patients' better access to modern imaging methods brings about development of molecular imaging. Therefore, there is real demand and the necessary research, development and industrial base in the field of diagnostics, which can develop into a flourishing industrial sector.

Research, development and manufacture of medical devices has a long tradition in the Czech Republic. There are dozens of companies of all sizes (from large businesses to budding start-ups) operating in this sector, a number of which are global players in the delivery of medical equipment. The segment's characteristic features are extremely high innovation potential, a higher than average number of successfully marketed innovations, high product value added and high pro-export potential. Manufacturers of medical devices have research and development capacities with a high level of expertise and knowledge, which allow continuous development of innovative devices while accelerating the rate of development. Development activities undertaken in the Czech Republic thus often result in products with unique features, which are considered innovative worldwide.

In addition to a positive effect on the Czech Republic's economic development, the segment of medical devices development and manufacture also has a direct positive impact on other sectors, most importantly the health service sector. Manufacturers of medical devices collaborate with clinical sites both in the research/development of new devices and during the subsequent application stage. This interconnection is crucial for the level of medical and nursing care provided. Without innovation in medical equipment, it would be impossible to improve the quality and efficiency of provided care, which would negatively affect not only the population's quality of life but also the growth of care costs. Modern medical devices thus represent an absolutely crucial and irreplaceable factor for current medicine, which needs to be further developed and innovated constantly.

Unlike many other segments, medical devices are a segment with extremely high generated value added. The technical performance and quality of medical devices manufactured in the Czech Republic allow exporting a substantial dedicated proportion of the production all over the world.

The deployment of modern medical devices is subject to extensive regulation with a view to protecting patients' health. Czech small and medium-sized enterprises must respond to legal requirements, as they develop (also under pressure exerted by multinational groupings), with much effort and at high costs. Incongruity between EN ISO standards and FDA and ANVISA requirements forces Czech manufacturers to comply with FDA and ANVISA requirements to be able to enter the markets that are subject to such regulation. These are markets in America (both continents) but also in Asia and elsewhere.

In addition to having a significant economic benefit, medicinal products, diagnostics and medical devices are an important tool for extending the length and improving the quality of the population's lives, contributing to the sustainability of human resources across industries and public administration.

### **Identification of needs and opportunities, aid targeting**

In the field of **innovativemedicinal products** – for both human and veterinary use – development will necessarily focus on new formulation techniques in the development of original but also generic products, and on disinfectants. A promising area is the development of low-molecular drugs, products for targeted therapeutics (drug delivery systems) using nanotechnological, biomolecular and macromolecular carriers, as well as the development and therapeutic use of advanced cell therapy medicinal products (ATMPs), including the use of regenerative medicine (stem-cell therapy). Another significant need is the development of therapeutic and preventive vaccines. There is also a growing need for health care and related research (e.g., into lifestyle diseases affecting the cardiovascular and gastrointestinal systems) in oncology, surgical oncology, neurology and psychiatry, paediatrics, haemato-oncology and issues associated with ageing.

Besides medicinal products, it is also necessary to develop **newdiagnostic methods** and technology (for both human and veterinary use), including personalised medicine. This will concern, in particular, the development of new technologies for in vitro diagnostics and the development of diagnostic, prognostic and predictive biomarkers of diseases. This will concern, in particular, the development of new technologies for in vitro diagnostics and the development of diagnostic, prognostic and predictive biomarkers of diseases.

The development of high-quality health care also depends on the production and development of **medical devices**, including research into materials (e.g., biopolymers and new alloys usable as replacement tissue and organs). This also includes instrumentation engineering products for use in health care, biotechnological production and veterinary medicine, as well as material research in biotechnology. Typical products of this segment are progressive robotic systems for medical applications, progressive imaging and other systems for non-invasive applications in medicine, intelligent and feedback systems, instruments and equipment for diagnostics and therapy, innovative medical instruments and implants made of new materials, including nanotechnology applications, progressive devices improving medical aftercare and its medical applications, new mobile devices for disaster medicine and, last but not least, new systems and instruments for effective physical therapy, personal protective equipment, as well as innovative devices for the prevention and timely indication of diseases and new devices improving the quality and effectiveness of provided medical care. Other medical devices that can benefit from the application of advanced materials, drugs and manufacturing technologies are, for example, functional absorbable wound dressings using composite nanotextiles, colloids, hydrogels, etc. allowing gradual release of antiseptics or other substances promoting healing.

Similarly to other areas, health care and veterinary care require development of **information and communications systems**, e.g. for the purposes of telemedicine and remote patient monitoring using electronic systems, the electronisation of medical records and efficient systems for their management and evaluation.

In **nanotechnology**, nanofibre barrier textiles are used in medicine as means of protection against allergens, bacteria and viruses.

In addition to the manufacture of textiles, nanofibre structures for medical purposes are used in regenerative medicine, tissue engineering and targeted distribution of drugs in nanocapsules. Pharmaceutics uses micro- and nanotechnology methods to change the physical properties of dietary supplements or medicines in order to enhance their efficacy and decrease toxicity and adverse reactions. Photocatalytic coatings with TiO<sub>2</sub> nanoparticles find application in medicine for their

biocidal properties. Titanium dioxide is also used in construction, namely planar structural elements as part of coatings or surface films (planar structural elements with self-cleaning properties, planar structural elements with deNOx capability, planar structural elements with antibacterial effects).

## 7.1.5 Creative Czech Republic<sup>222</sup>

### 7.1.5.1 Traditional cultural and creative industries

#### **Background**

The potential of cultural and creative industries (CCIs) in the Czech Republic is based on the historical background of culture with an extensive infrastructure, be it physical facilities or cultural traditions, professional activities or a high level of people's involvement and participation in cultural events, which is evidenced by the relatively high popularity of domestic production, among other things. Traditional industries such as artisanal handicrafts, the design of products made primarily of such materials as glass, fired clay, wood and metal experience a rapid growth in the number of customers as well as producers themselves.

CCI activities profoundly influence the development in such manufacturing industries as glassmaking, the design and manufacture of a wide range of products made of porcelain, metal and wood. Having 300 years of tradition in the territory of today's Czech Republic, this sector includes some companies established as early as in the late 19th century, which have survived thanks to technological and creative innovation. They employ tens of thousands of people and preserve irreplaceable human-resource competences passed from generation to generation. They are unique in their integration of manufacture, craft, design, creativity and cultural heritage as well as in providing employment in troubled regions (e.g. northern Bohemia), and they are also important for the development of tourism. However, the potential of integration between the business sector and design has not been developed sufficiently in the Czech Republic so far. The Czech Republic has a relatively low number of companies efficiently applying design to their production and Czech designers' and companies' successes both at home and abroad are rather sporadic. Moreover, after dissolving the Design Centre of the Czech Republic, the Czech Republic is the only EU country where design is not developed by a state-supported umbrella organisation creating favourable conditions for its development.

The field of design is often expanded to include traditional artisanal handicrafts, i.e., procedures taking advantage of craftsmanship, competency and knowledge of traditional materials, finishes and techniques for the creation, repair, restoration or preservation of objects or structures. Artisanal handicrafts have a long tradition in the Czech Republic and still maintain a good reputation in competition with foreign competitors, but any comprehensive support by the state de facto ceased to exist when the Arts and Crafts Centre and the Centre for Folk Art Production terminated their activities in 1992. In the international context, the products of contemporary artisanal handicrafts are presented as "design". Presumably the most important development trend is collaboration between traditional and contemporary handicrafts.

Human resources in this sector have a common denominator: dependence on the quality of the educational process aimed at developing specific competences and skills in contact with practice, resulting in the production of goods and services with higher value added. According to the results of surveys to date, there is a lack of systemic arrangements for education optimisation and

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<sup>222</sup> Outputs of the Cultural and Creative Industries NIP.

development; e.g., some industry-specific programmes coveted by the labour market lack accreditation. The field of human resources, especially cooperation between businesses and technical colleges, vocational schools, secondary schools and universities in the training of new artisans active in CCIs, is crucial for the sector's future. In this context, it is necessary to modernise the education system and optimise it in line with the manufacturing sector's needs and public demand.

The Czech Republic still lacks a government policy for cultural and creative industries. It should be defined by a new policy document of the Ministry of Culture, the Cultural and Creative Industries Development and Support Strategy.

### **Identification of needs and opportunities, aid targeting**

The making of products represents by nature a combination of traditional handicrafts with artistic and creative disciplines and industrial production. The outputs cover a wide range of human activities, including traditional industries.

In relation to research and development and innovation, all of the sector's branches give priority to **design innovations, technological innovations – especially the application of advanced technologies in the designing and manufacturing process, material research and research into traditional craft techniques, patterns and methods, including the goal of their restoration and preservation as national heritage.**

A key research topic across all sector branches continues to be **research into materials and technologies**, in particular the utilisation of the properties of new materials and new methods for working with such materials, search for and utilisation of new materials from basic and applied research and modification and development of technologies for their processing, innovation and modification of traditional methods for material processing and application, innovative methods for the processing and application of traditional materials, including research and application of results in the development of new products. The area of traditional CCIs is not immune to effects of “emerging industries”, so an important topic to be researched is innovative use of advanced technology in the process of design and creation (including ICT). In the field of cultural heritage preservation and conservation, special attention needs to be paid to research on the life cycle of materials and products made of them, and on materials intended for repairs of protected historic buildings.

A key area of traditional CCIs continues to be the **manufacture of glass, ceramics and porcelain** and development of glass in respect of safety and environmental responsibility, **advanced principles of glass preparation and robotisation of glass manufacture** with favourable energy, environmental and quality impacts (regeneration of existing technologies and application of new manufacturing structures) and glass surface finish in line with requirements set by business trends and legislation (protective and anti-adhesive coatings). This process is built upon by the development of glass integration into final products (fixing tubes, telescopic suspension systems) and search for new methods for using glass and glass products with overlap with construction and other manufacturing industries. Important topics also include material research and seeking new raw materials and glass with properties relevant to mass and special-purpose applications and original bulk and surface

treatment. In the manufacture of ceramics and porcelain, interest is focused on the development of coloured glazes and their properties and the development of ceramic granules.

In the **manufacture of textiles**, pivotal topics are the manufacture and use of **nanofibres and nanofibre structures** in textiles and the application of nanoparticles for special effects. Much attention should be paid to the development of additional new materials with a wide range of applications and new properties, such as composite structures containing inorganic fibres, textile reinforcements, in general, **smart textiles**. In this connection, attention should be paid to the development of the application of optical fibres and shape-memory materials in technical products, **including textile sensors** and sensors suitable for use in textiles. Here again, what is important for the development of the sector is the modification and development of technologies for the processing of new materials, including environmental aspects in their application.

In the **manufacture of wood and manufacture of musical instruments**, development and research should concern technology for joining wood-based materials, **mathematical simulations of wood structure stiffness, development of new wood-based materials with high resistance to biotic agents and fire**. Another major topic is glued laminated wood and its use in the architecture of wood-frame buildings.

In the manufacture of musical instruments from wood, it is acoustics and technical physics (research into the acoustic quality of musical instruments and their uniformity). What all woodworking segments have in common is addressing the environmental aspects of the processing of wood and wood-based materials.

The description of needs and how they should be addressed is also based on the field of nanotechnologies, where Czech businesses have successful applications and are competitive at global level. This concerns, above all, the use of **nanofibre** technologies. Know-how associated with the tradition of **textile manufacturing** finds its application today in the production of nanofibre membranes and special textiles for functional clothing. The nanofibre-oriented manufacture of textiles also provides products for a wide range of industrial applications, such as filtration.

### **7.1.6 Research topics in reaction to the incorporation of the national RIS3 strategy in the National R&D&I Policy**

Besides the five above-described application areas derived from the significance of economic and innovation dynamism in relevant application sectors, the RIS3 strategy has been expanded to include R&D&I topics in several additional critical areas where maintaining the Czech Republic's long-term competitiveness requires preventing risks and finding solutions to key challenges that may jeopardise the prosperity of the Czech economy and society in the long run. The additional topics, which are contained in the two following sections, 7.1.6.1 and 7.1.6.2, were derived from the activities and R&D&I priorities of competent ministries responsible for the relevant areas and discussed with representatives of research institutions under relevant NIPs.

For topics in section 7.1.6.1 – Agriculture and the environment, the priorities were identified in collaboration with the Ministry of Agriculture and the Ministry of the Environment; for section 7.1.6.2 – Societal challenges, the priority topics were identified in collaboration with the Ministry of the Interior, Ministry of Labour and Social Affairs and Ministry of Health. The topics thus also reflect measures in the National Research, Development and Innovation Policy of the Czech Republic for

2016–2020 aimed at creating the capacities to allow identifying, setting up and implementing/supporting priority research topics at the level of ministries.

Topics/challenges in these two sections are only partially relevant to the smart specialisation concept (e.g., security is relevant to priority areas 7.1.2, 7.1.3 and others; healthcare-related challenges are relevant to priority area 7.1.4; etc.). Topics with a described relevant relation to / overlap with the key application sectors of the Czech economy, which have already been identified in the previous five sections, can be considered fully qualified parts of the smart specialisation domains of the Czech Republic. The remaining topics are applied research topics reflecting the priorities of ministries and their partners, which will be primarily financed from national sources.

Competent managing authorities of ESIF operational programmes are authorised to stipulate, by agreement with the National RIS3 Manager, whether or not the topics that are not fully related to the smart specialisation of the Czech Republic should be reflected in the aid targets of relevant calls.

### **7.1.6.1 Agriculture and the environment<sup>223</sup>**

#### **7.1.6.1.1 Sustainable management of natural resources**

##### **Background**

Sustainable management of natural resources consists in utilising the natural resources (land, water and landscape) by means of such methods and management practices that will ensure their long-term ecological and biological integrity and stability. The management of natural resources inherently involves mutual relations with the climate and its ongoing change, especially the need to adapt to the impacts of the change.

The goal is to support, preserve and improve ecosystems dependent on agriculture and forestry and to improve ecosystem services. The key mission and content of this specialisation is thus sustainable management of fundamental natural resources that serve to ensure quality agricultural production (production function) while preserving fundamental functions for landscape management and rural development (non-production function).

The significance of agricultural and forest land as part of the national wealth has been continually increasing. Today, the production potential of Czech agriculture represents (according to LPIS) an area of about 3.5 million ha of agricultural land with more than 70% of tilled land. The percentage of tilled land is greater than in other EU countries with similar soil and climate conditions. About 50% of agricultural land is located in LFAs, i.e. areas with lower soil quality and worse climatic conditions. Concerning renewable energy sources, the quantity of energy generated from biomass has been playing an increasingly important role in the Czech Republic's energy mix.

The quality of surface water has improved greatly over the past 25 years, primarily as a result of reducing point-source water pollution, in particular by shutting down a number of manufacturing plants, rebuilding and modernising technological processes in industry and constructing, reconstructing and renovating sewerage systems and wastewater treatment plants. The number of

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<sup>223</sup> This is an EDP output from National Innovation Platform VI – Agriculture and the Environment.



people connected to a sewerage system grew by more than 10% and the length of sewerage systems doubled over the period in question.

Reduction in point-source pollution has been under control to a great extent; however, it is much harder to reduce pollution from non-point sources – farming, atmospheric depositions and erosive wash.

The situation is aggravated especially by erosion of agricultural land. The Czech Republic has specific water erosion conditions – resulting from the largest size of land parcels among EU countries. Moreover, farming intensification in the past led to the removal of a high number of hydrographic and landscape features (ploughing up field boundaries, grass-covered thalwegs and field paths, removing scattered vegetation, etc.), which would have effectively prevented accelerated erosion.

Due to the loss / slow restoration of landscape features, the agricultural landscape fails to perform its role in biodiversity protection. Forest ecosystems generally have a higher degree of biodiversity, but even-aged, pure forests are far from fulfilling the full potential of habitats. It is necessary to identify and support management practices that will allow increasing biodiversity while enabling commercial forests to sufficiently perform their wood-producing function. There are also the favourable effects of an increasing area of forests and continued growth in the area of land under organic farming.

#### **Identification of needs and opportunities, aid targeting**

Sustainable management of natural resources represents fostering, preserving and improving ecosystems dependent on agriculture, forestry and fishery; restoring, preserving and increasing biological diversity; and agriculture of high natural value corresponding to the condition of European landscapes.

**Biodiversity and its function in an agroecosystem for sustainable management of natural resources** forms the basis of landscape development and agricultural production development. This should primarily concern the restoration of a functional, productive and aesthetically pleasing landscape that will also be capable of fulfilling the basic economic (production) and food-related needs of society and contribute to improvement in water and soil management. Biodiversity preservation has a significant impact on regulating, provisioning and supporting ecosystem services as well as on the cultural and aesthetic function of the landscape, thus affecting the quality of human life.

Sustainable management of natural resources involves **land management systems (conventional, organic, etc.) and conservation of land stock and its functions in the landscape.**

Climate change effects can be mitigated by optimally designing and implementing adaptation measures that will reduce the negative impacts of extreme effects. Such effects are forecast and such impacts are addressed by **research into landscape and land utilisation and management designs leading to the restoration and enhancement of soil retention properties** and measures for **rational utilisation of water sources in a sustainable landscape management system.** **Systems of protection of (surface and ground) water quality against pollution** are of equal importance.

In connection with climate change, it is necessary to monitor and build **systems of natural resources management and utilisation under the conditions of changing climate** in alignment with **systems of adaptation measures to reduce the unfavourable consequences of climate change.**

**An integral part of agricultural production is machinery and technology in agriculture for efficient use of natural resources. Development is important for innovative methods and**

**technologies for utilising biomass for energy use (production of fuels, thermal and other energy) and as a raw material for the manufacturing industry, cultivation techniques for non-food crops.**

**Research and development of unmanned control systems for mobile agricultural machinery, remote sensing and soil and vegetation monitoring** is important.

The development of biometrics and bioeconomy using natural resources in agriculture and the application of modern biotechnologies in environmental protection **will be instrumental, among other things, in conserving and passing agriculturally used (or potentially agriculturally usable) natural resources on to future generations in better condition than today, as a prerequisite for ensuring self-sufficiency in food and quality of life in the Czech Republic.**

#### 7.1.6.1.2 Sustainable agriculture and forestry

##### **Background**

The fundamental basis for sustainable agriculture and forestry is development, increasing the efficiency, productivity and thus competitiveness of agricultural and forestry enterprises. Ensuring sustainable (environmentally friendly) agricultural and forestry production is conditional on stabilising and enhancing the quality of the fundamental capital good – soil – and ensuring a strategic level of production of major agricultural commodities of the temperate zone, especially those that have competitive production potential under the Czech Republic's conditions.

In crop production, the main interests of society concern sustainable use of land and water resources; in animal production, emphasis is put on animal welfare, active creation of animal health and high level of adaptability to growing production. In both cases, it means pressure on increase in production costs.

The current direction in forestry is managing and utilising forests and forest land in such a manner and to such an extent as to preserve their biodiversity, production capability and regeneration capacity and vitality. The expected climate change will raise demands on forest management in the middle term due to anticipated local fluctuations in the availability of raw wood, especially coniferous wood. Game management in the Czech Republic, whose falconry is inscribed on UNESCO's international list, contributes to nature conservation, in the protection of animals against extinction, as well as in the regulation of uncontrolled growth in game numbers due to its negative impacts on crop production, forest management, etc.

The Czech Republic has approximately 52,000 ha of water area consisting of ponds and reservoirs, where fish farming plays a prominent role. Besides its production function, it will also have extremely important non-production and social functions, in particular water management, landscape enhancement, cultural, flood prevention and protective retention functions.

##### **Identification of needs and opportunities, aid targeting**

The unstable global situation in the food and non-food crop products market results in a need for maintaining a significant level of self-sufficiency in basic crops while being able to respond adequately to emerging export opportunities. Crop production must secure the production of sufficient quantities of risk-free products while complying as much as possible with the requirements of the common agricultural policy.

**Genetic diversity** – its research is an essential tool for enhancing genetic potential for wider application in **plant breeding**. Another direction is the **creation of varieties** with enhanced technological quality, dietary value and yield.

**Phytosanitary measures** are a basic input to crop production eliminating the negative effects of pests, in combination with innovation in integrated **plant health control, including the protection of products in storage** with a view to reducing losses.

Another need is **sufficient, high-quality and safe crop production** (including fodder) as a result of growth in the efficiency and competitiveness of agricultural production and the food industry in the Czech and global markets, including an affordability aspect.

The expansion of **non-food production** within agricultural production (e.g., conversion of biomass into biofuels, energy, renewable, recyclable and degradable materials) offers farmers, most significantly, alternatives in land use and income and diversification in farming.

Another need is **sustainable production of safe and quality foodstuff and animal feedstuffs of plant origin**.

**Crop production adaptation to climate change impacts** and simplified farming systems, which contribute significantly to land degradation. Preservation of soil fertility is a priority for food security as well as in relation to non-food production; however, these two fields compete in demand for production areas. The application of **relevant adaptation measures** has benefits similar to those of reducing greenhouse gas emissions.

**Genetics and genomics** play a crucial role in the **breeding of high-performance types of livestock**, currently focusing on the identification of factors underlying genetic variability and on the development of breeding methods that make the best use of such variability in breeding in order to improve livestock farming economy.

There is currently a manifest need to improve **reproduction**, reproduction techniques and **reproductive biotechnologies**. Reproduction control is an integral part of cost-efficient livestock farming management.

In the field of livestock farming, it will be necessary to focus on **animal production technologies**, expand research into animal **welfare** and complement it by socio-economic studies that will cast light on the attitudes of consumers of food of animal origin. Knowledge obtained through animal ethology and sociobiology can provide innovation processes for the creation of a livestock farming environment so that the applied **livestock farming systems** are socially acceptable despite increasing farming intensity and efficiency.

Livestock farms' by-products, i.e., organic residues and especially gas emissions, have an adverse impact on the environment. Research must focus on the **development and deployment of low-emission technologies** in livestock farming, storage and application of farmyard manure and appropriate renovation of existing livestock premises in order to **reduce the total production of ammonia and greenhouse gas emissions** into the environment.

Research is required into the **optimisation of livestock nutrition and feeding** with respect to animal development, animal health and husbandry economy, in relation to the changing genotypes of kept animals and development in the **composition of feedstuff sources and alternative components**.

A growing pressure on economy and quality in the production of foodstuffs of animal origin results in the need for **healthy, disease-resistant animals** with a fully working **immunity system** and a **high level of adaptability to increasing production**; related to this is the study of **immunotherapy, pharmacology, chemistry and toxicology** effects.

The level of livestock health has now become a limitation on livestock production and farming economy. It is therefore necessary to focus research on **production and preventive medicine**, or control of the **active creation of health and production, control of antimicrobial resistance, biosecurity** and other areas.

**Forest ecosystems** are significantly affected by changing natural conditions both in the area of production and in non-production functions. Research activities are aimed at preserving the condition, resistance and resilience of forests and implementing **adaptation measures** to maintain sustainability in the performance of forest functions **in connection with climate change**.

A major role is played by **ecosystem services in forest management**. **Forest health status** needs to be addressed during the **monitoring and inventory of forest ecosystems**, which are conducted using both ground survey (more accurate but more costly) and remote sensing methods and technology, whose economic potential in forestry is also significant.

Existing research on wild game and game management should comprehensively address all areas relating to the topic (game genetics, introduced species, research on zoonoses and determination of measures to mitigate the impacts and spread of infections, suppression of invasive species, preparation of an endangered species support and protection strategy), including the study of how game affects the forest environment and agricultural and urbanised landscapes.

An inseparable part of research needs is the **application of modern biotechnology methods in agriculture (both crop and animal production)**.

#### 7.1.6.1.3 Sustainable food production

##### **Background**

Manufacture of food products is a principal segment of the manufacturing industry in the Czech Republic as well as throughout the European Union. The importance of food production consists in ensuring food for the population by the manufacture and sale of healthy, safe, quality and mostly also affordable foodstuffs and the industry's performance and increasing competitiveness. Some food business operators have direct links with primary agricultural production; others are engaged in the later stages of product finalisation.

##### **Identification of needs and opportunities, aid targeting**

The Czech food industry's potential for existence and growth is necessarily connected to intensive research and development of new types of food with a high share of value added. For consumers, such value added is connected with health benefits, consumption comfort, speed of food preparation, etc. Since all food production segments are mostly concerned with the processing of relevant agricultural commodities, food-related research is inseparable from agronomic research on such commodities.

Attention is paid to research into the **composition of new food raw materials, foodstuffs, their bioactive ingredients and their effect on human health**.

The changing life style and civilisation phenomena require, and will continue to require in the future, changes in eating habits, provision of healthy inputs to the food chain and related **development of technologies for food manufacture and preparation**.

Dietary composition can also have a significant effect on the prevention of lifestyle diseases, whose incidence has a growing tendency and the problem of which can be expected to last for a rather long time on account of technical development. It is desirable to provide **research into new foodstuffs and manufacturing processes and special foods for defined population groups, to ensure high-quality food for population groups with specific needs**, i.e. for diseases of all kinds, various age categories, especially, due to growing age, for seniors.

The topic of a healthy diet for quality of life is a comprehensive topic involving a number of aspects relating to the application of the latest findings from a range of research areas, from medicine and food sciences to the applications of modern biotechnologies in food production, including GMO applications, to the integration of advanced technology. And, if nanomaterials are accepted in the traditional manufacture of food products, the **development of nanotechnologies and nanotechnology-based products**.

The issue of **hygiene and sanitation in the food chain** is becoming more and more significant for the human population's nutrition and health.

To ensure food quality, research should also focus on the enhancement and creation of **new methods for analysing the composition of food raw materials**, intermediate food products, **foodstuffs and their properties** in terms of mutual interactions, as well as on research into food storage to prevent food deterioration.

Concerning the impacts of food production, research activities should also focus on **monitoring generated waste, atmospheric emissions and wastewater** in order to minimise them or use them as input materials for further processing.

#### 7.1.6.1.4 Ensuring a healthy and quality environment and efficient use of natural resources

##### **Background**

Environmental research is highly interdisciplinary and its level of knowledge impacts and affects a great number of other areas such as agriculture, health care and others. Applied environmental research is an integral and strategic part of R&D&I in the Czech Republic. Humans significantly impact the functioning of ecosystems at global and local level with their activities, often having minimum knowledge of all links and possible impacts. In the Czech Republic, this applies especially to interventions in the landscape, land appropriation, inappropriate agricultural techniques, the release and deposition of new chemicals in the environment, etc. Yet, many natural processes and mutual links have not been explored sufficiently. The stable functioning of natural services is significantly threatened by the ongoing climate change. Even if the atmospheric emissions of greenhouse gases are successfully reduced over time, the initiated change will proceed for the next few centuries and will require adaptation. Under the Czech Republic's conditions, this means getting ready for not only general changes in ecosystems and invasions of alien species, a range of pests and diseases and corrections to agricultural production but also heat waves and **dry spells**, rainstorms and floods and extreme fluctuations in temperature. Changes in the water regime, in particular, will require increased attention.

Another area is the necessary promotion of innovation to achieve sustainable management of natural resources, particularly within the meaning of decreasing the energy and material intensity of production and reducing pollutant emissions and waste. In the context of a circular economy, a significant area of innovation is the promotion of efficient use of natural resources, utilisation of secondary raw materials and use of waste as a resource.

### **Identification of needs and opportunities, aid targeting**

Identified needs for ensuring a healthy and quality environment and efficient use of natural resources can be divided into the following areas.

The main objective of research conducted in the area of **natural resources** is to ensure the functioning and stability of the main environmental compartments – **biodiversity, water, soil, air and mineral resources**. Another objective is to set down principles and introduce new methods for the protection and efficient use of natural resources in the Czech Republic.

The main objective of research conducted in the area of **global change** is to introduce **measures** to mitigate and **adapt to** the anticipated negative effect of global change on the environment, optimise the utilisation of natural compartments and mitigate the impact of global change on human **health**.

The main objective of research conducted in the area of **sustainable development of the landscape and human settlements** is to explore factors preventing the sustainable use of landscape compartments and contributing to an overall deterioration of their ecological functions, to implement modern methods and systems for building **smart human settlements** with minimum energy and material intensity and to research methods for achieving **sufficient environmental security**.

The main objective of research conducted in the area of **environmental technology and eco-innovation** is to introduce technologies and techniques with a lower environmental impact than other technologies with similar function and performance, and to introduce technologies and new techniques used to reduce environmental load in the area of **air protection, water protection, in waste management**, in the process of **waste recycling and the clean-up of legacy environmental damage**. The research objectives aim to apply technologies and materials with a minimum adverse environmental impact, deploy biotechnologies in manufacture and use **biotechnologies** in the production of **renewable sources of raw materials and energy**.

The main objective of research conducted in the area of **environmentally friendly society** is to develop and strengthen the knowledge base for setting up economic development in such a way that will prevent degradation of the environment, loss of biodiversity and unsustainable use of natural resources. The research aims to identify measures that will allow society's transition to **sustainable consumption patterns**.

## 7.1.6.2 Social challenges<sup>224</sup>

### 7.1.6.2.1 Security research

#### **Background**

Security research can be considered part of a wider security system framework. It is a subsystem that produces knowledge and tools expanding or enhancing the portfolio of given security system capabilities. A coordinated approach to the performance of this role requires new knowledge and modern technology to be obtained and put into practice efficiently and quickly. Increasingly high demands are placed on the preparation, equipment and capabilities of not only members of security forces but also other stakeholders. Increasing importance is attached to the state's ability to respond to all types of emergencies and crises over a wide range of tasks to perform, from prevention to prompt rescue activities and efficient dissemination of information to follow-up aid and restoration measures. Therefore, it is advisable to work out a holistic conception of security system capabilities.

Matters concerning the development and aims of a security research support system are currently managed as part of the preparation of the Interdepartmental Strategy of Security Research 2017–2023.

The current focus of security research at national level is primarily determined by Priorities that were created as part of the National Priorities of Oriented Research, Experimental Development and Innovation. There is an entire chapter devoted to security and defence research, into which approximately 14% of all funds allocated to applied research and experimental development in the future should be invested. However, this level has never been reached.

Comparable importance is attached to security research in the European and global contexts. Security research has been one of the areas supported under framework programmes since the very beginning and continues to play an important role in Horizon 2020. Obviously, the direction of European security research reflects primarily pan-European issues. National programmes that are developed in Europe address these issues specifically, depending on national needs and contexts. The Czech Republic's security research has long been complementary to the direction of European research. A number of European countries (Germany, France, Italy, Finland, Austria and others) implement national support programmes. In the United Kingdom and the United States of America, support for security research is institutionalised by way of various specialised agencies and targeted governmental development programmes. The two countries also have a developed tradition of governmental research laboratories specialising in topics of long-term security interest.

#### **Identification of needs and opportunities, aid targeting**

Security research should focus on three crucial topics, namely Security System Development, Security of Citizens and Security Contexts. The field of **security system development** involves security policy tools and crisis management processes, the development of tools to support the capabilities of security and rescue forces and other active constituents of the security system focusing on coping with large-scale security incidents or incidents with significant impacts on affected communities or society, forensic capabilities and the internal development of security system constituents.

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<sup>224</sup> Outputs of NIP VII – Societal Challenges.

The field of the **security of citizens** involves secure public space, development of early-warning capabilities and long-term situation awareness amongst responsible bodies, availability and functionality of socially significant infrastructures.

The field of **security context** combines economic (development of private entities' capacities to ensure the stability and continuity of their own operations in and outside crises; protection of intellectual property and know-how; development in the study of the legal aspects of technology failures; integrity, stability and availability of supply chains; work safety and protection and reliability of services from the end user's perspective), environmental (interaction between communities and the environment; sustainable development and availability and stability of ecosystem services; monitoring and enforcement of protection regimes; conservation of biodiversity; monitoring and analysis of climate change impacts, long-term risks arising from technological advancement or protection of the production capacities of agricultural land) and social (development in areas deserving special social interest, especially ethics, individual rights and freedoms, cultural identity and cultural heritage, social processes, democracy and public control) interfaces.

#### 7.1.6.2.2 Research in health care

##### **Background**

A healthy population is a crucial prerequisite for a successful society. The fundamental aspect of "health" is the dynamism of changes and processes; however, it usually has considerable inertia. This results in many discrepancies, with the most prominent being those between the development of medical science and a country's economic possibilities. Additionally, there are the changing life and working conditions of individuals and society and changes in the structure of society (e.g. population ageing). It is necessary to seek equilibrium between possibilities, needs and development in the field of health. From this perspective, research and development must be targeted at this area. This concerns not only medical research; sociology, population psychology, demography, etc. must also be involved.

In medicine, the most common and most dangerous issues must be addressed: chronic non-communicable diseases such as cardio- and cerebrovascular diseases, cancer, dementia and other mental diseases, or chronic musculoskeletal disorders, etc.

Prevention is the most effective; attention needs to be paid to the population's behaviour and inappropriate behaviour patterns concerning diet, addiction, exercise, etc. It is also necessary to pay attention to external effects of the environment, which undergo substantial changes. A vital role is played here by the primary prevention of diseases associated with the determinants/quality of the living and working environment, represented by the fields of hygiene, epidemiology and occupational medicine.

There will be not only new therapeutic technologies (genetics, nanotechnology) but also new risks, which can be estimated in a time frame of 5–10 years. In a longer time frame, it is necessary to be prepared for risks that are not known yet. This includes new infectious diseases and ever more common resistances of new agents.

The system of health care and related fields must be capable of adapting to the dynamic development to preserve the full population's access to high-quality prevention, treatment and health and healthy lifestyle support.



### **Identification of needs and opportunities, aid targeting**

The area of **disease emergence and progress** includes metabolic and endocrine diseases, cardiovascular diseases, cancers, nervous and mental disorders, musculoskeletal disorders and inflammatory and immunological diseases, childhood infections and diseases and rare diseases.

The priority of **new diagnostic and therapeutic methods** includes in vitro diagnostics, low-molecular medicines, biological medicines, including vaccines, drug delivery systems, gene and cell therapy and replacement tissues, development of new medical instruments and equipment and innovative surgical procedures, including transplantation.

The **epidemiology and prevention of the most serious diseases** includes metabolic and endocrine diseases, cardiovascular diseases, cancers, nervous and mental disorders, musculoskeletal disorders and inflammatory and immunological diseases, addictions and infections.

#### 7.1.6.2.3 Labour, social services and pension system

### **Background**

#### **Labour and employment**

Current economic growth results in increased demand for labour force – employer’s strong pressure on new sources of labour force, especially in technical fields, collides with severe lack of suitable skilled labour and creates long-term vacancies. In this context, support for positive trends will require mapping out labour force possibilities, most significantly concerning profession or qualification switches.

The field of employment is further affected by structural shifts in the Czech Republic’s economy, i.e. the reduction or expansion of certain industries. To eliminate as much as possible the negative effects of such changes, these issues need to be addressed at two fundamental levels concerning the labour market:

- monitoring and forecasting *labour market needs, as a prerequisite for the prevention and, if necessary, elimination of qualification disproportions;*
- *analysing and evaluating the job opportunities of dismissed employees from “reduced” industries.*

Technological advancement also results in changes in the organisation of work, which are associated with changes in the practical needs of the labour market, with the greatest emphasis put on the liberalisation of labour law and strengthening the autonomy of will of persons in labour relations; a similar trend has long been observable at European level. Labour legislation reacts to the trend in the long term by gradually liberalising labour law and introducing measures aimed to increase the freedom of contract for parties to employment contracts while preserving employee protection. Labour legislation’s task is to continue reacting to the trend adequately, i.e. to appropriately incorporate the principle of “flexicurity”.

#### **Social services**

Social services, as services of general interest focusing on providing aid and support to individuals in unfavourable social situations, are becoming a crucial area in the modernised approach to social policy. Like the areas of social work and social housing, they are developing in close connection with

society and as such, they need to be capable of sufficiently timely and sensitive response to new social phenomena, e.g., the development of information technology or demographic changes such as population ageing. At the same time, the system of social services must respond to people's real needs – the aid must have an active effect on people, support the development of their self-reliance, ensure their human dignity and maintain their rights and fundamental freedoms.

Research results in this area will allow further shaping of the development of social services and their methods and intensifying cooperation at the level of public administration and local authorities, including links to the non-governmental non-profit sector. At the level of social work, it is necessary to focus on social work professionalisation, on the identification of educational needs and priorities and on the development of social work at municipal level.

### **Pension system**

Today's society is acquainting itself with many new phenomena that will significantly affect both the labour market and the social system of national states. In the Czech context, the main issues that will have to be tackled include demographic ageing, the destabilisation of states especially in the Middle East and the related migration, drought and climate change or the arrival of digitisation and a new industrial revolution connected with greater automation. A number of these new societal challenges are directly related to agendas under the Ministry of Labour and Social Affairs. Research will focus on analysing and forecasting developments in all of the above-mentioned subfields. In demography, research will focus on the sustainability of pension systems and social services and on effects on the labour market.

### **Identification of needs and opportunities, aid targeting**

**MLSA priorities in R&D&I** ensue from the Czech Republic's international commitments, European strategic documents, government policy, strategic documents of the MLSA and other ministries and, last but not least, society's current needs. Defined priorities and objectives are also synergetic with the Ministry of Labour and Social Affairs' Policy for 2015–2017 with an Outlook to 2020.

**Research on family policy** will mostly focus on families' socio-economic and demographic situation, value positions and preferences, child care, equal opportunities and gender issues. Last but not least, attention will also be paid to the senior population's quality of life.

**In social policy**, research will focus on social work, social services and social housing and inclusion.

**The main objective of research into occupational safety and health** is to come up with base data and assessment methods for the socio-economic aspects of labour and provide scientific data and methods for assessing health risks from exposure to hazardous chemicals and nanoparticles. Study will be conducted into the effect of exposure to selected working environment and working condition factors (physical, physiological and psychological factors) and the effect of mental and socio-psychological stress at work. Selected occupational diseases and their diagnostic and assessment criteria will be studied as well. Education and training and OSH management are indispensable in this context.

**In the field of employment, it is crucial to study** employment and further professional learning in relation to the labour market, the employment of and aid for the disabled and the benefit systems of state welfare, poverty relief, benefits for the disabled and care allowances.

**Research into social insurance systems will concern the pension system** and pension, health and accident insurance and social security contributions. This area is also closely related to the area of employees' incapacity for work and the medical assessment service. Analyses of demographic development in relevant population groups and monitoring of changes in foreign pension systems are also essential for the Ministry's work.

**In the field of new societal challenges**, analysis will concern social changes in European and Czech society resulting from internal and external structural shifts.

Research into **internal departmental processes** is essential for improvement in the efficiency of public administration performance.

## **7.2 Institutional management of research and development and innovation by the Office of the Government of the Czech Republic in relation to the National RIS3 Strategy**

### **7.2.1 Section for Science, Research and Innovation of the Office of the Government of the Czech Republic**

The Section for Science, Research and Innovation within the Office of the Government of the Czech Republic (SRI Section) was established on 1 March 2014 with the aim of effectively coordinating and managing the R&D&I system. The Section is headed by the Deputy Prime Minister for Science, Research and Innovation, who is also Chairman of the Research, Development and Innovation Council (RDI Council) and the Government Council for Competitiveness and Economic Growth (C&EG Council). The SRI Section subsumed the RDI Council's secretariat and its agendas and, after staffing up, started to carry out the C&EG Council's agendas and the National RIS3 Strategy. This integration resulted in the coordination of a wide range of topics across various ministries, with a significant link to enhancing the Czech Republic's competitiveness. The position of National RIS3 Manager was established under the SRI Section to take charge of the management and coordination of the implementation of the National RIS3 Strategy.

### **7.2.2 Research, Development and Innovation Council**

The RDI Council is the Government's advisory body in the field of R&D&I. Its activities are governed by the R&D&I Act. A list of activities to be carried out by the RDI Council is provided in Section 35(2) of the Act. The role of the RDI Council in the R&D&I management and coordination system has changed slightly since the publication of the Updated National R&D&I Policy for 2013–2015 with an Outlook to 2020; in particular, executive functions needed for the RDI Council's activities were enhanced by creating the SRI Section of the Office of the Government.

### **7.2.3 Government Council for Competitiveness and Economic Growth**

The C&EG Council was established by Government Resolution No. 48 of 19 January 2015 and is the Government's expert advisory body in the field of competitiveness development and economic growth. The C&EG Council deals with long-term and conceptual issues concerning the Czech Republic's economic growth and competitiveness. The conception behind the C&EG Council is more general and involves a wide range of interrelated topics handled by individual committees. The C&EG Council's goal is to establish factual connections between topics and coordinate the activities of respective ministries. In its activities, the C&EG Council provides the Government with a knowledge base especially for its decisions concerning competitiveness and economic growth, including new fields within cultural and creative industries and the digital economy, so that departmental and national approaches and strategies are interlinked and coordinated.

### **7.2.4 Platforms of the Office of the Government of the Czech Republic**

The SRI Section of the Office of the Government of the Czech Republic strives to establish strategic sectoral dialogues with representatives from the national economy's sectors as part of its activities on a long-term basis so that expenditure from the national budget and European funds can be

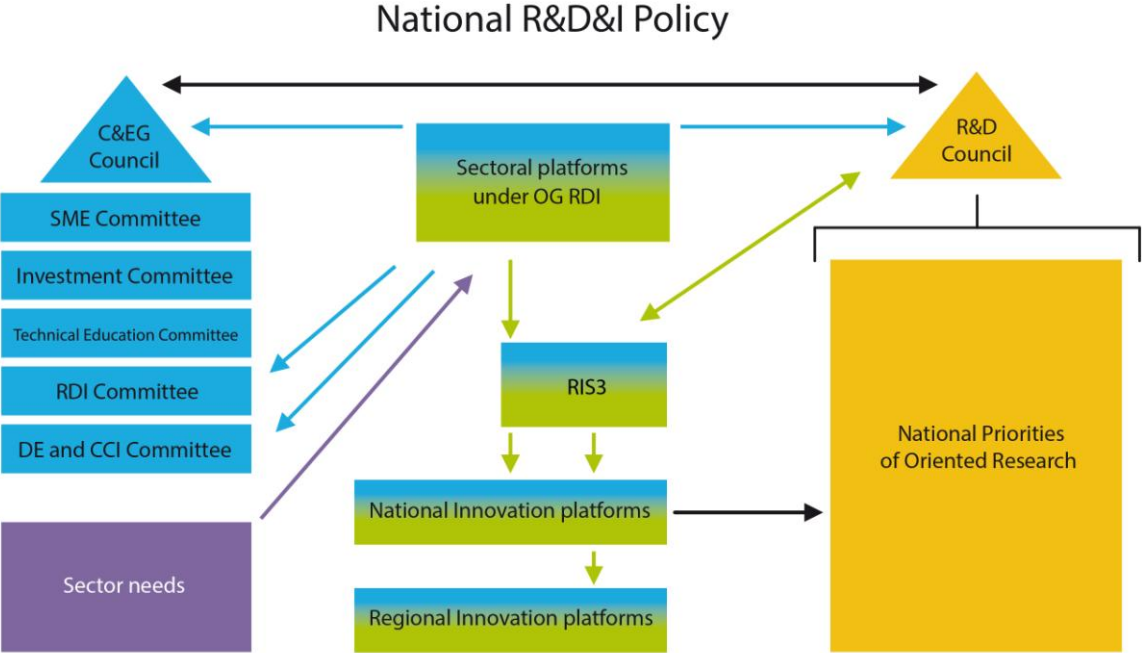
efficiently targeted to meet their material needs and to enhance the economy's competitiveness. To this end, sectoral platforms were created under the Office of the Government to identify fundamental problems encountered by businesses in the field of R&D&I and to prepare and discuss initial drafts describing material needs in applied research. Representatives in the platforms are sector leaders in private expenditure on R&D&I and also the producers of final products, determining the course of development of the national economy sectors they represent or representing strategic emerging industries. Outputs from the sectoral platforms' activities are essential for further discussion when putting the National RIS3 Strategy into concrete terms and for debate on applied research priorities.

The sectoral platforms share participants with and are functionally related to the National Innovation Platforms under the National RIS3 Strategy, which involve a wider range of stakeholders, as required by the European Commission. As part of their activities, the sectoral platforms also provide, through the Office of the Government, inputs to decision-making processes associated with the activities of the RDI Council and C&EG Council. Thus, three pillars (RDI Council, C&EG Council and National RIS3 structures) have been created, interrelated in terms of functions, organisation and personnel and providing one another, through working bodies and expert departments comprising the SRI Section, with expert information for their activities and decision-making to comprehensively cover the area of R&D&I support in the Czech Republic. In all three cases, the connecting and coordinating link is the SRI Section and the post of Deputy Prime Minister for Science, Research and Innovation.

The above-mentioned platforms offer significant feedback on the provision of state aid to R&D&I in the Czech Republic while also providing material inputs in the form of defining long-term research topics for sectors and the field of human resources. The sector priorities defined and widely discussed in this way (the entrepreneurial discovery process – EDP) form the basis for the *verticalisation* of the National RIS3 Strategy, i.e., linking specific topics to funds from the national budget and European funds, and the basis for the creation of applied research priorities (see Chapter 5). Verticalisation is required by the European Commission, as some calls made under operational programmes are anticipated to be targeted at sectors.

The following illustration shows mutual relations among coordinating entities and key documents in the R&D&I system under the overarching National R&D&I Policy.

**Graphic representation of relations among coordinating entities in the R&D&I system**



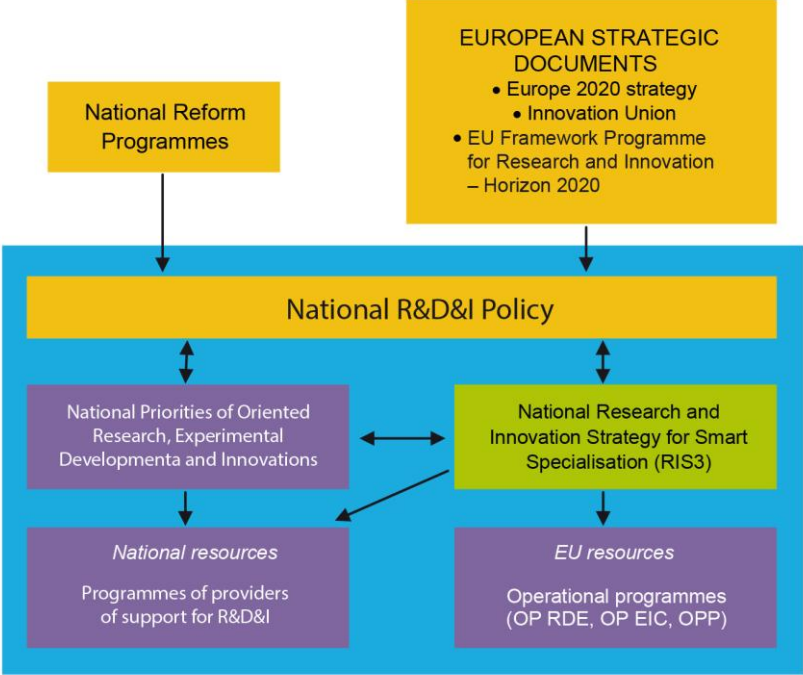
Source: Office of the Government of the CR

**7.2.4.1 Relation between the National Research, Development and Innovation Policy and the National RIS3 Strategy**

The National R&D&I Policy is a top-level national strategic document that defines the main strategic directions in research and development and innovation and serves as the umbrella document for the Czech Republic’s other related strategic documents. The main objective of the National R&D&I Policy is to foster the development of all components of research and development in the Czech Republic – basic research, applied research and experimental development, which all have their irreplaceable role – and take advantage of their interrelations and synergies to support the economic, cultural and social development of the Czech Republic.

The National RIS3 Strategy makes sure that funds are targeted effectively at activities that result in enhanced research and innovation capacity and at promising areas that have been singled out as priorities at national and regional level in order to take full advantage of the knowledge potential at national and regional level. From this point of view, the National RIS3 Strategy fulfils some of the National R&D&I Policy’s tasks and operates within its framework.

**Links between key documents in R&D&I**



## 7.3 Implementation structures for the National RIS3 Strategy and regional structures

### 7.3.1 RIS3 at national level

#### 7.3.1.1 RIS3 Management Committee

The Office of the Government of the Czech Republic – Section for Science, Reinsurance and Innovation is in charge of the establishment and organisational matters of the RIS3 Management Committee (RIS3 MC). The secretary of the RIS3 Management Committee is the National RIS3 Manager (see below).

Members of the RIS3 MC are:

- Deputy Prime Minister for Science, Research and Innovation
- Deputy Minister of Education, Youth and Sports in charge of the Operational Programmes Section
- Deputy Minister of Education, Youth and Sports in charge of the Higher Education, Science and Research Section
- Deputy Minister of Industry and Trade in charge of the OP EIC
- Representative of the Capital City of Prague representing the MA of the OP Prague – Growth Pole of the Czech Republic
- Representative of the Ministry of Regional Development

Also invited are:

- Representative of the Ministry of Finance in charge of public budgets
- Representative of the Ministry of Labour and Social Affairs
- Representative of regions

The Management Committee may also invite guests at its discretion depending on the topics discussed.

The RIS3 Management Committee:

- Discusses the National RIS3 Strategy and its updates, including the associated action plan and its updates
- Discusses and proposes measures to monitor the National RIS3 Strategy
- Discusses and makes recommendations on proposals for interventions, especially with regard to the achievement of the objectives of the National RIS3 Strategy
- Discusses and approves annual monitoring reports and National RIS3 Strategy progress reports
- Discusses specialisation domains and recommendations for changes and amendments to them
- Coordinates the implementation of the National RIS3 Strategy by various ministries
- Monitors and discusses the fulfilment of national priorities, especially with regard to synergy between relevant operational programmes and national budget expenditure
- Discusses RIS3 intervention implementation reports and submits reports on the fulfilment of National RIS3 Strategy objectives to the Government of the Czech Republic



The RIS3 MC also discusses conceptual and strategic issues relating to RIS3 management. The RIS3 Management Committee gives its opinions on call plans of relevant operational programmes and makes recommendations on the material focus of interventions in accordance with the contents of respective operational programmes. However, the management of operational programme in general is exclusively within the purview of their Managing Authorities.

The RIS3 Management Committee meets as needed, usually 4 times a year.

The RIS3 Management Committee had its inaugural meeting on 25 February 2015, when its members were appointed and it discussed its statutes, reviewed its plan of activities for 2015, received information on links between the National RIS3 Strategy and other institutions and on National Innovation Platforms' meetings and the current plan of calls contributing to the RIS3 strategy under relevant operational programmes, etc.

At its second meeting held on 25 June 2015, the RIS3 MC reflected on the results of the second round of meetings of National Innovation Platforms and discussed and approved the National RIS3 Implementation Plan for 2015–2016.

At its fourth meeting held on 20 April 2016, the RIS3 MC accepted the suggestion of the Ministry of Regional Development that it should become a permanent member. The Statutes were changed on this account.

#### **7.3.1.2 System project**

In June 2016, a call named *R&D&I Strategic Management at National Level I* was made under the Operational Programme “Research, Development and Education”, under which the Office of the Government of the Czech Republic can submit an individual system project (ISP).

The project should aim to aid the management of the implementation of the National RIS3 Strategy at national level, i.e., the management of the entrepreneurial discovery process (EDP) at national level and its coordination with regional level, including cooperation with relevant entities so that suggestions arising from the EDP are reflected by specific interventions.

Key activities of the system project and activities undertaken under the published Smart Accelerator call should complement one another to create a functional, well-rounded complex of management of RIS3 implementation at both levels, i.e., at both national level and regional level.

#### **7.3.1.3 National RIS3 Manager**

The Office of the Government of the Czech Republic, which is in charge of the management and coordination of the implementation of the National RIS3 Strategy, established the position of National RIS3 Manager under its Section for Science, Research and Innovation. The National RIS3 Manager is the executive head in charge of the management and coordination of the National RIS3 Strategy.

Roles of the National RIS3 Manager:

- Acts as secretary of the RIS3 Management Committee
- Prepares proposals and reports for the RIS3 Management Committee, using the analytical team's capacities, including National RIS3 Strategy progress reports, monitoring reports and reports on the fulfilment of National RIS3 Strategy objectives
- Prepares the National RIS3 Implementation Plan

- Establishes National Innovation Platforms as necessary, after approval by the RIS3 Management Committee
- Structures work and sets down the schedule of activities of National Innovation Platforms
- Convenes and presides over meetings of National Innovation Platforms
- Presents proposals and initiatives arising from National Innovation Platforms to the RIS3 Management Committee and the managing authorities of relevant operational programmes
- Coordinates and oversees the implementation of the National RIS3 Strategy through operational programmes and communicates with managing authorities in these matters
- Attends meetings of the monitoring committees of the operational programmes through which the National RIS3 Strategy is implemented
- Coordinates and oversees the implementation of the National RIS3 Strategy using national resources and coordinates their use for the fulfilment of the objectives of the National RIS3 Strategy in synergy with the resources of relevant operational programmes to ensure close coherence in the long-term financing of the vertical priorities of the National RIS3 Strategy (interventions enhancing smart specialisation) from national resources as well as relevant operational programmes' resources
- Creates "monitoring reports", documentation, etc.
- Does not intervene in the management of operational programmes, which is exclusively within the purview of the Managing Authority

#### **7.3.1.4 Analytical team**

An analytical team was established to support the activities of the National RIS3 Manager. The RIS3 manager's analytical team includes Regional RIS3 Managers and Regional RIS3 Coordinators.

The analytical team will:

- Gather information and documentation concerning the implementation of interventions contributing to the fulfilment of National RIS3 Strategy objectives and prepare documentation for the National RIS3 Manager and the RIS3 Management Committee
- Monitor the implementation of the National RIS3 Strategy and prepare monitoring reports using documentation from operational programmes and other sources
- Collect, process and evaluation information concerning the development of the innovation system in the Czech Republic and prepare proposals for updating the National RIS3 Strategy, including proposals for amending, specifying and selecting knowledge domains/specialisations

Some members of the analytical team were appointed as secretaries of innovation platforms, who will be responsible for the preparation of documentation for the innovation platforms, communication with the innovation platforms and the administration of the innovation platforms.

#### **7.3.1.5 National innovation platforms**

National innovation platforms are consulting groups established by the RIS3 Management Committee through the National RIS3 Manager in order to identify needs, elaborate/adjust strategic priorities, identify business opportunities and discuss the aim of proposed measures (i.e., interventions intended to support identified smart specialisation areas). National innovation platforms are established for proposed specialisation domains and represent a forum of an initiating

and recommending nature. The following 4 national innovation platforms were convened in the initial stage of the entrepreneurial discovery process:

- 1) Mechanical engineering & electricity generation and distribution & part of electrical engineering
- 2) IT services and software & electronics and part of electrical engineering
- 3) Manufacture of transport equipment
- 4) Pharmaceuticals and medical technology

The contents and names of the National Innovation Platforms were further refined during the subsequent entrepreneurial discovery process. New names were proposed:

- I. Mechanical Engineering, Energy Industry and Metallurgy
- II. Electronics and Electrical Engineering and ICT
- III. Manufacture of Transport Equipment
- IV. Medicinal Products, Biotechnologies, Medical Devices, Life Sciences

During the autumn of 2015, the structures of the National RIS3 Strategy were expanded into seven National Innovation Platforms, which better reflect the structure of the Czech economy as well as the European Commission's requirements for verticalisation, or sectoralisation of specialisation domains, which will be gradually applied when drawing up operational programme calls and national aid limits. The rearrangement of the National Innovation Platforms is based on the share of private expenditure on R&D&I in each sector (see Table 9). Related to that is adjusting the state policy to create the conditions for their further development. This concerns support for and development of firms, research infrastructure, universities, human resources, international cooperation.

In view of the topical focus, diversification and selection of proposed specialisation domains, the following additional NIPs have been defined:

- 5) Cultural and Creative Industries
- 6) Agriculture and the environment
- 7) Societal Challenges

When the structures of the National Innovation Platforms were expanded during the autumn of 2015, new members were also added. Original members were complemented by representatives of Sector (Work) Groups created for the purposes of debate on the aims of the National Research, Development and Innovation Policy for 2016–2020. Sector group members are grouped under individual NIPs according to their orientation and collaborate with the National RIS3 Manager during the EDP to identify priority aims for operational programme calls fulfilling RIS3 strategies. Links between individual NIPs and S(W)Gs are shown in Table 9.

#### **7.3.1.6 Current EDP status**

Research and innovation needs of the business sector are examined and identified at National Innovation Platform meetings. Once the NIPs were extended to include representatives of sector (work) groups, their members were asked to define their needs in the field of applied research. EDP direction and coordination were based on previously identified theses in proposed specialisation domains (Chapter 5) as well as research topics identified during the preparation of the National

R&D&I Policy 2016–2020. Activities and topics were gradually refined and focalised during the process, reflecting the requirements of all representatives of the triple/quadruple helix.

The EDP newly defined links to proposed specialisation domains, as preliminarily identified in Chapter 5. The EDP has resulted in refining and focalising the specialisation domains defined at national level.

The relation between EDP outputs, i.e. the focalised specialisations and the originally proposed domains, is illustrated by Table 9.

Selected topics of regional specialisation domains, identified in Table 8 (Chapter 4), were taken into account in connection with the entrepreneurial discovery process undertaken at national level when focalising the national specialisation domains (see Table 9). The configuration of national specialisation domains in the National RIS3 Strategy does not conflict with the identified regional-level specialisations (see Chapter 7.3.3.3).

The smart specialisation domains of the Czech Republic, as described in Chapter 7.1 and listed/outlined in Appendix 9.2, thus represent the first comprehensive output of the entrepreneurial discovery process.

**Table 9: Overview of National Innovation Platforms, with intersections with Sector Work Groups and summarised changes in smart specialisation domains based on an advanced EDP stage**

<b>Innovation platforms</b>	NIP I – Mechanical Engineering, Energy Industry and Metallurgy				NIP II – Electronics and Electrical Engineering and ICT		NIP III – Manufacture of Transport Means				NIP IV – Medicinal Products, Biotechnologies, Medical Devices, Life Sciences			NIP V – Cultural and creative industries			NIP VI – Agriculture and the Environment	NIP VII – Societal Challenges
<b>Intersections with Sector Groups</b>	Precision engineering	Machine tools and forming machinery	Metallurgy, steel-making and foundry industry	Energy industry	Electrical engineering	Digital economy and Industry 4.0	Automotive	Railway and rail vehicles	Aviation	Space industry	Biotechnology	Traditional cultural and creative industries			Traditional cultural and creative industries <sup>225</sup>			
<b>Material focus of Sector (Work) Groups</b>	Machine industry, manufacture of machinery and equipment	Other manufacturing industry, metallurgy		Production and distribution of water, electricity, gas and steam and waste-related activities	Electrical and electronics industry – manufacture of electrical and electronic products, manufacture of computer and optical products	Digital economy and digital content	Automotive industry – manufacture of motor vehicles	Manufacture of other transport equipment	Manufacture of other transport equipment	Manufacture of other transport equipment	Pharmaceutical industry, manufacture of medical ...	Textile, clothing and footwear industry	Wood industry	Glass, ceramics, porcelain and building materials industry	New cultural and creative industries based on digital technology			
<b>Originally proposed specialisation domains (application areas) before EDP completion</b>	Advanced and cost-effective mechanical engineering and automation			Sustainable and safe production and distribution of electricity	Cost-effective solutions in electronics and electrical engineering	IT services, software and IT security	Manufacture of transport equipment, sustainability and safety of transport				Medicines and medical devices and methods for healthy ageing						Natural resources, sustainable agriculture and food sufficiency	
<b>Specialisation domains (application areas) focalised after EDP completion in updated National RIS3 Strategy</b>	Advanced machinery/technology for strong and globally competitive industry				Digital market technologies and electrical engineering		Transport means for the 21st century				Health care, advanced medicine	Cultural and creative industries		See Digital market technologies and electrical engineering				
<b>Intensity of relevance/interlinkage of generic knowledge domains (i.e., KETs and non-technology domains) to/with individual application areas<sup>226</sup></b>																		
<b>Advanced materials**</b>	XXX		XX	X	XXX	XXX	XXX	XX	XXX	XXX	XXX	XX	XX	XX	XX	XX	XX	X*
<b>Nanotechnology**<sup>227</sup></b>	X		X		XXX	XXX	XX	XX	XXX	XXX	XXX	XX	X	XX	XX	XX	XX	X
<b>Micro-nanoelectronics** and advanced manufacturing technology**</b>	X			X	XXX	XXX	XX	XXX	XXX	XXX	XXX				XXX			X*
<b>Photonics**</b>	XXX		XXX	XX	XXX	XX	XX	XX	XXX	XXX	XXX	XX	XX	XX	XXX	XXX	XXX	X
<b>Industrial biotechnologies**</b>					XXX	XX					XXX						X	
<b>Knowledge for digital economy**<sup>228</sup> and Cultural and Creative Industries**<sup>229</sup></b>				X	XXX	XXX	XX	XX	XXX	XXX	XX	XXX	XXX	XXX	XXX	XXX	X	XX
<b>Social-science knowledge for non-technical innovations**</b>					XX	X					XX						X	XXX
<b>Region-specific specialisation domains (application areas)<sup>230</sup></b>	Chemistry and chemical industry; Glass and ceramics industry; Rubber and plastics industry; Textile; Balneology and spa sector;																	

Source: Office of the Government of the CR

<sup>225</sup>New cultural and creative industries are incorporated in Chapter 7.1 and linked to Digital Economy and Digital Content.

<sup>226</sup> Participants in National Innovation Platforms were asked to identify the intensity of interlinkage of knowledge domains and generic knowledge domains (i.e., KETs complemented by two non-technology domains). The intensity is expressed by a number of Xs on the following scale: **X** – potential link; **XX** – already identified link; **XXX** – existing strong link with future potential. The intensity of interlinkage has not yet been identified for NIPs V to VII as these platforms are in an initial stage of identifying their needs.

\* Link defined by Security and Defence Research as part of Societal Challenges.

\*\* Denoting generic knowledge domains / KETs (shown in light blue).

<sup>227</sup>The Nanotechnology KET is matched to a national specialisation domain and is generally identified, monitored and supported as part of RIS3 implementation and execution.

<sup>228</sup>This includes knowledge in the field of IT for new media, publishing and media, digital content processing and audio-visual production.

<sup>229</sup>This includes knowledge in applied and industrial design, visual and performing arts and knowledge and skills in traditional and modern living culture that can be used in cultural industries.

<sup>230</sup>For more information see Table 10 and Chapter 7.3.3.3; this is not a generic domain/KET.

National innovation platforms include:

- Representatives of major stakeholders from the application sector / users of R&D results (especially firms); both large firms and SMEs are represented; in both cases, they are enterprises with research activities
- Representatives of leading research organisations, whose task is to identify and link generic knowledge domains (incl. KETs) with application areas – representatives of the Academy of Sciences of the Czech Republic (relevant institutes), representatives of universities, research organisations and public research institutions
- Representatives of public administration, e.g. market regulators in relevant fields, etc.
- Regional level representatives

The number of innovation platform members is about 15–20 people. National innovation platforms are presided over by the National RIS3 Manager.

Roles of national innovation platforms:

- They can give their opinion on proposed horizontal interventions, especially with respect to their contribution to the objectives of the National RIS3 Strategy; to that effect, they can, at their own request or at the suggestion of the National RIS3 Manager, give their opinion:
  - On proposals for individual operational programme calls and priority axes that serve to fulfil the National RIS3 Strategy
- They discuss and make recommendations on profiling, targeting and refining specialisation domains at the national level during the entrepreneurial discovery process
- They discuss the targeting, objectives and results of interventions aimed to strengthen specialisation domains (vertical interventions) and can give recommendations for their future profiling
- They provide the National RIS3 Manager and RIS3 Management Committee with feedback about the long-term needs of the business and research sectors with respect to annual and longer R&D&I planning by the RIS3 Management Committee and the Office of the Government of the Czech Republic – Section for Science, Research and Innovation
- They provide the National RIS3 Manager and the RIS3 Management Committee with feedback on upcoming, ongoing or completed interventions, especially with respect to their efficiency, effectiveness and contribution to the objectives of the National RIS3 Strategy; to that end, they can give their opinion and feedback on the targeting, objectives and results of calls especially in terms of needs and contributions to the National RIS3 Strategy; they can, at their own request or at the suggestion of the National RIS3 Manager, give their opinion on National RIS3 Strategy progress reports
- They can give recommendations to the National RIS3 Manager and RIS3 Management Committee

For the purposes of giving opinions on proposed interventions and giving feedback to the National RIS3 Manager and RIS3 Management Committee, the National RIS3 Manager and their team

prepares documentation for the innovation platforms and provides information on planned, ongoing and completed interventions.

National innovation platforms meet as needed, usually twice a year.

They can be convened on the initiative of the National RIS3 Manager or members of the RIS3 Management Committee.

#### **7.3.1.7 Intervention verticalisation process**

The objective of verticalisation in relation to the National RIS3 Strategy is to identify long-term needs of sectors with a significant share of private investment in R&D&I and reflect them in the interventions of relevant R&D&I support programmes.

Specialisation domains proposed in the National RIS3 Strategy and its regional annexes were gradually “profiled” – narrowed to and targeted at selected topics – using the entrepreneurial discovery process, which is based on the activities of the National Innovation Platforms and structures corresponding to them at regional level. The National Innovation Platforms discussed and proposed the profiling of specialisation domains in the relevant fields they were established for. Inputs to the meetings of the National Innovation Platforms included specifications provided by the RIS3 MC as well as topic-focused analyses and other documentation prepared by the National RIS3 Manager’s team and outputs and recommendations from regional innovation platforms’ meetings provided to the National RIS3 Manager by Regional RIS3 Managers/Coordinators.

The Office of the Government, as the body in charge of the national research and development and innovation policy and the bearer of the RIS3 strategy, managed to link up the debates on businesses’ R&D&I needs, creating an environment for debate on the targeting of the National RIS3 Strategy and identification of applied research priorities.

The NIPs are currently used to discuss the targeting of OP EIC, OP RDE and OP PGP calls. The publication of pilot calls, which will be narrowed to reflect the identified specialisation in the National RIS3 Strategy, will take place in the second half of 2016. **Full verticalisation of calls is expected from the first quarter of 2017.**

The identified specialisation domains will be reflected in the preparation of programme calls.

#### **7.3.1.8 National RIS3 Implementation Plan**

Following the approval of the National RIS3 Strategy, the National RIS3 Implementation Plan was created. It is prepared by the National RIS3 Manager and their team using information and documentation from operational programmes and national programmes that contribute to the fulfilment of RIS3 strategy objectives. The National RIS3 Implementation Plan summarises information about interventions planned within at least one year and includes interventions planned in both operational programme calls and national R&D&I support programmes. The National RIS3 Implementation Plan is discussed and approved by the RIS3 Management Committee and is notified to the Government of the Czech Republic.

The Implementation Plan includes a list of upcoming interventions within at least one year, listing, in particular:

- Name and brief description of the intervention and its objectives
- Sponsor / organisation responsible for intervention preparation and management

- Amount of intervention, listing the source and, if using ESIF funds, an indicative breakdown into national and EU funds
- Expected intervention results and in what manner and to what extent they will contribute to RIS3 objectives
- Indicative intervention schedule

The National RIS3 Implementation Plan was prepared for the first time in the first half of 2015 for the period of 2015–2016. It was approved by the RIS3 Management Committee on 25 June 2015, subsequently discussed by the RDI Council and then submitted to the Government, who discussed it on 13 July 2015. The deadline for updates to the National RIS3 Implementation Plan, namely 31 March every year, results from Government Resolution No. 1028 of 8 December 2014. During the preparation, the National RIS3 Manager cooperates closely with the managing authorities of relevant ESIF programmes and national programmes by means of which the National RIS3 Strategy is implemented.

At the RIS3 MC meeting held on 25 June 2015, Mr. JUDr. Ing. Tomáš Novotný, Ph.D., made a recommendation that documentation should be amended to specify how the vertical (sectoral) priorities of the National RIS3 Strategy should be completed. The recommendation consists in specifying the Czech Republic's research specialisation areas based on an analysis of foreign trends, the existing research infrastructure and economic specialisation within the meaning of, in particular, export performance, value added and innovativeness. The National RIS3 Implementation Plan will be updated on the basis of the conclusions and will newly include financial contributions from national public sources to the fulfilment of the National RIS3 Strategy. The RIS3 MC agreed that it was necessary to complete the drafting of priority areas for intervention verticalisation by the end of the first half of 2016.

### **7.3.2 National level of operational programmes – OP RDE, OP EIC, OP PGP**

Government Resolution No. 867 of 28 November 2012 concerning the preparation of programmes co-financed by Common Strategic Framework funds for the programming period of 2014–2020 defined operational programmes. In the resolution, the MEYS was put in charge of OP RDE, the MIT was put in charge of OP EIC, the Capital City of Prague was put in charge of OP PGP, the MRD was put in charge of IROP and the MLSA was put in charge of OP E.

To promote the development of regional partnerships and strengthen the institutional capacity in regions, on 1 July 2015 OP RDE published a call named Smart Accelerator (see Chapter 7.3.3 for details), whose purpose is to support the functioning of regional partnerships, Regional RIS3 Managers and project managers for the preparation and implementation of interventions/projects at regional level. Under the Smart Accelerator, it will also be possible to implement some types of projects that are proposed in regional annexes and in line with the National RIS3 Strategy. However, those will not be investment projects<sup>231</sup>. Regional authorities or other applicants identified in the OP

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<sup>231</sup> An exception may be the purchase of HW and SW to be used by Smart Accelerator employees provided that the relevant OP and call list such expenditure as eligible. The RIS3 strategy does not predefine eligible expenditure. However, Smart Accelerator interventions cannot include investment in construction or the purchase of scientific apparatus or equipment for research and development.



will apply for such projects similarly to any other projects. Neither regions nor any other entities at the regional level will act as an intermediate body in this operational programme.

OP EIC envisages the implementation of projects for which applicants will apply at national level. It is anticipated that applicants from regions will include various regional entities actively involved in the regional innovation system – e.g., innovation centres, STPs or RDAs, who will apply for projects. Regions will be neither intermediate bodies nor grant scheme beneficiaries in the operational programme’s implementation system.

OP EIC interventions in regions are complemented in Prague by the operational programme “Prague – Growth Pole” (OP PGP), although not in the full range of activities for budget reasons. The National RIS3 Strategy is also an ex ante conditionality for the OP “Prague – Growth Pole”.

The role of regional partnerships (see below) is expected to be a consultative one for all three operational programmes, including OP PGP.

Specific conditions for the implementation of the National RIS3 Strategy by means of OPs, eligible applicants and other details will be specified in relevant operational programmes and individual calls.

### 7.3.3 Regional level

The **RIS3 management and implementation structure** should ultimately have a similar – multi-level – form in every region, ensuring **6 basic functions**:

- Managing (the bearer of which is, e.g., the regional innovation/competitiveness council or its equivalent)
- Executive (the bearer of which is the implementing entity – in most cases a specialised agency such as a regional development agency or innovation centre, or the relevant department of the Regional Authority)
- Consulting, within the meaning of the entrepreneurial discovery process (the bearers of which are innovation platforms, bringing together key stakeholders from all segments of the triple/quadruple helix but most importantly entrepreneurs)
- Coordinating (the bearer of which is especially the Regional RIS3 Manager and their team)
- Monitoring/evaluating
- Supporting (which also provides a labour and remuneration framework for efficient job performance in the implementation of the RIS3 strategy in the region)

The specific manner of providing these functions and proposals for responsible entities brought together at the individual levels of this structure are handled in each region individually.

#### 7.3.3.1. Regional innovation councils

Managing authorities for the RIS3 strategy in a given region have been established at the regional level. Those are usually regional innovation/competitiveness councils – they have names depending on the specific situation and customs in a given region, as implementation structures already exist in some regions that successfully implement their regional innovation strategies and will be given the role of the coordinating body. The regional innovation/competitiveness council (or the body having

its role) includes representatives of local authorities (regional and municipal, especially of metropolitan areas), innovative businesses and research organisations.

The role of regional innovation councils is similar to the roles of the structures already described at national level. The role of regional innovation/competitiveness councils in regions is governed by local conditions. Generally, they have a coordinating and recommendatory role rather than an executive one; they have an advisory role in relation to interventions controlled or financed by the regional authorities. Similarly, in matters concerning entrepreneurship promotion or governed by the Research, Development and Innovation Support Act or the Higher Education Act, the role of regional innovation/competitiveness councils is usually limited to acting as a consultation platform, but the situation in individual regions may vary<sup>232</sup>.

#### 7.3.3.2. Regional innovation (business) platforms

A supporting role in shaping interventions/operations in regions is played by **regional innovation (business) platforms**, which have different names in different regions, similarly to the regional innovation councils. Innovation/business platforms act as an advisory, consulting or working body to the regional innovation council in fields that will be the focus of regional specialisation on the one hand and in horizontal topics/change areas that are the focus of the regional annexes to the National RIS3 Strategy on the other hand. The role of regional innovation platforms is similar to that of innovation platforms at national level, but it mostly concerns the regional annexes to the national RIS3 Strategy and those interventions that are implemented in the region from the national level. The role of regional innovation platforms is primarily initiating, recommending and consulting. In addition, regional innovation platforms provide feedback during the execution of projects, evaluation of achieved results and submission of proposals for reinforcing the regional innovation system to the regional innovation/competitiveness council. In matters concerning entrepreneurship promotion or governed by the Research, Development and Innovation Support Act or the Higher Education Act, the role of regional innovation (business) platforms is limited to consulting.

#### 7.3.3.3. Regional specialisations

Specialisation domains are identified within regions, reflecting the specific development conditions for R&D&I and business opportunities in each region. A great number of R&D&I topics overlap with topics identified at the national level and were the subject matter of the EDP undertaken through NIPs.

Specialisations that are defined solely at the regional level are highlighted in Table 10 and are subject to negotiation between the regional and national levels.

Where such region-specific domains have a clear link to the focalised specialisation domains identified at the national level (e.g. textiles for use in Health Care and Advanced Medicine, in Transport Means for the 21st Century or in the field of CCI), the region-specific domains are included in the domains identified at the national level in the respective regions (see Table 10).

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<sup>232</sup> For example, the Research, Development and Innovation Council of the Hradec Králové Region (RDIC HKR) acts on a long-term basis as the Expert Advisory Board for the evaluation of public tenders in research, development and innovation invited by the Hradec Králové Region pursuant to Act No. 130/2002 Coll., on support for research, experimental development and innovation, as amended.

Table 10: Regional specialisations, highlighting specialisations that are not defined at national level<sup>233</sup>

Region name	Southern Bohemia	Southern Moravia	Hradec Králové	Karlovy Vary	Liberec	Moravia-Silesia	Olomouc	Pardubice	Pilsen	Prague	Central Bohemia	Ústí	Vysočina	Zlín
Specialisation of RIS3 regional domains	Biotechnology for sustainable social development	Advanced manufacturing and engineering technology	Manufacture of transport means and their components	Mechanical engineering and custom metalworking	Manufacture of engineering technology	Advanced materials	Mechanical engineering, electrical and electronics industry, powder metallurgy	Smart chemistry for industrial and biomedical applications	Mechanical engineering and mechatronics	Selected sciences	Manufacture of transport equipment	Product cycle of coal mining and utilisation, energy industry, supplier industries and reclamation	Automotive industry	Innovative polymer applications
	Mechanical engineering and mechatronics	Precision instruments	Mechanical engineering and industrial plants	Electrical engineering	Decorative optics and glassware <sup>234</sup>	Industrial automation	Optics precision mechanics, optoelectronics	Textiles – advanced materials based on textile structures	Industrial automation	Selected creative industries	Electronics and electrical engineering	Organic and inorganic chemistry	Mechanical engineering	Innovation in designing
	Electrical engineering	SW & HW development	New textile materials for new multidisciplinary applications <sup>235</sup>	Automotive industry	Advanced rehabilitation and separation technology	Mechatronics	Industrial chemistry	Competitive transport	Material engineering	Selected emerging technologies	Biotechnology / Life Sciences	Manufacture of glass and porcelain <sup>236</sup>	Metal industry	Smart and economical electronic systems
		Medicines, medical care and diagnostics	Electronics, optoelectronics, electrical engineering and IT	Traditional industries <sup>237</sup>	Advanced materials based on textile structures	Regenerative medicine, genomics and new approaches to data analysis	Pumping technology, pumping equipment, fluid transport systems, water management equipment, diaphragm technology	Mechanical engineering	ICT	Knowledge-based business services	Chemical industry (without pharmacy)		Electrical and electronics industry	
		Aviation industry technology	Medicines, medical devices and medical care	Manufacture of rubber and plastic products	Progressive metal composite materials and processing technology	Waste processing technology	Biomedicine and Life Sciences	Advanced applications of electrical engineering and information science	Biomedicine		Mechanical engineering and metalworking		Energy industry	
			Advanced agriculture and forestry	Energy industry and RES utilisation, processing of secondary raw materials – advanced recycling technologies	Nanomaterials	Smart industry <sup>238</sup>	Advanced agriculture		Electrical engineering		Mechanical engineering and metalworking			
				Spa sector and tourism	Transport equipment components	Integrated safety systems	New materials and technologies		Energy industry		Food industry <sup>239</sup>			
				Manufacture of beverages <sup>240</sup>		Supercomputer methods					Research and experimental development on natural sciences and engineering			
				Chemistry										

Source: Regions and OG CR

<sup>233</sup> The highlighted specialisations are either partially interlinked with a NIP (yellow) or without any identified interlinkage with a NIP (amber).

<sup>234</sup> Link to NIP II – Electronics & Electrical Engineering and ICT and NIP V – CCIs.

<sup>235</sup> Link to NIP III – Manufacture of Transport Means and NIP V – CCIs.

<sup>236</sup> Link to NIP III – Manufacture of Transport Means and NIP V – CCIs.

<sup>237</sup> Link to NIP V – CCIs.

<sup>238</sup> Link to NIP I – Mechanical Engineering, Energy Industry and Metallurgy.

<sup>239</sup> Link to NIP VI – Agriculture and the Environment.

<sup>240</sup> Link to NIP VI – Agriculture and the Environment.

#### 7.3.3.4. Regional authorities

Since it is anticipated that the source of financing for region-specific interventions, mostly under OP RDE and OP PGP at the moment, will be regional budgets, in addition to relevant operational programmes, regional authorities are one of the regional-level players and will undertake specific interventions, especially under OP RDE and OP PGP. Interventions will be undertaken solely in the form of projects that regions will apply for under individual calls in the manner specified in the documents regulating operational programme implementation. Funds or projects the beneficiaries of which will be regional authorities are not determined or even guaranteed in advance in either the National RIS3 Strategy or operational programmes.

If they win a project, regional authorities may delegate the execution to its own organisation – e.g. a development agency or innovation centre – in accordance with competition rules.

Operations may also be implemented using the budgets of other stakeholders in the region; regional authorities must not necessarily participate in all intervention undertaken at regional level.

Specifically, the field of education is subject to the mechanism proposed in the Partnership Agreement, namely: “**In regional education**, a large proportion of interventions will be provided for by collecting and evaluating specific needs at regional and local level. In cooperation with partners in the area, such needs will be included in regional and local action plans for education development, which will serve to coordinate and target calls under OP RDE (PA 3) and IROP (PA 2) and OP PGP (PA 4) and enhance the territorial concentration of investment. The action plans will be used to manage the synergies of OP RDE, IROP and OP PGP.

#### 7.3.3.5. Regional RIS3 Manager

To date, the preparation of regional annexes to the National RIS3 Strategy has been coordinated and the regional annexes were implemented by **Regional RIS3 Managers**, who also manage regional partnerships for RIS3 implementation. Their role consists in supporting regional structures, building regional partnerships and promoting cooperation at the regional level. The Regional RIS3 Manager acts as secretary of the regional innovation/competitiveness council. The Regional RIS3 Manager is the preparer of regional annexes to the National RIS3 Strategy.

The Regional RIS3 Manager is a member of the National RIS3 Manager’s analytical team under the Office of the Government of the Czech Republic. Before the SmAcc project was launched, the Regional RIS3 Manager acted as a communicator between the region and the Office of the Government of the Czech Republic. The role of the Regional RIS3 Manager in the SmAcc project is described below.

#### 7.3.3.6. Regional RIS3 Coordinator

The Regional RIS3 Coordinator is a new position within the system of RIS3 management at regional level. Their main task will be to take care of communication between the national and regional levels of RIS3. Their inclusion in the Regional Authority will ensure the region’s regional development is implemented using progressive forms based on the utilisation of research and development results in the application sector in the form of innovations.

The Regional RIS3 Coordinator is a member of the National RIS3 Manager’s analytical team under the Office of the Government of the Czech Republic. The Regional RIS3 Coordinator is the National RIS3 Manager’s liaison officer at the regional level and intermediates intensive two-way communication

between the national and regional levels of RIS3. The role of the Regional RIS3 Coordinator in the SmAcc project is described below.

#### **7.3.3.7. Regional annexes to the National RIS3 Strategy**

“Regional annexes to the National RIS3 Strategy” have been prepared for the National RIS3 Strategy in regions. These annexes serve multiple purposes:

- To complement the innovation system at regional level, which is the main purpose, with regional annexes being one of the tools and grounds for key players’ communication. In the given case, this concerns stimulating partnerships in the triple/quadruple helix and instigating regional players’ activity.
- To specify specialisation domains at the level of the region. Regional domains may differ a little from national domains – refine them – or may represent specialisation domains important for the region that are, however, concentrated in one or a few regions and inappropriate to be specified at national level.
- To identify regional interventions responding to local conditions, both amongst specialisation domains and amongst interventions of a general nature that aim to complement and reinforce regional innovation systems.

Regional annexes to the National RIS3 Strategy are subject to approval at the regional level, and all 14 annexes were approved by the respective regional assemblies in May – June 2014. Analogously to the national level, regional annexes to the National RIS3 Strategy will be regularly updated and amended in the next years to include regional action plans proposing specific interventions/measures to implement the RIS3 strategy in the next year. Regional action plans for the first year of implementation of the regional annexes to the National RIS3 Strategy were prepared during May and June 2015.

Interventions proposed in regional annexes will be undertaken in various ways: (i) proposed interventions serve as a basis for the preparation of projects that will apply for support from national-level resources, both ESIF programmes’ resources and national programmes’ resources; (ii) some interventions will be funded to a limited extent from regional budgets; (iii) interventions in, especially, capacity-building at the regional level will be funded from the “Smart Accelerator” (see below).

In the process of building partnerships and the RIS3 structure in regions, the Regional RIS3 Managers will henceforth be supported by the MEYS and the Office of the Government so that the partnerships are as functional as possible when implementation starts and so that they allow and facilitate cooperation amongst the various entities (triple/quadruple helix) in taking decisions on the contents of regional annexes to the National RIS3 Strategy as well as in the planning, coordination and undertaking of individual interventions. As part the Regional RIS3 Managers’ other activities, regular several-day training courses led by the Office of the Government of the Czech Republic and the MEYS will continue.

Most regional authorities in the Czech Republic lack the capacity and sufficient expertise to coordinate the RIS3 agenda and implement its priorities, i.e., to implement tools promoting cooperation between the public and private sectors in research and development and innovative entrepreneurship. This manifests itself in insufficient development of the innovation environment in

the Czech Republic and its regions. The implementation of the National RIS3 Strategy, including its regional annexes, requires the existence and development of a supporting infrastructure of services directly targeted at the implementation of the National RIS3 Strategy. One of the development promoting tools is the Smart Accelerator.

#### 7.3.3.8. Smart Accelerator<sup>241</sup> – a tool for developing regional innovation systems<sup>242</sup>

As the formation of regional innovation systems is at an initial stage in most of the Czech Republic's regions, the process requires targeted support. The support for RIS3 implementation in regions, including the Capital City of Prague, and especially the creation and reinforcement of appropriate institutional capacity (the activities of regional managers and business/innovation platforms, support for the generation of suitable types of pro-innovation schemes and projects) will be aided through OP RDE; to that end, there is a specific tool prepared under that OP – the Smart Accelerator.

The purpose of the tool is to enable the development of an innovation environment in the individual regions of the Czech Republic using the National RIS3 Strategy and to enable high-quality management of the entrepreneurial discovery process. Through such a process, smart specialisation strategies can unleash economic transformation through modernisation, diversification or radical innovation in all regions.

The Smart Accelerator's obligatory activities include:

- **Core Team** – The activity aims to provide the capacity and key competences for the coordination and implementation of the RIS3 agenda through the core team of an executive unit<sup>243</sup> and to ensure the stabilisation and gradual development of the executive unit according to the development of the innovation environment in the region. The executive unit will be either an integral part of the beneficiary (region) or established outside the organisational structure of the beneficiary (region) in **entities where regions participate in the control of such entities and such entities carry out** the best part of their activities for the benefit of the beneficiary. The executive unit will ensure comprehensive support for the development of the innovation environment in the region using the RIS3 strategy, communication within the region, updating and discussing the regional RIS3 strategy and the Action Plan for the regional RIS3 strategy, meetings of the regional innovation platforms and preparation of strategic interventions in the region.
- **Education** – The activity aims to develop the competences of executive unit members and the region's specialists, strengthen the relevant competences of experts from partner organisations that are involved in the development of the innovation environment in the region and in the implementation of strategic interventions fulfilling the RIS3 in the region and strengthen the relevant competences of public administration officers and

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<sup>241</sup> The Smart Accelerator is one of possible tools for implementing the RIS3 strategy at regional level.

<sup>242</sup> The text of the Smart Accelerator subsection is a quotation / quotation updated in collaboration with the MA of OP RDE; for a detailed description of specialists and the Core Team of an executive unit, see the SmAcc call.

<sup>243</sup> A SmAcc executive unit is usually, but not always, an external entity having a partnership agreement with the region and meeting partnership requirements specified in the call. The core team consists of the executive unit personnel that participate in the key SmAcc activities (see the list of activities below), described under the Core Team activity. A SmAcc team (executive unit) can include additional personnel, as results from the description of other activities (e.g. analyst, marketing expert or Twinning officer). If an applicant submits a project without a partner, the applicant's relevant department is considered to be the executive team.

representatives of autonomous authorities in the region that participate in the preparation, approval and implementation of the regional RIS3 strategy.

- **Mapping** – The activity aims to prepare and create regional RIS3 Strategies, where regional RIS3 managers, in collaboration with other key innovation system stakeholders, map the innovation environment to a certain degree, identifying the main entities of the regional innovation system and specifying their main problems and needs. In addition, the innovation environment develops and it can be expected that the implementation of interventions and activities proposed in regional RIS3s and the national RIS3 will result in additional changes to which the system in the region will have to react.

The Smart Accelerator's optional activities include:

- **Assistance** – This activity aims to provide conceptual supervision of the preparation of project outlines for strategic interventions in the region so that they are in line with the regional RIS3 strategy and project applications can be submitted for a relevant call under a suitable national-level or EU-level programme or are ready for implementation using resources identified elsewhere (e.g., local budgets).
- **Twinning** – The activity aims to allow detailed familiarisation with the activities of an experienced foreign development or innovation agency or agency for entrepreneurship promotion through partnership with a selected foreign partner and to ensure the adoption of a specific supporting tool through joint activities so that it can be used under local conditions.
- **Pilot testing** – The activity aims to test the functionality of a planned intervention/tool and configuration of conditions and rules, including testing the roles and possible cooperation of entities that will implement a given intervention/tool and/or testing whether the target groups will be interested under given circumstances and whether the intervention will bring them the planned benefit (demand testing).
- **Promotion** – The aim is to enhance innovation system communication and marketing by setting up a local model of marketing and communication activity management, preparing and implementing a marketing strategy, and having a marketing plan.

### **Executive unit – make-up**

The fundamental element of the supporting service infrastructure for RIS3 implementation in regions will be an executive unit.

The executive unit ensures that key regional stakeholders are involved in the creation and implementation of the regional RIS3 strategy. This is achieved by means of thematic innovation platforms, which provide the Regional Innovation/Competitiveness Council with suggestions for defining strategic areas and propose individual measures to support the regional RIS3 strategy. All these structures/platforms bring together key regional stakeholders from all sectors in accordance with the “quadruple helix” approach (i.e., entrepreneurs, representatives of R&D, academia and regional administration, including representatives of relevant intermediaries operating in the region – development agencies, science and technology parks, business incubators, innovation centres, etc.). If the Regional Authority has a partner in a SmAcc project (an Innovation Centre, STP, RDA, etc.), the role of the executive unit is played by a specified entity. If the Regional Authority has no

partner in a SmAcc project, the role of the executive unit is played by the Regional Authority. Group 1 – RIS3 Manager’s Core Team and Group 2 – Regional Specialists are financially involved in a SmAcc project, so they are either the beneficiary or a partner with a financial contribution.

### **Group 1 – RIS3 Manager’s Core Team**

A SmAcc executive unit consists of the RIS3 Manager’s Core Team and other personnel involved in obligatory or optional SmAcc activities, who report to the RIS3 Manager.

#### **Core team roles**

- **Key expert roles** in the Core Team are played by the RIS3 Manager and RIS3 Strategic Project Developer.
- **Supporting roles** in the Core Team are played by the RIS3 Specialist Assistant and RIS3 Financial Manager.

This activity also provides the Core Team with a labour and remuneration framework for efficient job performance in the implementation of the RIS3 strategy in the region.

### **Group 2 – Regional Specialists**

This group includes the Regional RIS3 Coordinator and Financial RIS3 Coordinator. The Core Team provides this group with cooperation in SmAcc implementation, including expert services for the Regional RIS3 Coordinator in their communication and cooperation with the National RIS3 Manager. This activity also takes care of covering the costs associated with SmAcc activities.

#### **Other target groups/stakeholders – make-up**

Group 3 – key partners in the region involved in RIS3 implementation, Group 4 – users involved in RIS3 implementation in the region, and Group 5 – key central-level partners are concerned with SmAcc project activities but are not beneficiaries.

### **Group 3 – key partners in the region involved in RIS3 implementation**

This group includes especially organisations and experts involved in the thematic innovation platforms and the regional innovation/competitiveness council. It also includes people that influence the implementation of the RIS3 strategy in the region from their formal roles, i.e., in particular, representatives of local authorities and relevant regional officials.

The Core Team provides this group with expert services to facilitate their involvement in RIS3 activities and enhance the efficiency of their involvement. The Core Team also provides the representatives of local authorities with better information service for competent decisions supporting the RIS3 strategy.

### **Group 4 – users involved in RIS3 implementation in the region**

This group includes especially those that are not directly involved in the managing or expert structures for the implementation of the RIS3 strategy but are active actors in the region’s innovation environment. This includes firms, research and development organisations, educational institutions, etc.

The Core Team provides this group with information service and creates the conditions for their involvement in RIS3 activities and direct structures wherever mutually beneficial.



## **Group 5 – key central-level partners**

This group includes especially the Office of the Government of the Czech Republic, in particular the National RIS3 Manager, the MEYS, the MIT and other relevant ministries as appropriate.

The Core Team, in cooperation with the Regional RIS3 Coordinator and using the related Mapping activity, provides this group with analytical and information service for RIS3 implementation at the level of the region, efficient communication of strategic plans between central institutions and regions and easier implementation of centrally managed strategic interventions linked to RIS3.

## **7.4 Monitoring, evaluation and updating of the National RIS3**

### ***Monitoring of the National RIS3 Strategy***

Interventions fulfilling the National RIS3 Strategy are monitored by means of monitoring reports prepared once a year by 30 June of a given year. The monitoring reports are prepared by the National RIS3 Manager with support from the analytical team and using inputs from Regional RIS3 Managers and managing authorities. The National RIS3 Manager submits the monitoring reports to the RIS3 Management Committee. The RIS3 Management Committee discusses and approves the monitoring reports. The monitoring report includes, in particular:

- Overview of the implementation of funds to execute the National RIS3 Strategy, broken down by the strategic objectives of the National RIS3 Strategy and by:
  - ESIF programmes for operations implementing the National RIS3 Strategy
  - National budget funds
  - Regional budget funds
- Overview of undertaken interventions, broken down by strategic and specific objectives together with the amount of funds for such interventions.
- Overview of the fulfilment of the indicators of the National RIS3 Strategy, using the indicators of relevant OPs, broken down by strategic objectives and specific objectives.
- Information about progress in the implementation of the National RIS3 Strategy and progress in the fulfilment of the objectives of the National RIS3 Strategy, using evaluation reports, analytical documentation prepared by the analytical team, etc.
- Information about innovation platforms' meetings and proposals for intervention targeting.

In monitoring report preparation, the National RIS3 Manager and analytical team cooperate closely with the managing authorities of operational programmes and with intermediate bodies, who provide information and data concerning the contribution of individual OPs to the fulfilment of the National RIS3 Strategy's objectives and indicators. Similarly, organisations responsible for the management of national R&D&I programmes provide the National RIS3 Manager with information necessary for intervention monitoring.

### ***Cooperation with the managing authorities of ESIF operational programmes***

Managing authorities provide the National RIS3 Manager with information about projects implemented under respective operational programmes for the preparation of monitoring reports, in particular:

- Implementation of funds
- Fulfilment of indicators, including indicators relating to the fulfilment of those National RIS3 Strategy objectives that are monitored by the managing authorities (i.e., indicators gathered from applicants/beneficiaries and indicators from MS14+)

The National RIS3 Manager can obtain outputs from MS14+ for monitoring purposes.

#### ***Cooperation with organisations responsible for national R&D&I programmes***

For the purposes of monitoring interventions that are supported through national R&D&I programmes, the National RIS3 Manager receives information from the organisations in charge of the national programmes. The structure and scope of information are similar to those provided by managing authorities.

#### ***Cooperation with the regional RIS3 level***

If an intervention supported by a region contributes to the fulfilment of the specific and strategic objectives of the National RIS3 Strategy, connection with relevant National RIS3 objectives will be specified for relevant projects. Information will be provided on projects implemented under the regional annex to the National RIS3 Strategy and contributing to its objectives, broken down by projects supported through individual OPs and by projects implemented from regional players' own resources. Regional RIS3 Coordinators' information will include, in particular:

- The Regional RIS3 Coordinator, who is responsible for providing information about project activities and outcomes to the Regional Authority structure and the National RIS3 Manager.
- The executive unit of the Regional RIS3 Manager, who is responsible for managing all SmAcc activities in the development of the innovation environment in the region.
- The Core Team, in cooperation with the Regional RIS3 Coordinator and using the related Mapping activity, provides analytical and information service for the implementation of the National RIS3 Strategy at the level of the region, efficient communication of strategic plans between central institutions and regions and easier implementation of centrally managed strategic interventions linked to the RIS3 strategy.
- It is an obligatory activity of the Core Team and the Regional RIS3 Coordinator to provide regional-level information and analytical service, communication and cooperation with key national-level partners responsible for the implementation of the National RIS3 Strategy, namely the Office of the Government, especially the National RIS3 Manager, the MEYS and the MIT. Implementing a key activity will involve, in particular, mapping interventions for the purposes of monitoring and evaluating the effects of implemented interventions from regional annexes to RIS3 strategies.
- Reports on the regional annex to the RIS3 strategy will be prepared at the end of each half-year and Implementation Progress Reports will be prepared annually (as of 31 December of a given year) for the purposes of the National RIS3 Manager and submitted to the National RIS3 Manager no later than two months after the end of the half-year; the Regional RIS3

Coordinator will discuss any recommendations on the report made by the National RIS3 Manager and ensure that they are carried over into further SmAcc activities.

- Proposals for strategic projects will be submitted to the National RIS3 Manager. The National RIS3 Manager will issue an Opinion<sup>244</sup> on the proposals for strategic projects in respect of their compliance with the National RIS3 Strategy and the Regional RIS3 Coordinator will ensure proposal negotiation as applicable and make sure that the National RIS3 Manager's recommendations are carried over into SmAcc in the region. The negotiation, together with the National RIS3 Manager's Opinion, will be documented in the Regional RIS3 Report and monitoring report.

### ***Evaluation of the National RIS3 Strategy***

Evaluations of the National RIS3 Strategy or its parts, individual interventions or groups of interventions and evaluations of various aspects of National RIS3 Strategy implementation are prepared as necessary, at least once in two years in good time before the National RIS3 Strategy is updated. Evaluations are prepared by the national RIS3 Manager either at their discretion or following the RIS3 Management Committee's decision. Evaluation reports are prepared by either the analytical team or external evaluators; combining these methods is possible. Evaluation reports prepared between RIS3 strategy updates are an input into proposals for updates to the National RIS3 Strategy.

Regional RIS3 Managers prepare their own evaluations of the regional annexes to the National RIS3 Strategy at their discretion or at the request of the National RIS3 Manager. Regional evaluation outputs (evaluation reports) are provided by the Regional RIS3 Managers to the National RIS3 Manager.

### ***Updating of the National RIS3 Strategy***

*The National RIS3 Strategy is updated every two years, always at the end of the calendar year (December). The first update to the NRIS3 is planned for December 2018.* Supporting documentation for National RIS3 Strategy updates is prepared by the National RIS3 Manager with support from the analytical team and submitted by the National RIS3 Manager to the RIS3 Management Committee. **The RIS3 Management Committee discusses proposals for updates and submits them to the Government of the Czech Republic, who approves them.** Updates to the National RIS3 Strategy are prepared especially on the basis of information comprising the description and analysis of:

- Changes in the environment, i.e., the description and analysis of problems and their causes identified in the National RIS3 Strategy (changes relating to the analytical part of the National RIS3 Strategy)

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<sup>244</sup>The National RIS3 Manager gives their opinion on a proposal for a strategic intervention/project before the intervention is either directly executed by the intervention bearer using their own resources or submitted as a project application under a subsidy programme (National Programmes, ESIF – OP RDE, OP EIC, Cross-Border Cooperation, Horizon 2020, etc.). The National RIS3 Manager will only give opinions on strategic projects at regional level. Smart Accelerator beneficiaries must deal with the comments, which means either accepting the comment or not accepting it and giving reasons.

- The course of interventions, their success and progress in the fulfilment of the objectives of the National RIS3 Strategy and its regional annexes, including the fulfilment of indicators
- The course of interventions specifically targeted at developing selected specialisation domains, including recommendations for refining and narrowing the specialisation domains at national level and/or identifying new specialisation domains resulting from innovation platforms' recommendations and based on analytical documentation
- Barriers to implementation and the success of proposals for their elimination

Inputs into National RIS3 Strategy updates include evaluation reports prepared between updates.

A change to the focus of domains, focalising or transforming them, or the creation of a new domain are possible mainly in the context of debate with partners during the entrepreneurial discovery process; in the context of an identified change, the proposals will be backed by analytical documentation and studies.

New needs are manifested by partners' attitudes at NIP meetings and their significance is supported by data or qualitative analysis. Stimuli may also result from policy implementation or the reflection of current trends. Such facts are evidenced by an analysis or study and become the subject of subsequent debate among stakeholders within the EDP. The opinion of NIP members is crucial for a change to a domain. The **profiling of existing specialisation domains** – i.e. narrowing and targeting them – **is not considered updating the National RIS3 Strategy** and takes place continuously as part of the entrepreneurial discovery process.

Reviews are set up on the basis of National RIS3 Strategy evaluation reports, which are prepared twice a year. If reviews based on evaluation do not come up with requests for changes, then there will be no major update and the RIS3 Management Committee and the Government will be notified of that.

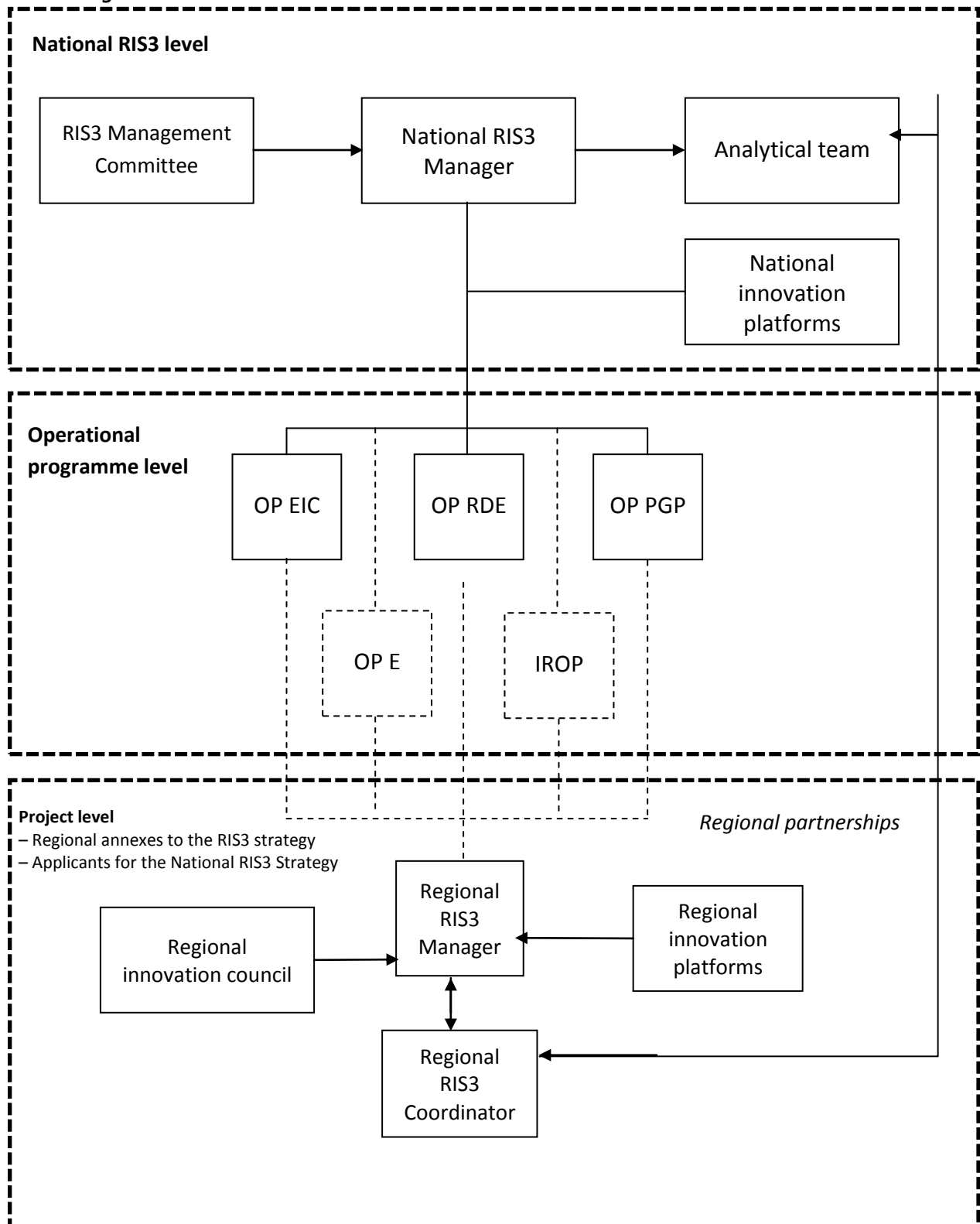
#### ***Cooperation with Regional RIS3 Managers in the updating of the National RIS3 Strategy***

**Regional annexes to the RIS3 strategy are updated 6 months before the National RIS3 Strategy is updated.** The procedures for and course of updating regional annexes to the RIS3 strategy follow similar rules as the preparation of regional annexes and are based on similar information as National RIS3 Strategy updates above, limited to information relevant for a given regional annex<sup>245</sup>. Updated regional annexes to the RIS3 strategy are an input into updates to the National RIS3 Strategy. An update to the National RIS3 Strategy is not an aggregation of updates to the regional annexes to the RIS3 strategy but uses information in them to amend the actual document, especially to modify or propose new model activities.

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<sup>245</sup> Information relevant to a regional annex does not have to be limited just to information about the region in question.

**RIS3 management structure<sup>246</sup>**



<sup>246</sup> Note: The OP “Employment” (OP E) and IROP are included because interventions proposed in the National RIS3 Strategy concern also these programmes, but the National RIS3 Strategy is not an ex ante conditionality for these OPs. Proposals in the National RIS3 Strategy concern especially social innovations from the OP “Employment” and eGovernment in a wider sense from the IROP.

## 8 Funding of the National RIS3 Strategy

The allocations of financial support committed for the support and development of the National RIS3 Strategy in operational programmes are shown in Table 11: Indicative allocation of operational programme funding to key change areas in the National RIS3 Strategy (EUR). The values of individual items were taken from the National RIS3 Strategy approved in December 2014, page 149. The amounts of indicative allocations have been verified and updated against information from respective ministries.<sup>247</sup>

Vertical priorities are refined and interventions are identified in the National RIS3 Strategy over time. To this end, pilot industries are selected in collaboration with the MIT to analyse their internal structure and their needs. The purpose is to verify whether the proposed verticalisation will result in applicable recommendations for managing authorities and be able to be used for the publication of calls<sup>248</sup>.

**Table 11: Indicative allocation of operational programme funding to key change areas in the National RIS3 Strategy (EUR)**

Key area / strategic objectives	OP	SO	ESIF contribution (EUR)	National financing (public + private) (EUR)	co-financing (public + private) (EUR)	Total (EUR)
Key change area A: Higher innovation performance of companies		SO 1.1	974,888,932	974,842,633		1,949,731,565
		SO 1.2	339,889,931	339,873,790		679,763,721
		SO 2.1 <sup>249</sup>	609,428,042	293,096,703		902,524,745
		SO 2.2	56,540,420	27,192,400		83,732,820
Key change area C: Increasing the economic benefits of public research		SO 1.2	37,765,548	37,763,754		75,529,302
Key change area E: Development of eGovernment and eBusiness to improve competitiveness (ICT development and digital agenda)	OP EIC	SO 4.1	521,380,364	471,203,877		992,584,241
		SO 4.2	222,277,225	200,885,759		423,162,984
OP EIC			2,762,170,462	2,344,858,916		5,107,029,378

<sup>247</sup> Specific objective 2.4 has been removed from the key change areas in the National RIS3 Strategy, as the objective was not primarily linked to the National RIS3 Strategy in the approved OP EIC programming document. As for OP RDE, allocation duplicities have been removed and strategic objectives have been grouped under summary allocation items. IROP values have been taken from publicly available documents, which does not allow further detailing.

<sup>248</sup> The MIT will prepare an analysis based on received applications for project support (number of applicants, project size, industries) under calls already published for OP EIC programmes. The analysis will be used in discussion on both the verticalisation and the absorption capacity of programmes and on call planning. Subsequently, the proposed verticalisation concept and its usability by the managing authority.

<sup>249</sup> The table shows the total allocation for OP EIC SO 2.1. Note, however, that only the “Risk Capital” and “Expansion” financial instrument programmes and the “Consultancy” subsidy programme have relation to the National RIS3 Strategy.

Key change area C: Increasing the economic benefits of public research	OP RDE <sup>250</sup>	PA1 IP1 SO2	160,555,556	28,333,333	188,888,889
Key change area D: Better supply of HR, in terms of both quality and quantity, for innovative enterprises, research and development		PA2 IP1 SO5	213,444,444	37,666,667	251,111,111
Key change area F: Improvement and better utilisation of social capital and creativity in addressing complex societal challenges:		PA1 IP1 SO1	733,518,519	129,444,444	862,962,963
Key change area B: Improving the quality of research		PA1 IP1 SO3	220,370,370	38,888,889	259,259,259
		PA1 IP1 SO4	50,370,370	8,888,889	59,259,259
		PA2 IP1 SO1	484,814,815	85,555,556	570,370,370
Key change area D: Better supply of HR, in terms of both quality and quantity, for innovative enterprises, research and development <sup>251</sup>		PA2 IP2 SO1			
		PA2 IP1 SO4			
		PA3 TO10 IP1 SO2			
		PA3 TO10 IP1 SO3	? <sup>252</sup>	?	?
	PA3 TO10 IP1 SO5				
OP RDE		min. 1,863,074,074	min. 328,777,778	min. 2,191,851,851	

<sup>250</sup> In the case of OP RDE, the National RIS3 Strategy is an ex ante conditionality for all specific objectives of PA1 (SO1–SO4) and specific objective SO5 of PA2 IP1. All other specific objectives under OP RDE are primarily governed by strategies other than the National RIS3; however, some specific objectives actually contribute to the fulfilment of the National RIS3 with their interventions; see the next footnote. The allocations in the table are just indicative and may be subject to change, which is within the purview of the MA of OP RDE. The ESIF contribution and national co-financing are broken down in a simplified manner as 85% for ESIF and 15% for national co-financing (i.e. the funding breakdown percentages for beneficiaries from less developed regions) since at the moment it is impossible to predict the share of subsidies received during the programming period by projects from the more developed region of Prague, where the funding breakdown percentages are different – based on the pro rata method.

<sup>251</sup> The following specific objectives in PA2 and PA3 partially contribute to the fulfilment of the National RIS3 Strategy in change area D, but it is not an ex ante conditionality for them. Indicated allocations correspond to planned calls under the specific objectives; however, since the calls often partially cover additional specific objectives – irrelevant to RIS3 – the exact allocation relating to just the relevant SOs is not identifiable at the moment.

<sup>252</sup> The degree of the contribution of given specific objectives of OP RDE PA3 to the fulfilment of the specific objectives of the National RIS3 Strategy cannot be determined at the moment. Specific allocations contributing to the fulfilment of RIS3 objectives under PA3 will depend on the results of surveys for Regional Action Plans (RAPs) and Local Action Plans (LAPs) and the related level of use of templates for supporting certain model activities relevant to the RIS3. However, the results of the RAP/LAP surveys will not be available until 2017/2018. No long-term schedule of PA3 calls is available at the moment for the same reason.

Key change area F: Improvement and better utilisation of social capital and creativity in addressing complex societal challenges	OP E <sup>253</sup>	SO 3.1.1	42,170,750	3,171,511	45,342,261
OP E			42,170,750	3,171,511	45,342,261
Key change area E: Development of eGovernment and eBusiness to improve competitiveness (ICT development and digital agenda)	IROP	SO 3.2	78,166,947	330,247,845	408,414,792
IROP			78,166,947	330,247,845	408,414,792
Key change area A: Higher innovation performance of companies	OP PGP <sup>254</sup>	PA 1	62,492,932	62,492,932	124,985,864
Key change area C: Increasing the economic benefits of public research					
OP PGP			62,492,932	62,492,932	124,985,864

Source: Operational programmes<sup>255</sup>

**Table 12: Indicative affiliation of operational programmes to RIS3 key change areas**

Key area / strategic objectives	Operational programme
Key change area A: Higher innovation performance of companies	OP EIC OP PGP
Key change area B: Improving the quality of research	OP RDE
Key change area C: Increasing the economic benefits of public research	OP RDE OP EIC OP PGP
Key change area D: Better supply of HR, in terms of both quality and quantity, for innovative enterprises, research and development	OP RDE
Key change area E: Development of eGovernment and eBusiness to improve competitiveness (ICT development and digital agenda)	OP EIC IROP
Key change area F: Improvement and better utilisation of social capital and creativity in addressing complex societal challenges	OP RDE OP E

<sup>253</sup> The link between OP E and key area E was removed as the area was not primarily linked to the National RIS3 Strategy.

<sup>254</sup> OP PGP's link to key area B was changed to key area C based on approved OP PGP.

<sup>255</sup> The allocations are based on operational programmes' proposed allocations. The allocations are indicative as the list of model projects/activities in the design part of the RIS3 is not final. The amounts of allocations for individual key change areas in the RIS3 may change during the Entrepreneurial Discovery Process (EDP), which ensures entrepreneurs' and researchers' participation in the preparation and updating of the RIS3. The allocations do not include isolated model projects/activities, which can be funded through other operational programmes. This applies, for example, to aligning maternity and parental leave with careers in sciences and research, which can be funded through the OP "Employment". Such excluded activities and interventions will not affect the fulfilment of ex ante conditionalities as they concern thematic objectives for which the RIS3 is not an ex ante conditionality.

Zero public co-financing of business entities is defined for OP EIC. The Government of the Czech Republic will decide on increasing the national budget contribution to up to 15% of the programme allocation (ERDF) under these conditions: sufficient absorption capacity of OP EIC is evidenced (i.e., committed share of ERDF appropriations will be at least 15% greater on 31 December 2017 than the sum of allocations for the period of 2014–2017) and automatic decommitment will not be applied in 2017. If these conditions are met, OP EIC will be receive national co-financing from the national budget of up to EUR 761,658,109 in 2018–2020.



## 8.1 National resources and synergies with Community programmes

In addition to operational programmes funded by ESIF resources, for which the National RIS3 Strategy is an ex ante conditionality, the National RIS3 Strategy also has links to some national programmes/funding schemes and regional-level resources.

**Table 13: Czech Republic's total national budget expenditure on research, development and innovation in 2017–2019 as approved by the Government in its resolution of 30 May 2016**

Year	Expenditure on research, development and innovation	Expenditure on RDI (EUR) <sup>256</sup>
2017	CZK 32.75 billion	EUR 1,212.96 million
2018	CZK 35.00 billion	EUR 1,296.30 million
2019	CZK 34.56 billion	EUR 1,280 million

The funding will be used in compliance with Act No. 130/2002 Coll., on support for research, experimental development and innovation.

Lack of involvement of national and regional resources in the funding for the National RIS3 Strategy was criticised by the European Commission. As matters concerning the National RIS3 Strategy are completely new, there was no reason in the past to identify innovative elements corresponding to the National RIS3 Strategy in national and regional funding instruments. Therefore, there is no time series for comparison and prediction of future development.

Thus, links between national and regional funding sources are identified gradually. National RIS3 Strategy funding was also taken into consideration in the implementation and updating of national R&D&I priorities (financing verticalisation). Therefore, it will be necessary to correctly identify National RIS3 Strategy elements within all funding instruments of national and regional (here, the system is already set up) providers of funding. During the preparation of the national budget for 2017–2019, debate with the providers identified national sources of funding that are relevant for the National RIS3 Strategy in the following programmes:

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<sup>256</sup> The values of the Czech Republic's total national budget expenditure on RDI in 2017–2019 were converted to EUR at the average exchange rate of CZK 27/EUR 1.

**Table 14: Identified programmes – maximum funding according to relevant Government resolutions approving the programmes (EUR million)<sup>257</sup>**

National programmes	MA/Owner	Starting year	Closing year	Total financial appropriation	Expected intensity of national support	RIS3-relevant value (scope of subsidiarity)	Programme volume allocated to RIS3, national resources	Programme volume allocated to RIS3, private resources
Competence centres	TA CR	2012	2019	150.89	70%	50%	52.78	22.67
EPSILON		2015	2023	310.48	60%	50%	93.15	62.09
GAMA		2014	2019	62.59	65%	50%	20.54	10.76
TRIO	MIT	2016	2021	128.15	60%	80%	61.63	40.89
<b>TOTAL</b>				<b>652.11</b>			<b>228.09</b>	<b>136.41</b>
National programmes	MA/Owner	Starting year	Closing year	Total financial appropriation	Expected intensity of national support	RIS3-relevant value (scope of subsidiarity)	Programme volume allocated to RIS3, national resources	Programme volume allocated to RIS3, private resources
Competence centres	TA CR	2012	2019	50.30	70%	50%	17.59	7.56
EPSILON		2015	2023	244.44	60%	50%	73.33	48.89
GAMA		2014	2019	20.48	65%	50%	6.65	3.59
TRIO MPO	MIT	2016	2021	99.63	60%	80%	48.00	31.70
<b>TOTAL</b>				<b>414.85</b>			<b>145.57</b>	<b>91.74</b>

Source: MIT, TA CR<sup>258</sup>

Besides ESIF resources and national resources, the resources of some Community programmes are also planned to be used for funding interventions supported under the individual strategic and specific objectives of the National RIS3 Strategy, especially Horizon 2020 (for Key Change Area B: Improving the Quality of Research and to a lesser extent for other key change areas) and COSME (especially for Key Change Area A: Higher Innovation Performance of Companies). However, the specific use of such resources depends on the success of individual Czech entities in the competition for funding. Interventions under the National RIS3 Strategy will be set to allow leveraging potential synergies between such resources to the highest extent possible, as results, for example, from the Synergy Guide (EC, 2014), by making OP RDE calls complementary to Horizon 2020 calls of strategic importance (Teaming, EIT KICs, joint undertakings under Article 187, etc.).

<sup>257</sup> The values of maximum funding according to relevant Government resolutions were converted to EUR at the average exchange rate of CZK 27/EUR 1.

<sup>258</sup> Data shown in the table was provided by the respective providers of public support for R&D&I. The values (in millions of EUR) are indicative, based on Government resolutions on the individual programmes, which however do not guarantee the allocation of given amounts from the national budget because the draft national budget is prepared annually in compliance with Act No. 130/2002 Coll., on support for research, experimental development and innovation.

## **8.2 National and regional co-financing during the implementation of the National RIS3 Strategy**

The funding of interventions under National RIS3 Strategy objectives is identified not only as the contribution of ESI Funds and national programmes but also as co-financing by national, regional and private resources. Co-financing is expressed as the ratio of the share of national co-financing and the share of private co-financing. An overview of indicative allocation to National RIS3 Strategy interventions, together with co-financing, is included in Table 15.

At the regional level, various sources of support for R&D&I development are identified that are either identical with National RIS3 Strategy objectives or fulfil them complementarily/synergistically. Their indicative funding and the regional co-financing of given activities are shown in Table 16.

Table 15: Overview of indicative allocation to National RIS3 Strategy interventions, together with co-financing, for 2016–2018 and 2019–2020+ (EUR)<sup>259</sup>

		2016–2018													
Competent body	Activity	ESIF programmes							National programmes						
		Total financial appropriation / Total allocation	Proportion under RIS3 / Prediction of support (EUR) 2016–2018 (ERDF)		Share of national co-financing / Funded by national resources		Share of private co-financing / Funded by private resources		Total financial appropriation	Proportion under RIS3		Share of national co-financing		Share of public co-financing	
			% of total allocation	Absolute	% of total allocation	Absolute	% of total allocation	Absolute		% of total allocation	Absolute	As %	Absolute	As %	Absolute
MIT	TRIO								128,148,148	80%	102,518,519	60%	61,518,519	40%	41,007,407
	OP EIC	4,331,062,617	13.69%	592,800,000	0.82%	35,634,373	11.23%	486,556,867							
MEYS	OP RDE <sup>260</sup>	2,770,000,000	21%	574,814,815	3%	86,222,222	–	–							
Prague	OP PGP	201,600,000	13.7%	27,600,000	5.5%	11,040,000	1.4%	2,760,000							
TA CR	Competence centres								135,343,915	50%	67,671,958	70%	47,370,370	30%	20,301,587
	EPSILON								134,629,630	50%	67,314,815	60%	40,388,889	40%	26,925,926
	GAMA								16,259,259	50%	8,129,630	65%	284,260	0%	0
		2019–2020+													
Competent body	Activity	ESIF programmes							National programmes						
		Total financial appropriation / Total allocation	Proportion under RIS3 / Prediction of support (EUR) 2016–2018 (ERDF)		Share of national co-financing / Funded by national resources		Share of private co-financing / Funded by private resources		Total financial appropriation	Proportion under RIS3		Share of national co-financing		Share of public co-financing	
			% of total allocation	Absolute	% of total allocation	Absolute	% of total allocation	Absolute		% of total allocation	Absolute	As %	Absolute	As %	Absolute
MIT	TRIO								109,629,630	80%	87,703,704	60%	52,622,222	40%	35,081,481
	OP EIC	4,331,062,617	44.99%	1,948,574,545	2.70%	117,132,644	36.93%	1,599,346,030							
MEYS	OP RDE	2,770,000,000	8%	211,481,481	1%	31,722,222	–	–							
Prague	OP PGP	201,600,000	17.3%	34,850,000	6.9%	13,940,000	1.7%	3,485,000							
TA CR	Competence centres								50,264,550	50%	25,132,275	70%	17,592,593	30%	7,539,683
	EPSILON								244,444,444	50%	122,222,222	60%	73,333,333	40%	48,888,889
	GAMA								13,296,296	50%	6,648,148	65%	4,319,346	0%	0

<sup>259</sup>The values of indicative funds for National RIS3 Strategy interventions were converted to EUR at the average exchange rate of CZK 27/EUR 1.

<sup>260</sup> For OP RDE, only the allocation to specific objectives for which the RIS3 is an ex ante conditionality, i.e. PA 1 SO1–SO4 and PA2 SO5, is included.

The ESIF (ERDF/ESF) co-financing rate for OP RDE is not greater than 85% and the remaining 15% or more is funded by national resources, either directly by national budget resources or by the applicant's/beneficiary's own resources. Specific co-financing rates for OP RDE projects differ according to the ESI Fund (ERDF vs. ESF), beneficiary legal form, their activities and region categories (less vs. more developed); in addition, the co-financing rate depends on whether the supported activity is classified as state aid within the meaning of Article 107 of the Treaty on the Functioning of the EU. For more information, refer to the Rules for European Structural and Investment Funds Co-Financing in the Programming Period 2014–2020 (MF document, available at: <http://www.strukturalni-fondy.cz/getmedia/495ea682-77ab-4053-a231-29550d532418/Pravidla-spolufinancovani-evropskych-fondu-v-PO-2014-2020.pdf>).

Private funding for OP RDE cannot be determined/estimated in advance because it depends on the participation of private sector entities in a project. It is impossible to predict in advance how many applicants/partners for projects under relevant calls will be private entities. Moreover, the rate of co-financing by a private applicant/partner depends on whether or not the entity fits the definition of a research and knowledge dissemination organisation according to Communication from the Commission (EU) Framework for State aid for research and development and innovation (2014/C 198/01), as well as on the region category (less vs. more developed), ESI Fund (ERDF vs. ESF) and whether the supported activity is classified as state aid within the meaning of Article 107 of the Treaty on the Functioning of the EU (see the MF document cited above).

**Table 16: Identification of indicative funding and the regional co-financing of National RIS3 Strategy interventions (thousands of EUR<sup>261</sup>)**

Region	ESF				NP				Region		SmAcc				Key activities <sup>262</sup>	
	2016–2018		2019–2020+		2016–2018		2019–2020+		2016–2018	2019–2020+	2016–2018		2019–2020+		2016–2018	2019–2020+
	ESF	Region <sup>263</sup>	ESF	Region	NP	Region	NP	Region			ESF	Region	ESF	Region		
Southern Bohemia									1,785.19	551.85	283.33	116.67	18.89	10.33	SmAcc; STP – Science & Technology Park; Construction and operation of R&D centres – JAIP public services; Education grants – Scholarship incentive programme for secondary-school students in selected vocational training programmes, support for university students, support for collaboration with firms; Activities under the Action Plan for Technical Education Support; Innovation vouchers; Exhibitions and fairs – CERN Exhibition	
Southern Moravia	367,629.63	74,333.33							13,407.41		2,471.48	370.37	611.11	107.41	SmAcc; Project co-financing under OP EIC; Project co-financing under OP RDE; Researcher mobility; Permanent exhibitions and facilities; Exhibitions and fairs; JIC; South Moravian Centre for International Mobility; RDA – regional development agency, other; Other – OPEI, ROP, OP RDI, OP EC, etc. projects; Education grants – PhD students; Education grants – Other; Innovation vouchers; RDI popularisation, promotion and marketing; Project co-financing under other OPs related to RIS3	
Karlovy Vary									533.74	347.41	282.59	50	45.19	8.15	SmAcc; Project co-financing under OP RDE; Education grants; Innovation vouchers; Exhibitions and fairs	
Hradec Králové	3,255.93	3,074.07							133.33		624.07	79.63	94.44	16.67	SmAcc; Project co-financing under OP RDE; Project co-financing under other OPs (related to RIS3); RDA – regional development agency	
Liberec	2,325.93	462.96							221.48		881.48	155.56			SmAcc; Construction and operation of R&D centres; Project co-financing under OP RDE; Education grants; Information service and innovation consulting	
Moravia-Silesia	140.74	25.93							2,155.56		1,514.87	433.33	496.30	88.89	SmAcc; Regional Development Agency; Innovation infrastructure costs; Science and research – custom programmes; Researcher mobility; Enhancement of qualifications – innovation potential; Innovation vouchers; Loans and microloans	
Olomouc	876.67	46.30	585.19	26.63	133.33	934.81	88.89	709.63	1,904.44	1,207.41	1,415.56	249.63			SmAcc; RDA – regional development agency; Personnel costs – management; Project co-financing under OP RDE; Education grants, gifted students – secondary/vocational schools; Human resources; Innovation vouchers	
Pardubice	7,666.67	851.85							2,952.22	787.78	503.70	88.89			SmAcc; RDA – regional development agency; Project co-financing under other OPs (related to RIS3); Cost of acquisition of analytical and strategic documents; Innovation structure costs; Education grants	

<sup>261</sup>The values of indicative funds for National RIS3 Strategy interventions at regional level were converted to EUR at the average exchange rate of CZK 27/EUR 1.

<sup>262</sup> Information on the funding of activities from the programming period of 2007–2013 concern only the sustainability of research and development projects.

<sup>263</sup> The column “Region” includes totals of expected regional co-financing for given operational programmes. Only the amount for OP RDE includes co-financing amounting to 15% of provided subsidies; the co-financing is broken down as follows: 10% from the beneficiary and 5% from the national budget.

Region	ESF				NP				Region		SmAcc				Key activities <sup>255</sup>	
	2016–2018		2019–2020+		2016–2018		2019–2020+				2016–2018		2019–2020+			
	ESF	Region <sup>9</sup>	ESF	Region	NP	Region	NP	Region	2016–2018	2019–2020+	ESF	Region	ESF	Region	2016–2018	2019–2020+
Pilsen									4,857.04	3,103.70	472.22	3.338	629.63	111.11	SmAcc; Building and reinforcing research & development capacities; Costs of specific “soft” projects; Innovation vouchers; RDI popularisation, promotion and marketing; Other RIS3-related regional costs not specified above; Building and reinforcing research & development capacities; Support for innovation businesses and entrepreneurship; RDI popularisation, promotion and marketing	
Prague	17,592.59	21,111.11	10,185.19	12,222.22					362.96						Innovation infrastructure costs; Personnel costs – management; Project co-financing under other OPs (related to RIS3) = OP PGP; Support for innovation businesses and entrepreneurship	
Central Bohemia					59,878.52				11,413.33		2,465.19	93.70			SmAcc; Personnel costs – management; Science and research – custom programmes; Human resources; Education grants; Innovation vouchers; Other RIS3-related regional costs not specified above	
Ústí			2,411.85	127.04					1,977.78	869.26	899.26	158.52			SmAcc; Costs of own (subsidised and other) scientific research institutions; Ústí Region Innovation Centre, membership fee; Cost of acquisition of analytical and strategic documents; Education grants; Innovation vouchers; Exhibitions and fairs	
Vysočina									855.56		197.04	34.81	197.04	34.81	SmAcc; Cost of acquisition of analytical and strategic documents; Personnel costs – management; sustainability of the “Sciences and Engineering Study – A Future Challenge” programme (OP EC); support for the regional cooperation with institutes of the Academy of Sciences of the Czech Republic; systemic support for polytechnic education through incentive scholarships for students in vocational training programmes demanded by businesses on a long-term basis; talent development – Vysočina Talent; Region President’s Award; education grants for secondary-school and university students; Innovation vouchers; conference/workshop to support innovative business activities	
Zlín									980	585.199	810.33	143	34	6	SmAcc; Project co-financing under OP RDE; RDI popularisation, promotion and marketing; Information service and innovation consulting; Services for innovation firms, start-ups; etc.; Support for innovation businesses and entrepreneurship; Education grants	

Source: Regions and OG CR

## 9 Appendices

**Table 17: Employment in industry in selected EU countries (share in pp), 2002–2013**

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Change 2002–13
EU-27	26.1	25.7	25.4	25.2	25.0	25.0	24.8	23.8	23.1	23.0	22.6	22.4	-3.7
EU-15	24.8	24.4	24.0	23.7	23.4	23.3	23.0	22.1	21.5	21.2	20.9	20.6	-4.2
Czech Rep.	38.7	38.2	38.7	38.8	38.3	38.2	38.0	36.6	36.0	36.4	36.5	36.2	-2.5
Germany	27.5	26.9	26.4	25.8	25.5	25.4	25.5	25.0	24.6	24.7	24.7	24.7	-2.8
Hungary	32.3	32.0	31.5	31.0	31.0	31.0	31.0	30.1	29.4	29.7	29.5	28.9	-3.4
Austria	25.4	25.1	24.7	24.4	24.1	24.3	24.3	23.8	23.5	23.4	23.4	23.3	-2.1
Poland	:	:	29.1	29.5	30.2	30.9	31.8	30.9	30.0	30.4	30.2	30.3	1.2
Romania	31.7	30.7	33.2	32.0	32.3	31.5	31.5	29.8	28.8	28.9	28.7	28.8	-2.9
Slovenia	35.7	35.2	34.7	34.6	34.1	34.2	34.2	32.6	31.0	30.6	29.9	29.4	-6.3
Slovakia	33.7	34.2	33.8	33.9	34.0	33.9	34.4	32.6	32.1	32.1	31.6	31.2	-2.5

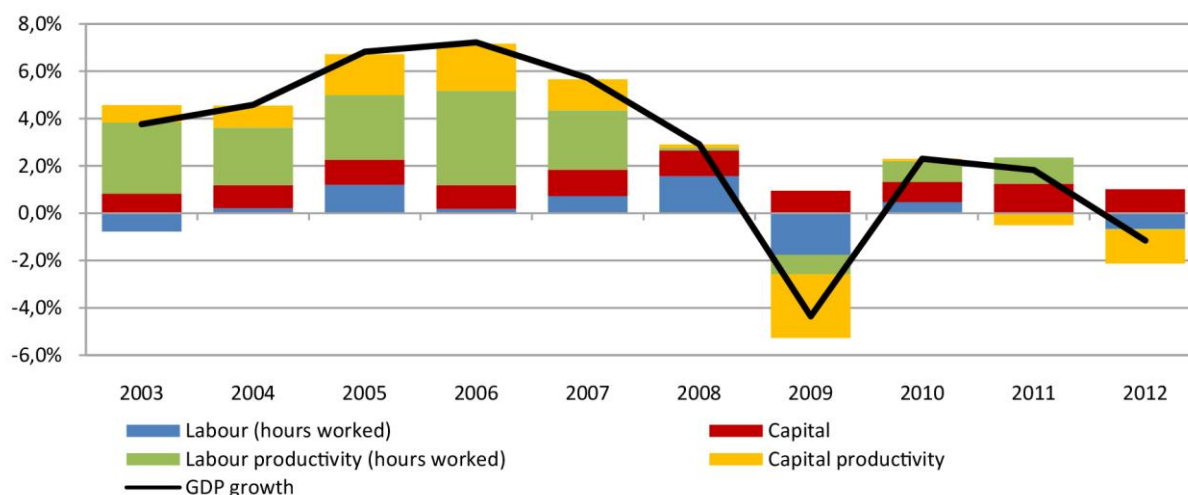
Source: Eurostat (Labour Market – Labour Force Survey)

**Table 98: Newly established firms in the Czech Republic, 2000–2013**

	2000	2002	2004	2006	2008	2009	2010	2011	2012	2013
Newly established firms	102,886	64,084	84,908	84,979	116,367	117,288	120,475	117,652	104,952	99,287
Share in active economic entities	8.8%	5.1%	6.7%	6.8%	8.6%	8.7%	8.6%	8.1%	6.9%	6.7%

Source: CSO – Statistical Yearbook of the Czech Republic

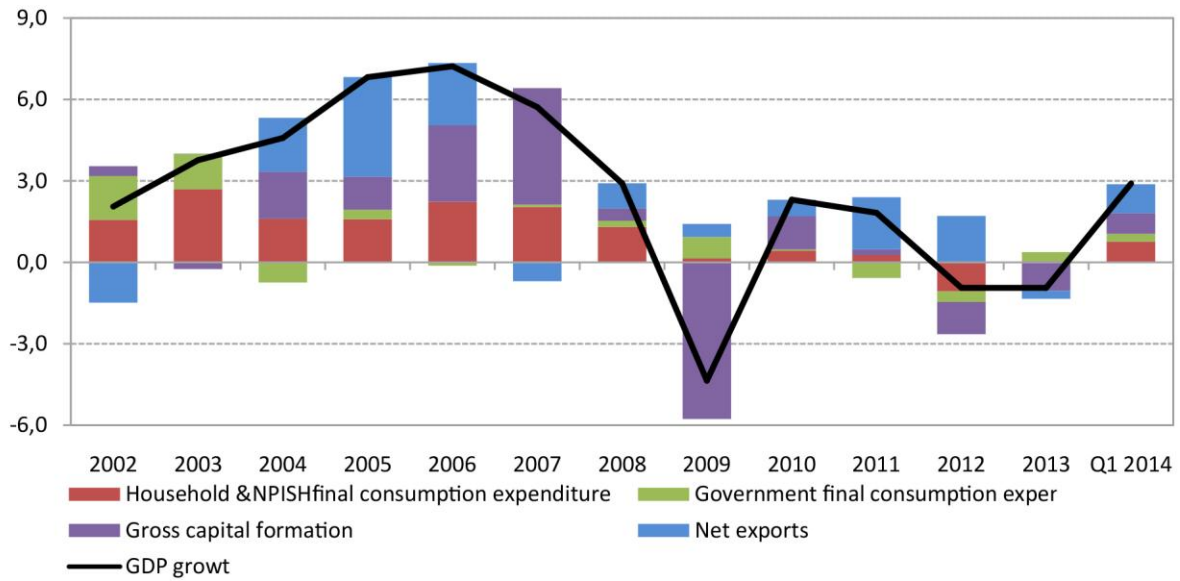
**Chart 6: Contributions of sources of long-term GDP growth in the Czech Republic (constant prices, pp)**



Source: CSO – Tendencies and Factors of Macroeconomic Development and Quality of Life in the Czech Republic in 2012



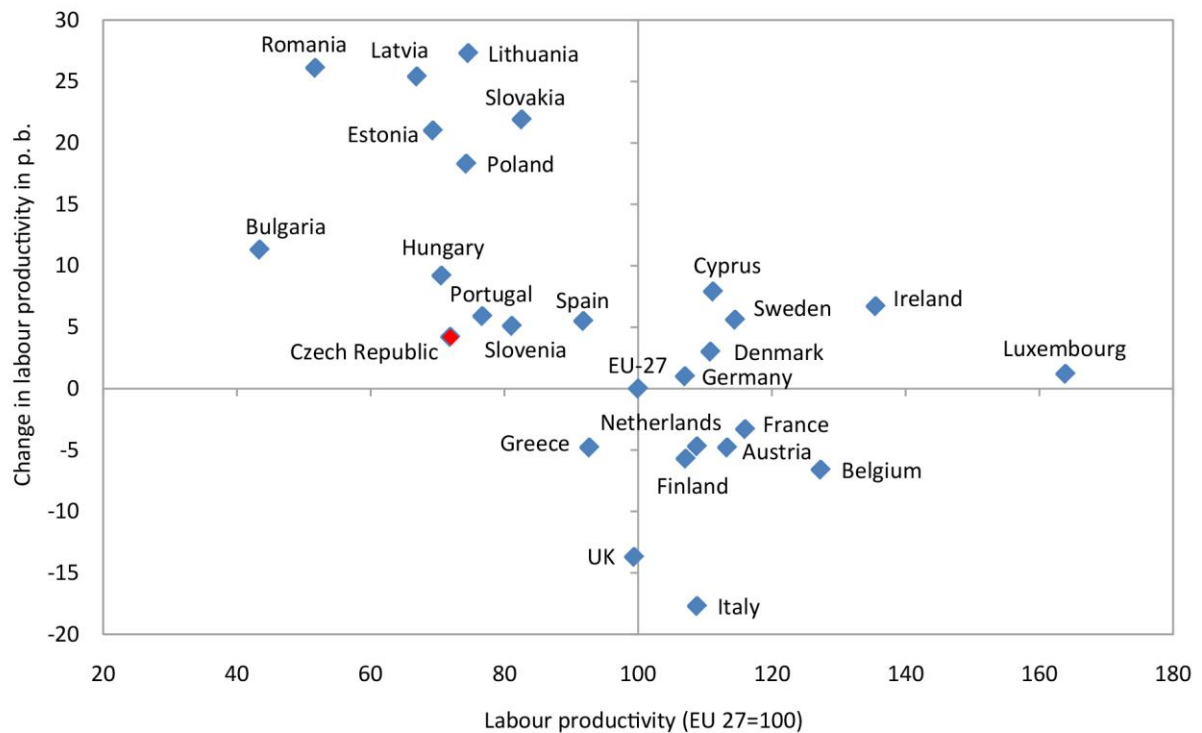
**Chart 7: Contributions to GDP growth on the expenditure side in the Czech Republic, 2002–2013**



Note: NPISH – Non-Profit Institutions Serving Households as used by the CSO

Source: CSO – national accounts (Contributions to GDP – time series of quarterly account indicators)

**Chart 8: Labour productivity per person employed and its change in 2013–2001 (EU-27=100)**



Source: Eurostat – National Accounts



**Table 109: Gross territorial structure of the Czech Republic's external trade (CZK billion)**

	Exports (CZK billion)		Imports (CZK billion)		Balance	
	2012	2013	2012	2013	2012	2013
Total	3,062,779	3,173,543	2,752,018	2,820,403	310,761	353,140
Of which: Developed market economies	2,698,506	2,795,366	1,980,049	2,041,308	718,457	754,059
Of which: EU	2,473,592	2,557,099	1,763,581	1,829,584	710,011	727,515
Other developed market economies	224,914	171,872	216,468	152,476	8,446	19,395
Developing economies	124,703	129,592	212,195	209,870	-87,492	-80,279
Transition economies and CIS	202,108	199,183	237,962	239,983	-35,854	-40,800

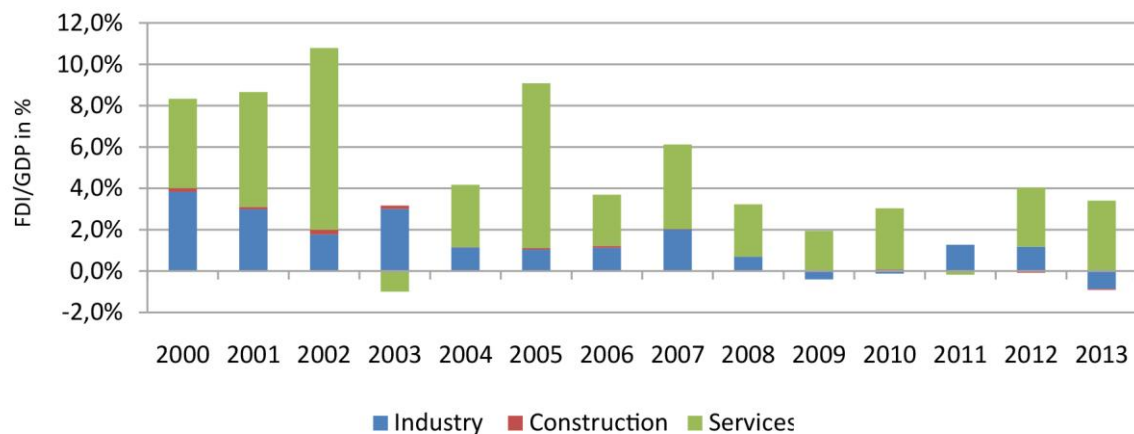
Source: CSO – external trade (cross-border concept)

**Table 11: Main export partners of the Czech Republic, 2006 and 2013**

	2006		2013		Change (pp)
	Exports (CZK million)	Share (pp)	Exports (CZK million)	Share (pp)	
Germany	684,974	31.9	991,075	31.3	-0.7
Slovakia	180,459	8.4	281,945	8.9	0.5
Poland	121,387	5.7	188,732	6.0	0.3
France	118,723	5.5	156,383	4.9	-0.6
United Kingdom	102,599	4.8	152,642	4.8	0.0
Austria	109,503	5.1	143,845	4.5	-0.6
Russian Federation	42,589	2.0	116,213	3.7	1.7
Italy	99,034	4.6	114,183	3.6	-1.0
Netherlands	77,986	3.6	88,619	2.8	-0.8
Hungary	64,176	3.0	82,111	2.6	-0.4
Belgium	61,610	2.9	79,897	2.5	-0.4
United States	49,275	2.3	69,093	2.2	-0.1
Spain	57,799	2.7	67,916	2.1	-0.6
Switzerland	29,585	1.4	49,095	1.5	0.2
Sweden	35,028	1.6	47,327	1.5	-0.1
Turkey	12,287	0.6	43,233	1.4	0.8
Romania	26,112	1.2	39,489	1.2	0.0
EU-27	1,837,052	85.7	2,557,099	80.7	-4.9

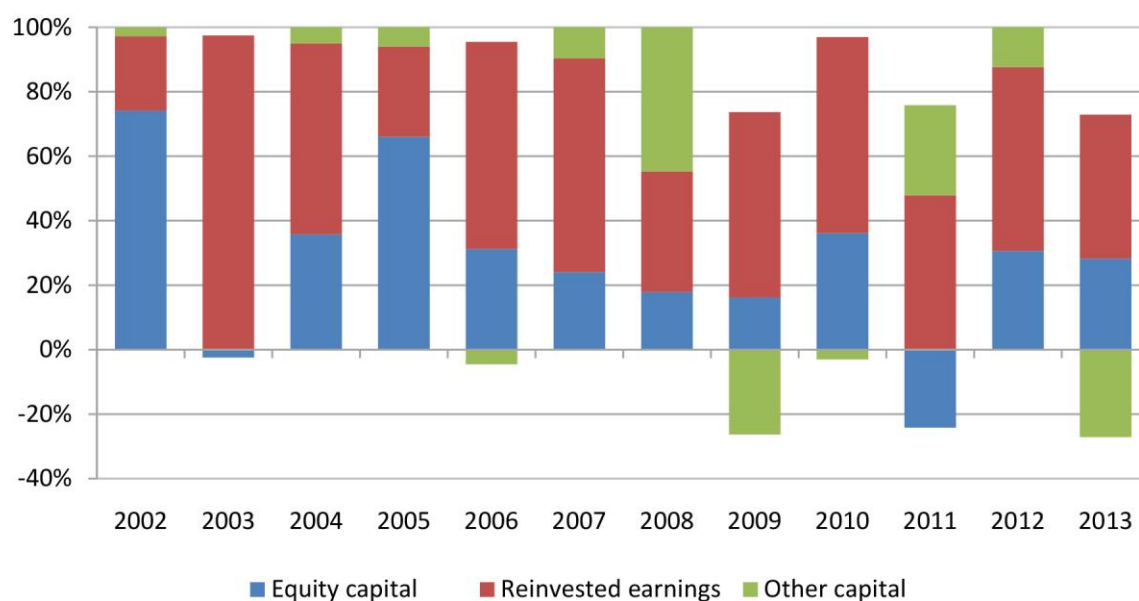
Source: CSO – external trade database (cross-border concept)

**Chart 9: FDI inflows by sector of economy, 2000–2013**



Source: CNB (FDI statistics), CSO – national accounts

**Chart 10: FDI inflow structure by type of capital**



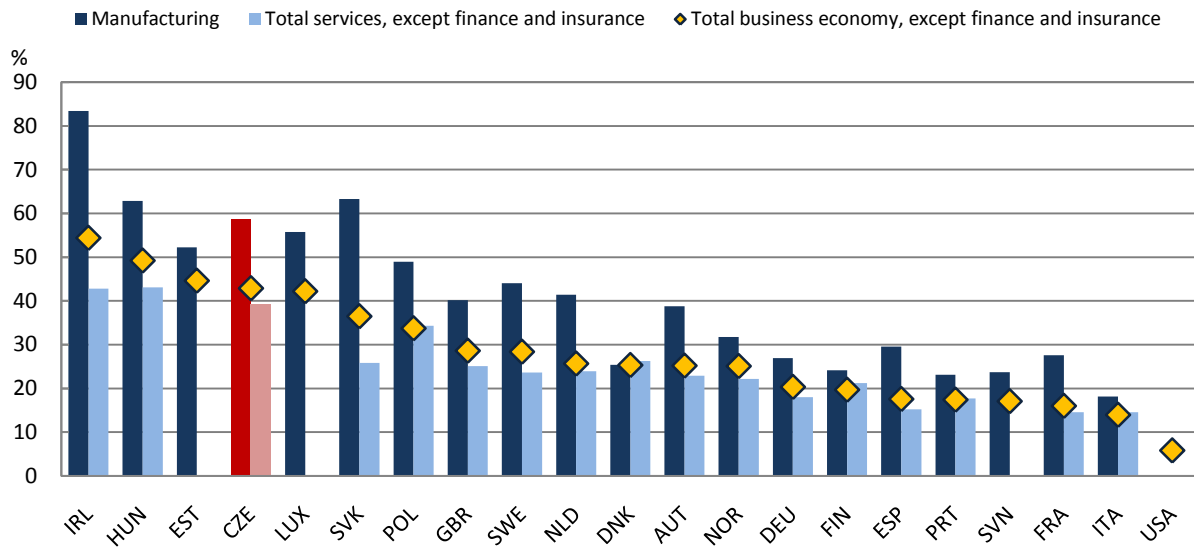
Source: CNB (FDI statistics)

**Table 12: FDI by main country of origin as of 31 December 2012 (CZK billion)**

	Registered capital	Reinvested profit	Other capital	Total	Share (%)
Netherlands	345,556	323,721	84,809	754,086	29.0
Germany	179,092	164,161	22,097	365,350	14.0
Austria	124,468	177,061	33,365	334,895	12.9
Luxembourg	80,805	7,606	71,558	159,969	6.2
France	76,372	75,615	-21,185	130,801	5.0
Switzerland	42,578	66,309	6,172	115,059	4.4
Belgium	28,554	63,453	11,561	103,568	4.0
Cyprus	59,479	38,754	4,134	102,367	3.9
United States of America	32,531	51,018	3,372	86,921	3.3
Spain	55,682	18,838	2,043	76,563	2.9
Slovakia	38,710	14,204	22,167	75,082	2.9
World	1,304,238	1,038,388	258,251	2,600,877	100.0

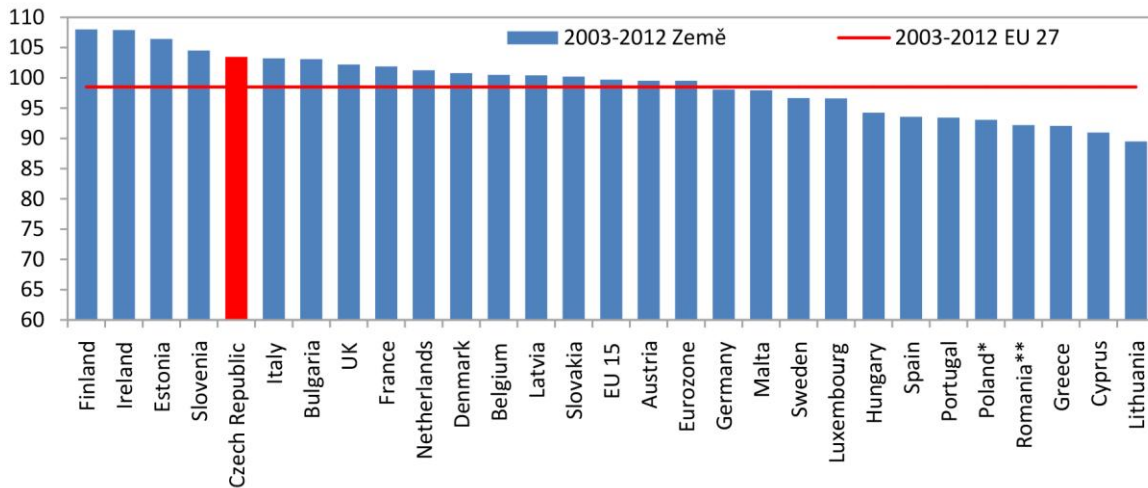
Source: CNB (FDI statistics)

**Chart 11: GVA generation by branches of multinational companies (pp), 2010**



Source: OECD – Science, Technology and Industry Scoreboard 2013

**Chart 12: Changes in real unit labour costs in EU-27 countries, 2003–2012 (year 2003=100)**



Note: Real unit costs compare cost of work (compensation per employee at current prices) and productivity (GDP at current prices per employment). Their growth represents the degree to which labour as a production factor contributes to the value of the output produced.

Source: CSO, Eurostat

## INTERNATIONAL COMPETITIVENESS

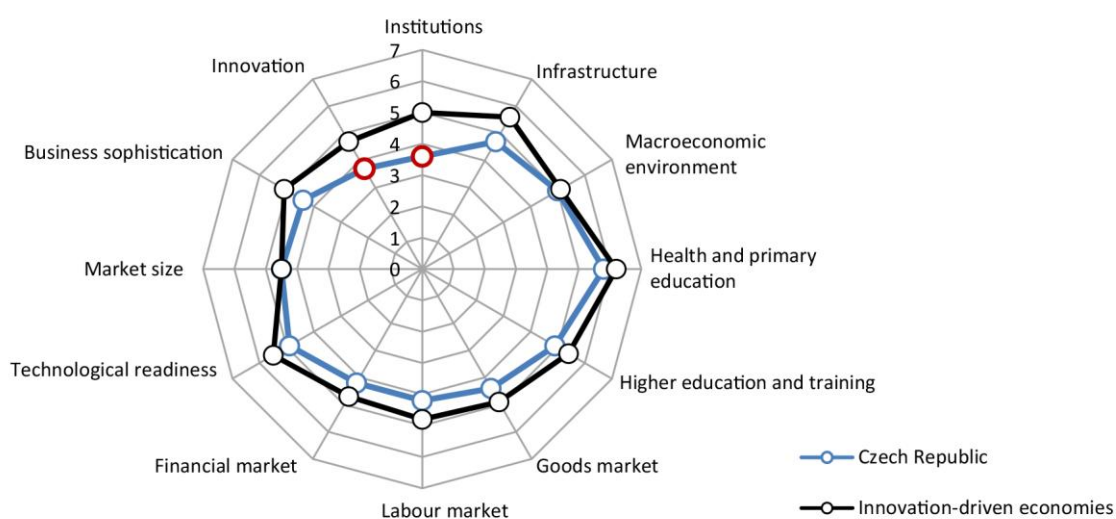
Table 2213: Selected indicators of the Competitiveness Index (WEF), 2009–2013

		2009	2011		2012		2013		Trend
		Rank (value)	Value	Rank	Value	Rank	Value	Rank	
<b>Overall GCI</b>		<b>33 (4.7)</b>	<b>4.5</b>	<b>38</b>	<b>4.5</b>	<b>39</b>	<b>4.4</b>	<b>46</b>	↓
<b>Institutions pillar, total</b>		<b>62 (3.9)</b>	<b>3.6</b>	<b>84</b>	<b>3.7</b>	<b>82</b>	<b>3.6</b>	<b>86</b>	↓
Institutions	Public trust in politicians	115	1.7	134	1.6	139	1.5	146	↓
	Judicial independence	61	3.7	74	3.7	75	3.8	68	↑
	Transparency of government policy-making	103	4	96	4	98	3.8	98	–
	Ethical behaviour of firms	74	3.3	109	3.4	115	3.6	109	↓
<b>Higher education pillar, total</b>		<b>24 (5.1)</b>	<b>5</b>	<b>30</b>	<b>3.8</b>	<b>4.9</b>	<b>4.9</b>	<b>39</b>	↓
Higher education	Quality of the education system	25	4.1	49	3.9	59	3.7	57	↓
	Quality of maths and science education	10	4.1	66	3.8	78	4	83	↓
	Quality of management schools	36	4	82	3.8	95	4	90	↓
No. of days required to start a business		41	20	81	20	86	20	88	↓
Brain drain		44	3.2	79	3.3	82	N/A		↓
Venture capital availability		55	2.4	85	2.4	84	2.6	74	↑
Availability of latest technologies		48	5.6	40	5.5	43	5.2	53	↓
<b>Business sophistication pillar, total</b>		<b>25 (4.8)</b>	<b>4.4</b>	<b>36</b>	<b>4.5</b>	<b>35</b>	<b>4.4</b>	<b>38</b>	–
Business sophistication	Local supplier quality	15	5.4	17	5.4	17	5.3	21	↓
	State of cluster development	34	3.9	47	4	50	4.1	45	↑
	Nature of competitive advantage	35	3.9	38	4.1	36	4.1	38	–
	Value chain breadth	21	4.3	30	4.5	25	4.6	24	↑
	Control of international distribution	91	3.6	111	3.6	112	3.5	120	↓
<b>Innovation pillar, total</b>		<b>25 (4.0)</b>	<b>3.8</b>	<b>33</b>	<b>3.8</b>	<b>34</b>	<b>3.7</b>	<b>37</b>	↓
Innovation	Quality of scientific research institutions	19	4.8	26	4.9	26	4.9	26	–
	Company spending on R&D	25	3.9	28	3.9	28	3.8	32	↓
	University-industry collaboration in R&D	26	4.5	30	4.5	28	4.4	35	–
	Government procurement of advanced technology products	23	3.5	81	2.9	122	2.8	124	↓
	Availability of scientists and engineers	24	4.5	42	4.5	43	4.2	64	↓

Note: The assessment involved 133 countries in 2009, 142 countries in 2011, 144 countries in 2012 and 148 countries in 2013; factors are assessed on a scale of 1 (the worst) to 7.

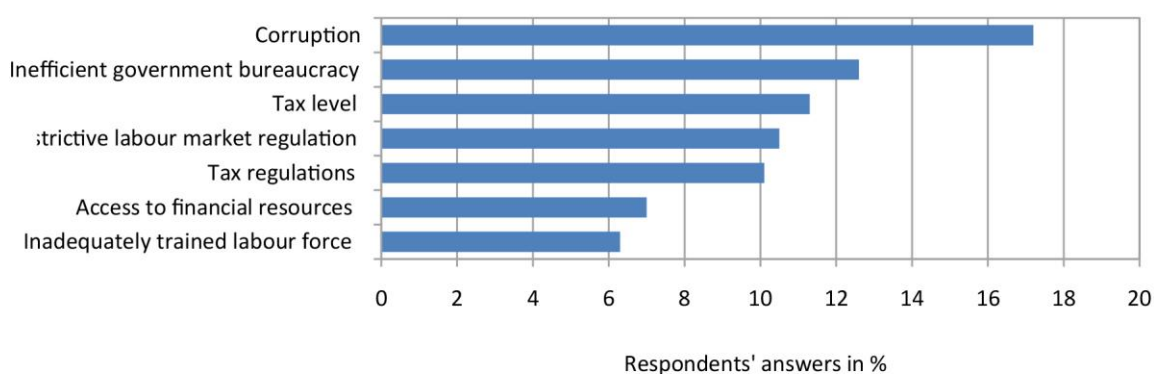
Source: World Economic Forum (Global Competitiveness Reports 2009–2013)

**Chart 13: Global Competitiveness Index (GCI) and its pillars, 2013–2014**



Source: WEF – Global Competitiveness Report 2013–2014

**Chart 14: Main barriers to doing business in the Czech Republic according to the Global Competitiveness Report 2013**



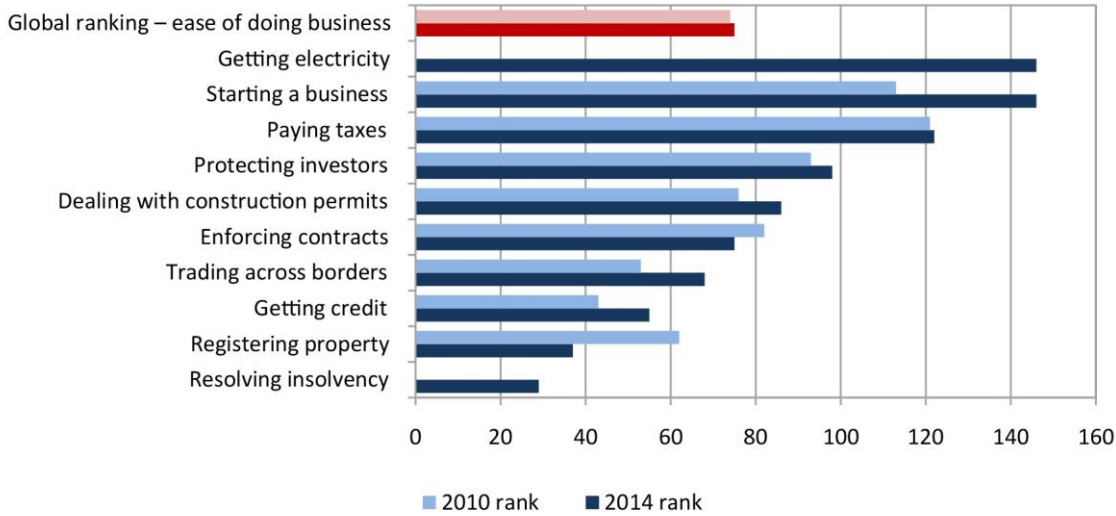
Source: WEF – Global Competitiveness Report 2013

**Table 23: GCI – Values and rankings within the Institutions pillar of the Czech Republic and surrounding countries, 2006–2013**

Country	Rank 2006	Value 2006	Rank 2013–14	Value 2013	Rank change	Index change
Czech Rep.	60	3.84	86	3.6	26	-0.24
Romania	87	3.4	114	3.3	27	-0.1
Hungary	46	4.18	84	3.7	38	-0.48
Slovakia	53	4.03	119	3.3	66	-0.73
Poland	73	3.62	62	4	-11	0.38
Slovenia	43	4.27	68	3.9	25	-0.37
Austria	13	5.45	21	5.1	8	-0.35
Germany	7	5.69	15	5.3	8	-0.39

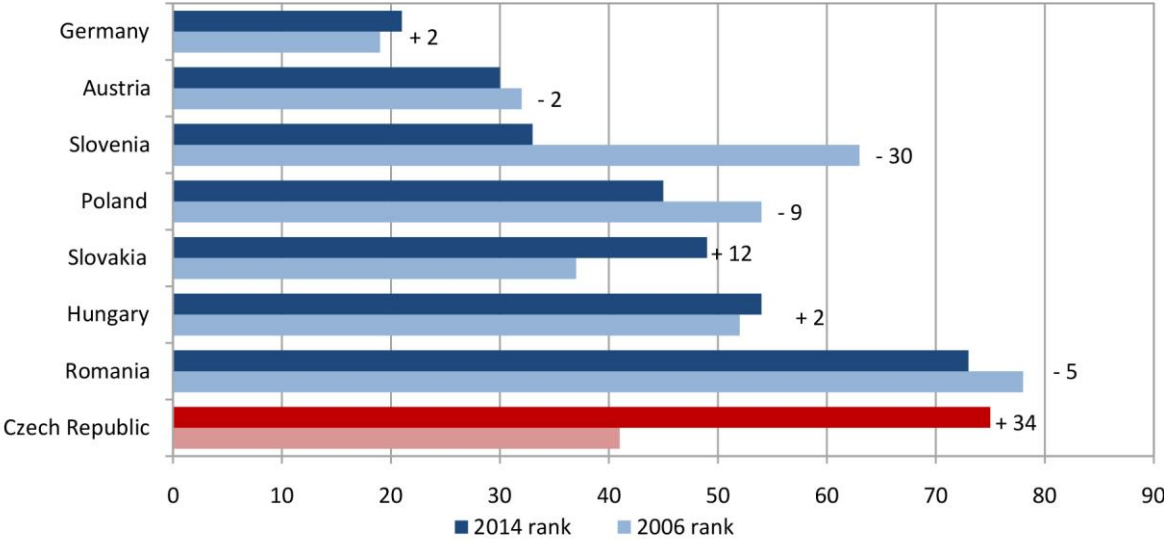
Source: WEF – Global Competitiveness Report 2006 and 2013

**Chart 15: Czech Republic's position in the Doing Business rankings and topics, 2010–2014 change**



Source: Doing Business 2014 (2010) – World Bank

**Chart 16: Summary Easy of Doing Business Rank for the Czech Republic and surrounding states, 2006 and 2014**



Source: Doing Business 2014 – World Bank

**Table 24: NACE divisions by share in exports and business expenditure on R&D 2010–2012**

<b>NACE</b>	<b>NACE – Description</b>	<b>Share in the Czech Republic's exports 2010–12</b>	<b>Share in non-investment R&amp;D expenditure in the Czech Republic</b>
29	Manufacture of motor vehicles	17.10%	30.62%
26	Manufacture of computer, electronic and optical products	15.88%	2.97%
28	Manufacture of machinery and equipment	11.33%	6.83%
27	Manufacture of electrical equipment	11.23%	3.73%
32	Other manufacturing	5.59%	0.80%
25	Manufacture of fabricated metal products	5.28%	1.58%
24	Manufacture of basic metals; casting of metals	4.59%	0.74%
20	Manufacture of chemicals and chemical products	4.36%	2.00%
22	Manufacture of rubber and plastic products	3.29%	1.68%
23	Manufacture of other non-metallic mineral products	2.10%	0.93%
1	Crop and animal production	2.04%	0.27%
13	Manufacture of textiles	1.86%	0.56%
35	Electricity, gas, steam and air conditioning supply	1.85%	0.06%
31	Manufacture of furniture	1.65%	0.10%
10	Manufacture of food products	1.63%	0.48%
17	Manufacture of paper and paper products	1.49%	0.03%
21	Manufacture of pharmaceutical products and preparations	1.15%	2.35%
38	Waste collection, treatment and disposal activities	1.11%	0.09%
19	Manufacture of coke and refined petroleum products	1.03%	0.03%
30	Manufacture of other transport equipment	0.95%	5.29%
14	Manufacture of wearing apparel	0.92%	0.16%
5	Mining of coal and lignite	0.91%	0.00%
16	Manufacture of wood and of products of wood and cork	0.66%	0.02%
2	Forestry and logging	0.65%	0.02%
15	Manufacture of leather and related products	0.48%	0.05%
11	Manufacture of beverages	0.32%	0.01%
12	Manufacture of tobacco products	0.31%	0.00%
8	Other mining and quarrying	0.14%	0.04%
3	Fishing and aquaculture	0.08%	0.02%

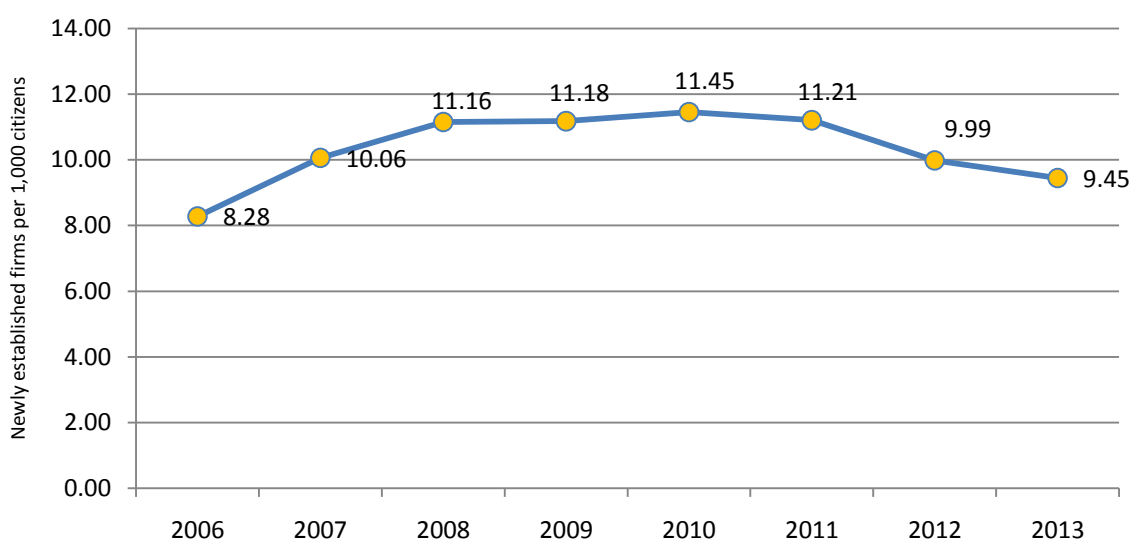
Source: Authors' calculations based on CSO (Research and Development) and UN COMTRADE data

## 9.1 Appendices to the vision

### Trends in baseline values for vision measurement

**Czech Republic will be a country with an increasing intensity of business activities per 1,000 citizens**

**Chart 17: Number of newly established firms per 1,000 citizens, 2006–2013**



Source: CSO, Organisation statistics

**Czech Republic will be a country with an increasing share of young people up to 35 years of age doing business for a living**

**Table 25: Share of entrepreneurs up to 35 years of age, 2012–2013**

	Self-employed (thousands)		Economically active (thousands)		% of self-employed	
	2012	2013	2012	2013	2012	2013
From 15 to 24 years of age	28.7	23.2	368.9	355.8	7.8	6.5
From 25 to 29 years of age	57.4	53.8	555.9	560.8	10.3	9.6
From 30 to 34 years of age	94.4	82.2	659.0	635.4	14.3	12.9
<b>15–34 years of age, total</b>	<b>180.5</b>	<b>159.2</b>	<b>1,583.8</b>	<b>1,552.0</b>	<b>11.4</b>	<b>10.3</b>

Source: Eurostat, LFS

**Czech Republic will be a country with an increasing share of newly established and surviving firms**

**Table 26: Share of newly established firms in the total number of active entities, 2000–2013**

	2000	2002	2004	2006	2008	2009	2010	2011	2012	2013
Newly established firms	102,886	64,084	84,908	84,979	116,367	117,288	120,475	117,652	104,952	99,287
% of all active economic entities	8.8%	5.1%	6.7%	6.8%	8.6%	8.7%	8.6%	8.1%	6.9%	6.7%

Source: CSO, Organisation statistics



Czech Republic will have an increasing number of firms doing business in cultural, creative and similar sectors (including, e.g., industrial design)

Table 27: Accounts of cultural and creative industry in 2010

SECTOR	AREA	TOTAL INCOME (REVENUES)	TOTAL EXPENDITURE (COSTS)	COLUMN 1 LESS COLUMN 2	CONSUMPTION of materials, energies, goods and services	GROSS VALUE ADDED	EMPLOYEES (FTE) thousands	INVESTMENT EXPENDITURE	EXPORTS OF GOODS AND SERVICES	IMPORTS	NUMBER OF LEGAL AND NATURAL PERSONS	NACE
a	b	1	2	3	4	5	6	7	8	9	10	
CULTURAL SECTOR	Historic monument	2,110,236	2,115,133	-4,897	920,148	1,190,088	1,888	740,371	31,479	36,041	288	91.03
	Museum and gallery	4,368,396	4,493,921	-125,525	1,719,140	2,649,256	6,100	1,629,410	108,771	203,940	478	91.02
	Libraries and archives	3,631,299	4,008,450	-377,151	1,338,180	2,293,119	6,888	449,463	-	-	5,446	91.01
	Performing arts	12,449,528	12,171,083	278,445	5,939,838	6,509,690	15,035	383,758	61,172	187,889	746	90.01, 02, 04
	Graphic arts	4,768,214	3,961,066	807,148	2,378,458	2,389,756	1,778	236,470	28,381	31,053	6,031	74.20, 90.03
	Cultural and arts education	989,266	820,012	169,254	478,524	510,742	735	31,052	-	-	1,288	85.52
	Crafts	-	-	-	-	-	-	-	-	5,551,545	2,108,429	-
	<b>Sector total</b>	<b>28,316,939</b>	<b>27,569,665</b>	<b>747,274</b>	<b>12,774,288</b>	<b>15,542,651</b>	<b>32,424</b>	<b>3,470,524</b>	<b>5,781,348</b>	<b>2,567,352</b>	<b>14,277</b>	<b>2,227,702</b>
CULTURAL INDUSTRIES	Film and video	13,239,930	12,569,145	670,785	10,124,600	3,115,330	1,728	807,534	6,356,763	4,762,862	1,155	59.11, 12, 13, 14
	Music	2,006,431	1,708,638	297,793	1,400,590	605,841	342	103,798	9,770	101,620	3,272	59.20
	Television	20,262,248	19,083,431	1,178,817	9,495,408	10,766,840	4,520	1,839,877	109,900	707,769	128	60.20
	Radio	3,368,623	3,113,618	255,005	1,708,033	1,660,590	1,639	188,558	1,751	4,649	61	60.10
	Books and printing	47,218,459	43,576,674	3,641,785	22,351,008	24,867,451	16,528	1,395,578	6,410,257	4,509,631	35,724	58.11, 13, 14, 63.91, 74.30, 47.61, 62
	Video games	1,761,347	1,710,665	50,682	467,164	1,294,183	1,375	45,000	-	-	22	58.21
	<b>Sector total</b>	<b>87,857,038</b>	<b>81,762,171</b>	<b>6,094,867</b>	<b>45,546,803</b>	<b>42,310,235</b>	<b>26,132</b>	<b>4,380,345</b>	<b>12,888,441</b>	<b>10,086,531</b>	<b>40,362</b>	<b>36</b>
CREATIVE INDUSTRIES	Architecture	26,992,029	24,470,579	2,521,450	17,824,762	9,167,267	8,792	1,525,591	318,200	59,444	695	71.11
	Advertising	70,231,516	66,905,432	3,326,084	50,676,196	19,555,320	13,333	2,687,785	12,122,622	8,450,020	1,242	73.11
	Design	2,343,689	1,929,421	414,268	1,318,012	1,025,677	637	254,148	363,958	1,857,434	475	74.10
	<b>Sector total</b>	<b>99,567,234</b>	<b>93,305,432</b>	<b>6,261,802</b>	<b>69,818,970</b>	<b>29,748,264</b>	<b>22,762</b>	<b>4,467,524</b>	<b>12,804,780</b>	<b>10,366,898</b>	<b>2,412</b>	<b>36</b>
	Unknown area	13,368,426	17,178,560	-3,810,134	2,907,881	11,037,765	5,700	1,429,844	-	-	6,209	47.63, 78, 79, 77.22, 84.11, 94.99.2
	<b>CULTURE TOTAL</b>	<b>229,109,637</b>	<b>219,815,828</b>	<b>9,293,809</b>	<b>131,047,942</b>	<b>98,638,915</b>	<b>87,018</b>	<b>13,748,237</b>	<b>31,474,569</b>	<b>23,020,781</b>	<b>63,260</b>	

Source: Žáková E., Cikánek M. (2012): Problémová analýza kulturních a kreativních průmyslů (KKP) v kontextu politiky soudržnosti EU 2014+

<http://www.idu.cz/media/document/problemova-analyza-kulturnich-a-kreativnich-prumyslu.pdf>

**The Czech Republic will be a country with an increasing trend in the technology balance of payments – foreign trade in advanced technological services**

**Table 168: Technology balance of payments, services (CZK million), 2011–2012**

	Exports		Imports		Balance	
	2011	2012 <sup>1</sup>	2011	2012 <sup>1</sup>	2011	2012 <sup>1</sup>
<b>Total</b>	<b>52,385</b>	<b>60,396</b>	<b>55,525</b>	<b>63,278</b>	<b>-3,140</b>	<b>-2,882</b>
Computer equipment services	27,343	33,907	19,278	19,902	8,065	14,005
Technical services	16,662	18,120	10,686	15,341	5,976	2,779
Research and development	3,188	3,986	7,043	9,205	-3,855	-5,220
Licence fees	1,591	3,426	15,905	14,679	-14,315	-11,252
Sale of ownership rights	3,602	958	2,614	4,152	989	-3,194

Source: CSO, Science, research, innovations

Note: 1) Preliminary data

**Table 179: Technology balance of payments, % of total income from exports of services, 2011–2012**

	Exports		Imports		Balance	
	2011	2012 <sup>1</sup>	2011	2012 <sup>1</sup>	2011	2012 <sup>1</sup>
<b>Total</b>	<b>19.1%</b>	<b>20.5%</b>	<b>20.5%</b>	<b>21.2%</b>	<b>-1.4%</b>	<b>-0.7%</b>
Computer equipment services	10.0%	11.5%	7.1%	6.7%	2.9%	4.8%
Technical services	6.1%	6.2%	3.9%	5.1%	2.1%	1.0%
Research and development	1.2%	1.4%	2.6%	3.1%	-1.4%	-1.7%
Licence fees	0.6%	1.2%	5.9%	4.9%	-5.3%	-3.8%
Ownership rights	1.3%	0.3%	1.0%	1.4%	0.3%	-1.1%

Source: CSO, Science, research, innovations

Note: 1) Preliminary data

**The Czech Republic will create and offer a friendly working environment, i.e., a creative ecosystem for enterprise (at all levels)**

**Table 30: Ease of doing business**

Indicator	Rank 2014
Resolving insolvency	29
Registering a business	37
Availability of financing	55
Foreign trade	68
Enforceability of contracts	75
Obtaining building permits	86
Investment protection	98
Paying taxes	122
Setting up a business	146
Getting electricity	146
<b>Total ease of doing business index</b>	<b>75</b>

Source: World Bank – Doing Business

**The Czech Republic will have a positive “talent balance” – BRAIN GAIN**

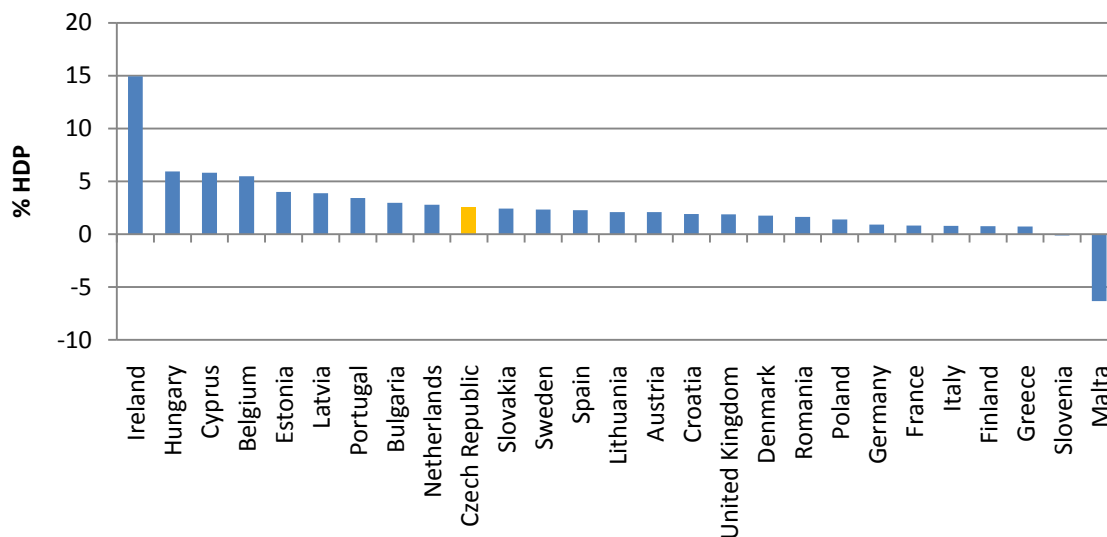
**Table 181: Capacity to retain and attract talent**

Global Competitiveness index		2014–2015		2013–2014	
		Value	Rank	Value	Rank
<b>7th pillar: Labour market efficiency</b>					
7.08	Country capacity to retain talent	3.3	80	2.8	109
7.09	Country capacity to attract talent	3.1	93	3.2	87

Source: World Economic Forum – Global Competitiveness Report

**The Czech Republic will be among the top 10 EU countries with the highest inflow of foreign direct investments relative to GDP**

**Chart 18: FDI relative to GDP, average for 2011–2013**



Source: Eurostat, Auxiliary indicators (tipsax)

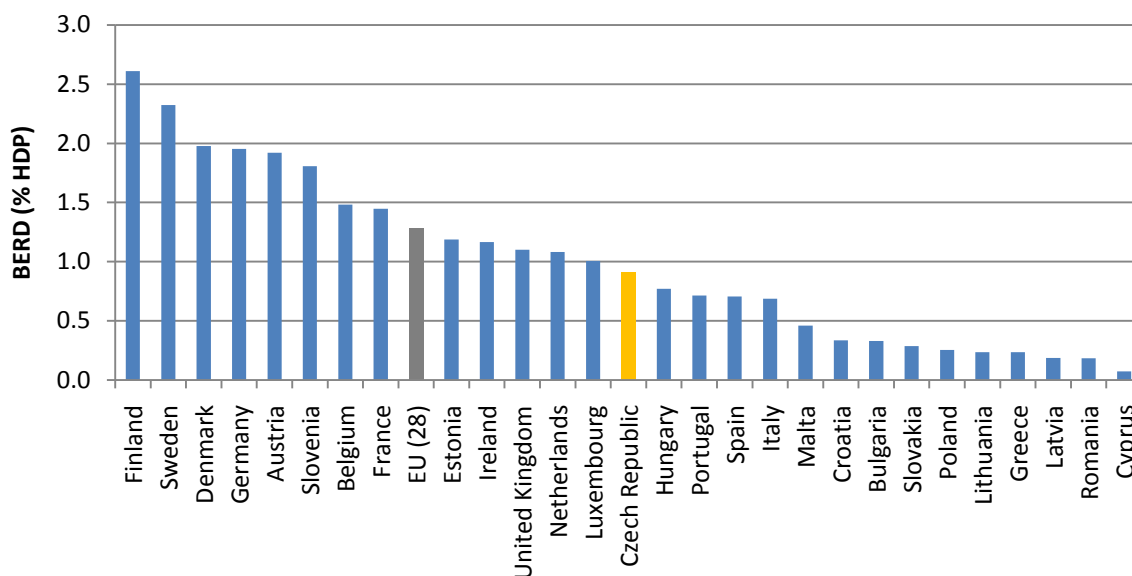
Note: Due to its high proportion, Luxembourg is not shown in the chart (688% of GDP)

The Czech Republic ranks 11th.

Calculated using a 3-year average to eliminate random fluctuations

**The Czech Republic will be among the top 10 EU countries with the highest private expenditure on science and research relative to GDP**

**Chart 19: BERD relative to GDP, average for 2010–2012**



Source: Eurostat, Statistics on research and development

Note: The Czech Republic ranks 14th.

Calculated using a 3-year average to eliminate random fluctuations

## 9.2 Research and development and innovation priorities identified through the EDP within National Innovation Platforms

This appendix includes detailed EDP outputs collected within National Innovation Platforms that were used to prepare the NRIS3 text in section 7.1.

### 9.2.1 Advanced machinery/technology for strong and globally competitive industry; outputs of National Innovation Platform I “Mechanical Engineering, Energy Industry and Metallurgy”

#### 9.2.1.1 Mechanical engineering – mechatronics

A/ R&D&I topics identified through the EDP:

- **The global sector strategy for machine tools (MT) and precision engineering (PE) involves:**
  - Increasing precision – especially increasing geometric and dimensional precision in both small and large dimensions of parts, components, machines and methods.
  - Increasing quality – especially increasing the quality of surfaces, purposefully positively affecting surface integrity characteristics.
  - Increasing manufacturing performance – increasing the short-term and long-term manufacturing performance of machinery and equipment as well as the performance characteristics of parts and components.
  - Increasing reliability – increasing the reliability of products, functions and processes.
  - Increasing economy – minimising the unit costs of products, minimising running costs, costs of operation and minimising product acquisition costs.
  - Reducing negative environmental impacts – minimising the negative environmental impacts of products throughout their life cycle.

Listed below are promising areas and directions of research and development and innovation that should be supported by the national budget and the EU through targeted subsidies for research and development and innovation at the level of institutional and special-purpose aid. The promising areas and topics the implementation of which helps to fulfil the sector’s strategy and main R&D&I objectives are as follows:

- **Product optimisation**
  - R&D of industrially applicable methods, techniques (especially design, computation and optimisation techniques), procedures and especially software for designing optimum machinery, equipment, instruments, components, systems, products, machine cells, production systems and industrial plants (products) and optimising their usage.
  - Development of tools and methods that allow maintaining or improving end-use properties of products while minimising the cost of development, manufacture and use and minimising risks for the manufacturer, user and surroundings.

- Tools that allow optimising one or more parameters at once and allow multi-physical optimisation (e.g., simultaneous optimisation of temperature and frequency properties).
  - Creation of tools and methods, especially SW, that support a quick development process and minimise risks when developing products and designing technology for their manufacture, processing, assembly and subsequent use.
  - R&D of new methods and SW to make full use of the potential of new additive technologies and new materials, especially with the application of bionics principles and bio-inspired approaches in mechanical engineering.
  - R&D of methods for optimum product design and operation/use with respect to safety and interaction with the operator and surroundings.
  - R&D of mathematical models that form the basis of optimisation tasks and can be used for product development or utilised during product operation as virtual images of real products (cyber-physical systems) and can enable enhanced/optimum product use.
- **New product conceptions and designs**
    - R&D of new conceptual, structural, constructional and executional forms of machinery, equipment, component, systems, software and products that eliminate shortcomings and extend the frontiers in achieved precision, quality, performance, reliability and economy, offering the customer better parameters in key end-use properties.
    - Seeking completely new forms, principles, styles and shapes of engineering products that allow improving end-use properties demanded by users.
    - R&D solutions allowing efficient use of products over a wide range of working conditions (temperature, performance, dimension, etc.).
    - R&D application of new materials, actuators, sensors, instrumentation and control techniques and other advanced outcomes to KETs and input industries (affecting specifically oriented engineering production) for application in engineering products.
    - R&D adaptation of existing production to Industry 4.0 in terms of multifunctionality and adaptability of products.
    - R&D of new conceptual, structural, constructional and executional forms of products with respect to safety, interaction with the operator, interaction with the surroundings and with respect to legal and formal requirements.
    - R&D in advanced robotics, advanced and unconventional use of robots, cybernetics, agent systems, emergent behaviour, cyber-physical form of engineering products, self-learning systems and human-machine interaction systems.
    - R&D of new and enhanced technology and equipment for efficient and advanced energy production, energy distribution and storage and integrated energy solutions.
    - Bionics and bio-inspired approaches in mechanical engineering.

- **New and progressive technologies**

- R&D of enhanced and new technological processes, principles and process parameters for machining that will enable processing previously hard-to-machine materials that allow increasing production performance and process reliability and achieving higher-precision production with better surface integrity while preserving production cost effectiveness (e.g., solutions in micro-machining, machining of hard-to-machine and rare materials).
- R&D of enhanced and new technological processes, principles and process parameters for forming, including injection moulding, that will enable processing previously hard-to-form materials that allow increasing production performance and process reliability and achieving higher-precision production with better surface integrity while preserving production cost effectiveness (e.g., solutions for precision forming, forming of new and non-standard materials, laser sintering).
- R&D of enhanced and new technological processes, principles and process parameters for additive manufacturing, including hybrid manufacturing, that will enable processing previously unprocessed materials that will allow increasing the reliability of material properties of such manufactured parts and increasing production performance, precision and surface quality. Solutions for increasing the productivity and reducing the costs of AM and HM technology.
- R&D of software, simulation and modelling techniques and procedures for modelling technological processes to be used for virtual debugging, for obtaining boundary conditions for technology and machinery design and to implement cyber-physical technological processes where a virtual process in the background can be used as a source of control feedback for technology, machinery or a higher unit.
- R&D of advanced software and software modules (e.g. post-processors) for efficient and productive technological use of modern, complex, comprehensive and multifunctional machines and products that are impossible to use efficiently without advanced SW support. R&D of software for the preparation of technology and the monitoring, diagnostics and evaluation of process parameters, performance and reliability of technological processes.
- R&D of methods, procedures, equipment and products for tracking, monitoring and measuring technological processes. Improving technologies, methods, data processing and equipment for post-process and in-process control of manufacture and implementation of feedback in production technology.

- **Virtualisation of products and technologies**

- R&D of verified and industrially applicable techniques and tools for virtual production design, virtual product design, virtual technological processing, virtual measurement and diagnostics.
- R&D of methods for as well as specific models of parts, components, systems, machinery and equipment fit for the design stage when a product is developed and virtual testing of its properties is needed (e.g., virtual machining, injection moulding,

forming, hydraulic system operation, ventilation, cooling, transmission operation, etc., but also prediction of physical properties such as conductivity, thermal insulation, electric insulation, thermal resistance, thermal stability, magnetic properties, hardness, vibration resistance, etc.). Such models need to be developed with the aim of possible application to optimisation processes.

- R&D of suitable methods and models for the construction of virtual products that “run” in the background in parallel with the use of the actual product and allow making cyber-physical products under the Industry 4.0 concept, where we use both real and virtual data and inputs for feedback, measurements, diagnostics, etc.

- **Components, system and management**

- R&D of components, principles, systems and algorithms for product measurement and management during product manufacture and use, and design of techniques for active feedback affecting product properties, behaviour, shape, position, temperature, etc.
- Design of new techniques for the measurement, control and compensation of position, static and dynamic stiffness and, generally, deformation and shift over time due to a technological process and the surroundings.
- R&D of systems for enhancing precision and reliability and decreasing energy intensity, reducing environmental load and decreasing parasitic vibration and deformation.
- R&D of artificial intelligence technology and self-learning methods applicable to mechanical engineering, which will allow enhancing the end-use properties and individualisation of products.
- Development of innovated and new actuating devices (actuators, drives, valves, etc.) with advanced diagnostic and feedback control capabilities.
- Broadening the range of effectiveness and usability of components, structural elements, groups, nodes, sensors, adjustment methods and control systems (e.g., broader frequency, temperature, rpm, torque, power, force, etc. ranges).

- **SW features and digitisation**

- R&D of hardware but especially software technology and applications that extend and increase the added value of mechanical engineering products for the user and allow specific product customisation with minimum physical interventions in the product.
- Expanding the functionality of control systems, improving interaction with the operator, enhancing communication with higher-level systems, advanced analysis of measured and monitored data of products and processes.
- R&D of techniques for secure data transmission with low HW requirements in engineering products (network security in industrial processes, advanced and secure

communication [radio, wireless, microwaves, remote control and data transmission]).

- R&D of techniques for the implementation of the digital production concept (modelling, simulation, visualisation, process automation and control, analysis of big data for production), embedded intelligence for operation productivity enhancement.
- Development of HW and SW means for wider application of the Industry 4.0 concept wherever practical and effective.

- **Improvement of known materials**

- R&D of the detailed properties of and processing technologies for existing (known) metallic and non-metallic (especially plastic and composite) materials used in mechanical engineering with the aim of increasing efficiency and performance in their processing (machining, forming, injection moulding, deposition, 3D printing).
- R&D of methods and analyses to support optimum processing (technological, chemical and heat treatment) with the aim of affecting the internal stress, surface integrity, hardness, material structure and possibly other micro- and macro-properties of parts in a controlled manner.
- Research into material processing and modifications for specific applications, purposes and new and progressive industries (injection moulding, AM, modern medicine, aviation, energy industry, automotive industry, etc.).
- R&D of properties and process optimisation for joining, connecting materials and joining technology (glueing, bonding, soldering, welding, etc.).
- R&D of techniques for the simulation and modelling of material properties and their changes during the manufacturing process, preparation of data for higher-level technology and part optimisation.

- **New materials**

- R&D of new or innovated metallic and non-metallic (especially plastic and composite) materials and material structures (hybrid materials) with improved anti-wear properties, minimised friction in combination with conventional materials, reduced weight, increased specific modulus, specific strength and other specific quantities in relation to cost and price aspects for key engineering applications (machining, forming, injection moulding, deposition, 3D printing).
- R&D of new materials for specific and new application fields (aviation, energy industry, medicine, electronics, extreme resistance to heat and acids, etc.).
- R&D of new materials for joining (e.g. high temperature resistant joints).
- R&D of materials and structures with increased internal damping and more efficient external damping of structural and local vibration. Controlled increase in structural damping using new materials or additional materials.



- R&D of new techniques, approaches and applications for environmental technology and engineering, in particular in the treatment of process materials (water and waste management) and in the reuse (recycling) of materials. R&D in materials and technologies for additive and environmentally friendly manufacturing, integration of conventional (subtractive) and additive technologies.
- **Broader use of composite materials**
  - R&D of cheaper fibre- and particle-reinforced composites with properties approximating those of top-level fibre-reinforced composites.
  - R&D of methods for maximally effective (optimal in terms of costs and properties) utilisation of top-level fibre- and particle-reinforced composites in mechanical engineering.
  - R&D of techniques for joining composites with one another and composites and other materials (e.g. laser welding of composites and plastics, laser surface treatment for the application of adhesives and binders, etc.).
  - R&D of SW tools to support design engineers designing parts of composites with anisotropic properties.
- **Materials for additive technologies**
  - R&D of materials, material forms (powders, wires, pellets, etc.) and process parameters for processing using additive technologies (both thermal fusion processes and low-temperature kinetic deposition) and hybrid technologies.
  - R&D of relations between process parameters, chemical composition of materials, material form, technology used, process boundary conditions and resulting properties of materials processed using AM and HM methods.
  - R&D of technologies and process parameters for efficient joining (welding, soldering, glueing, etc.) and surface treatment of parts manufactured using additive methods (AM and HM).
  - R&D of techniques for local surface treatment and modification.
- **Surface improvement**
  - R&D of advanced finishing and surface modification of parts and components with focus on improving their end-use properties.
  - R&D of methods for surface enhancement with focus on targeted modification of hardness, corrosion resistance, friction properties, minimum contamination of the surroundings, useful life, chemical resistance and other mechanical, electrical, optic and thermal properties, which is a very progressive and material-efficient technique for enhancing end-use properties.
  - R&D of methods and techniques for increasing the homogeneity and durability of surface treatment properties while minimising surface layer thicknesses and effects on the dimensions of parts.

- Nanotechnological surface protection.
- **Repairs and recycling**
  - R&D of methods for reconstructing the shape of worn-out parts, reconstructing the working surfaces of parts and material structures.
  - R&D of additive, hybrid, deposition and coating methods, materials and technologies for restoring the shapes and properties of parts and components.
  - R&D of methods for efficient recycling of engineering products.

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

Note: This concerns only high-tech and medium high-tech production from the listed CZ-NACE production categories and only products with high engineering demands, the innovation of which requires research and development as standard.

25.4 Manufacture of weapons and ammunition

26 Manufacture of computer, electronic and optical products

27 Manufacture of electrical equipment

28 Manufacture of machinery and equipment n.e.c.

33 Repair and installation of machinery and equipment

The area in question also includes expert fields thematically overlapping with CZ-NACE 24, 29 and 30.

Naturally, relevant groups also include:

71 Architectural and engineering activities; technical testing and analysis

##### **Downstream CZ-NACE items, functional relations**

The most significant **downstream divisions** of CZ-NACE placing the highest demands on MT and PE are groups from the following divisions:

25 Manufacture of fabricated metal products, except machinery and equipment

28 Manufacture of machinery and equipment n.e.c.

29 Manufacture of motor vehicles

30 Manufacture of other transport equipment

25 Manufacture of fabricated metal products, except machinery and equipment

27 Manufacture of electrical equipment

72 Scientific research and development

##### **Upstream CZ-NACE items, functional relations**

The most significant **upstream divisions** of CZ-NACE that affect machine tools and precision engineering the most are groups from the following divisions:

28 Manufacture of machinery and equipment n.e.c.

24 Manufacture of basic metals; casting of metals

25 Manufacture of fabricated metal products, except machinery and equipment

13 Manufacture of textiles

### 9.2.1.2 Energy industry

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved by government resolution No. 135 of 17 February 2016 and previous debate organised in connection with the preparation of the document Proposed Priority Topics for Research and Development and Innovation – Energy Industry (Czech Sustainable Energy Technology Platform).

A/ R&D&I topics identified through the EDP:

- **Technologies for electricity and heat generation at nuclear facilities**
  - Safety (analyses, tools and data for oversight activities, legislation and operators' purposes), long-term reliable economic operation and new technologies, prevention of and response to severe accidents
  - Nuclear fuel cycle – optimisation, useful life (deduction of the behaviour and ageing of materials, components and equipment)
  - Radioactive cycle – preparation of superior methods for the processing and treatment of radioactive waste and the decontamination and disassembly of nuclear power plants after decommissioning (including the application of robots)
  - Advanced Generation IV systems, SMRs
- **Technologies for electricity generation from fossil fuels**
  - New modes of operation, including compliance with requirements applicable to conventional pollutants
  - Enhancement of waste utilisation for materials and energy – use of coal combustion products from combustion processes in coal-fired facilities, conditions for use of new materials (assessment of pollutant impacts, designs of testing methods, ecotoxicology, etc.)
  - Value enhancement of hard and brown coal through use other than combustion
- **Technologies for heat/cold generation and distribution based primarily on fossil fuels**
  - Enhancing the efficiency of existing heat supply systems – boiler capacity ranges, optimum solutions for deSO<sub>x</sub>/deNO<sub>x</sub>/dust removal, reduction of minimum required condensing power generation, solutions for multi-fuel applications, etc.
  - Heat and energy storage
  - Technologies for small cogeneration and microgeneration, trigeneration, cold generation and distribution
- **Technologies for electricity and heat generation from renewable and secondary sources**

- Development and testing of technologies for the Czech Republic's conditions
  - Biomass – sustainable biomass procurement, transformation processes, boilers, waste, biogas (heat utilisation)
  - Hydropower – efficiency, environmental aspects, comprehensive system management models, small hydroelectric power plants
  - Wind energy – loss reduction, connection to the electricity system
  - Solar heat – photovoltaic installations with storage, residential sector, solar thermal systems
  - Heat pumps – increase in SOC, gas pumps, combination with other technologies at house or local level
  - RES power-to-gas
  - Synergistic operation of individual generating facilities
- **Electric networks, including electric power storage**
    - Reliable and safe operation of the transmission system – management models, robustness, system efficiency and reliability, network integration and balancing in the European context
    - Reliable and safe operation of a distribution system – new automation elements; advanced approaches in diagnostics and monitoring; smart metering and integration of renewables, distributed generation and electric mobility
    - Generation and consumption optimisation – advanced load management and demand side management / demand response
    - Energy storage
- **Energy consumption and energy savings, Smart Cities**
    - Energy savings in industry, services and agriculture
    - Preparation and demonstration of integral solutions for cities and urban agglomerations (smart cities and smart regions)
    - Smart buildings and improvement in the energy performance of buildings (reducing emissions of air pollutants, which will help to meet pollution limits), external wall insulation
    - Energy saving technologies on the consumption side (including business and financing models)
- **Energy in transport**
    - Efficiency of energy transport systems
    - Electric mobility (integration of charging stations into a network, control systems, integration with energy storage, hybrid solutions, inductive charging, etc.), hybrid vehicles

- Fuel cells in transport
- New types of biofuels, use of coal combustion products for the construction of road networks and infrastructure
- **Promising energy technologies**
  - Small modular reactors operating at high temperatures with a high level of safety
  - Generation IV reactors
  - Hydrogen technologies, especially for energy storage
  - Nuclear fusion
  - Advanced energy storage and transformation technologies
  - Thermodynamic cycles
  - Research on graphene (artificial form of carbon) and its possible applications (graphene supercapacitor)
  - Use of nanomaterials in battery construction (3D batteries)
- **Analytical support**
  - Development of risk-oriented decision-making models (operation models, maintenance) based on advanced mathematical solutions and treatment of data
  - Analysis of opportunities and limits for the development of the energy industry in the Czech Republic in different time frames
  - Ensuring energy security, increasing the economy's energy and material efficiency
  - Improvement of energy management
- **Cross-sectoral topics**
  - Application of ICT technologies – digitisation, big data
  - New materials
  - New manufacturing technologies – rapid prototyping, customised manufacturing, etc.

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

- 35 Electricity, gas, steam and air conditioning supply
  - 35.1 Electric power generation, transmission and distribution
    - 35.11 Production of electricity
    - 35.12 Transmission of electricity
    - 35.13 Distribution of electricity
    - 35.14 Trade of electricity
  - 35.2 Manufacture of gas; distribution of gaseous fuels through mains

- 35.21 Manufacture of gas
- 35.22 Distribution of gaseous fuels through mains
- 35.23 Trade of gas through mains

35.3 Steam and air conditioning supply; production of ice

**Downstream CZ-NACE items, functional relations**

**Inputs**

- 35 Electricity, gas, steam and air conditioning supply
- 06 Extraction of crude petroleum and natural gas
- 05 Mining of coal and lignite

**27 Manufacture of electrical equipment**

- 28 Manufacture of machinery and equipment

**Outputs**

- 35 Electricity, gas, steam and air conditioning supply
- 68 Real estate activities
  - 71.2 Engineering activities and related technical consultancy
- 72 Scientific research and development

### 9.2.1.3 Metallurgy

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved on 17 February 2016 and previous debate organised in connection with the preparation of the document List of Summary Scientific Topics, drawn up by umbrella association Hutnictví železa, a.s.

#### A/ R&D&I topics identified through the EDP:

- **New sophisticated products**
  - New and improved steels; development of new categories of steel with combined properties (strength, ductility, toughness, energy absorption, weight reduction, resistance to thermal shocks, etc.)
  - Light alloys, cellular materials and composites
  - Extreme alloys and composites
  - Advanced superconductors
  - Biocompatible metallurgy
  - Development of combination alloys
  - Metal structures and technology units, metal elements for construction, technology containers, pressure tanks and silos
  - Intermediary metallurgical products of copper and alloys, aluminium foundry, processing of precious metals, abrasion-resistant and refractory materials, ferro-alloys
  - Development of new and enhancement of existing auxiliary materials (chemicals, oils, etc.)
  - New types of refractory materials, including coatings of such materials for casting new types of alloys
  
- **New technologies**
  - New procedures to decrease the energy intensity of metal production (e.g., direct manufacture of iron from ore)
  - New techniques and technologies for the processing and enhancement of final metal products
  - Thermoelectrics with a high ZT value
  - Scalable thermoelectrics
  - Coating and surface protection

- Powder metallurgy
- **Production management**
  - Optimising manufacturing costs and increasing the energy efficiency of metal production
  - Decreasing the material intensity of metal production
  - Optimisation of the qualitative parameters of metal products, including improvement in the control and management of manufacturing processes (mechatronics)
  - Sophisticated control systems
  - Development of artificial intelligence and advanced systems
  - Advanced testing, computing and simulation methods specifically used in development
  - Recycling, refining and recovery of critical and high-value metals
  - 3D microparticles and sensors
  - Automated additive manufacturing
  - Predictive modelling
  - Reduction of dust nuisance and environmental burdens

B/ Indicative relation to the CZ-NACE classification

**Main relevant CZ-NACE items**

24 Manufacture of basic metals; casting of metals

- 24.1 Manufacture of basic iron and steel and ferro-alloys, flat products (except cold working of narrow strip); hot forming of products
- 24.2 Manufacture of steel tubes, pipes, hollow profiles and related fittings
- 24.3 Manufacture of other products of first processing of steel
- 24.4 Manufacture of basic precious and other non-ferrous metals
- 24.5 Casting of metals

**Downstream CZ-NACE items, functional relations**

**Inputs**

- 07 Mining of metal ores
- 24 Manufacture of basic metals; casting of metals
- 25 Manufacture of fabricated metal products, except machinery and equipment

**Outputs**

- 24 Manufacture of basic metals; casting of metals
- 25 Manufacture of fabricated metal products, except machinery and equipment
- 27 Manufacture of electrical equipment
- 28 Manufacture of machinery and equipment n.e.c.



## 9.2.2 Digital Market Technologies and Electrical Engineering, outputs from National Innovation Platform II – “Electronics and Electrical Engineering and ICT”

### 9.2.2.1 Electronics and electrical engineering

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved by government resolution No. 135 of 17 February 2016 and previous debate organised in connection with the preparation of priorities provided by the Electrical and Electronic Association of the Czech Republic.

#### A/ R&D&I topics identified through the EDP:

- **New materials and technologies**
  - New materials for electrical engineering, especially for soldering, insulation and to replace rare-earth permanent magnets
  - Micro-nanoelectronic technologies
  - Intruder detection systems, probes, sensors, measuring instruments, new methods for measuring physical quantities, control systems and instrumentation, microscopes, calibrators, camera systems for pipelines, monitoring systems in geodynamics, measuring technologies for geological sciences and meteorology
  - Electrical terminations, printed circuits, switchgear, cables and solutions for electrical engineering infrastructure, electrical wiring materials, contact and connector systems, fibre optic technologies, superconducting materials, valves, storage batteries, microwave links for data transmission
  - LED lamps, luminous paving stones, warning light equipment
  - Development of technologies for ultra-precision machining (in the order of nanometres)
  - Development of technologies and processes for the manufacture of precision aspheric and free-form optical elements (lenses and mirrors)
  - Design of optical illumination and display systems that can take advantage of the unique properties of precision aspheric and free-form elements
- **Electrical engineering for Industry 4.0**
  - Sensors, actuators, data aggregators, new system parts and components, embedded systems
  - Fibre-optic technologies and sensors, advanced sensors and methods for the processing of sensor data

- Automation, robotics, mechatronics, measurement, simplified application of industrial automation and robotisation to new industrial processes, especially to human-robot collaboration – human-machine interfaces: voice and natural language control, including human gestures, motions and emotions, virtual and augmented reality – both for consumer and medical electronics and for the industry and services segment, solutions for machinery’s interaction with surroundings
- Industrial process automation, diagnostic systems, control and information systems, systems controlling technological processes, industrial transfer arms, equipment for intelligent transport systems
- Devising new methods and simulation tools for the control of units, production plants and parent systems
- Technical and SW support for the control of manufacturing technologies, solutions for data collection, transfer, storage, processing and archiving and creation of information for complete life-cycle management, for quality assurance, environmental friendliness and safety of people and things
- Tools for IoT (Internet of Things), IoS (Internet of Services) and IoP (Internet of People) support, development and design of embedded processor systems
- Development of artificial intelligence tools and their implementation in the manufacturing industry
- Control elements and systems for units, machines, production lines and buildings, including software support
- Identification systems, related services
- Special robots for the inspection of distribution networks and other linear structures
- Tools for the integration of Smart Systems

- **Electrical engineering for individual industries**

Interdisciplinary solutions (priority is given to solutions for the automotive industry, mechanical engineering, chemical industry, transport, construction and health care).

- Automotive and industrial electronics, electric motors for the automotive industry, replacement of batteries in electric vehicles
- Drives and control of drives, specific drives, increasing the energy efficiency of drives, new materials for the construction of drives (permanent magnets, insulation)
- Consumer and medical robotics
- Electrical engineering for medical applications
- Electrical engineering for the defence industry and special applications (passive and active radiolocation, especially for civil aviation, meteorology and security applications)
- Semiconductor industry

- Nanotechnology for electronics
- Imaging technology and digital projection – technical provisions for analogue and digital transmissions in respect of increasing transfer rates and quality and reducing transmission energy demands
- Electron microscopy
- Safety and reliability of all of these items
- Smart Society, smart buildings
- Electrical engineering for the defence industry and special applications
- Development of supercomputers
- Passive and active radiolocation, especially civil aviation, meteorology and security applications
- Automatic identification and RFID

B/ Indicative relation to the CZ-NACE classification

**Main relevant CZ-NACE items**

26 Manufacture of computer, electronic and optical products

26.1 Manufacture of electronic components and boards

26.2 Manufacture of processors, embedded systems, computers and peripheral equipment

26.3 Manufacture of communication equipment

26.4 Manufacture of consumer electronics

26.5 Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks

26.6 Manufacture of irradiation, electromedical and electrotherapeutic equipment

26.7 Manufacture of optical instruments and photographic equipment

26.8 Manufacture of magnetic and optical media

27 Manufacture of electrical equipment

27.1 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus

27.2 Manufacture of batteries and accumulators

27.3 Manufacture of fibre optic and electric cables, electric wires and wiring devices

27.4 Manufacture of electric lighting equipment

27.5 Manufacture of domestic appliances

27.9 Manufacture of other electrical equipment

**Downstream CZ-NACE items, functional relations**

29 Manufacture of motor vehicles, trailers and semi-trailers

30 Manufacture of other transport equipment

28 Manufacture of machinery and equipment n.e.c.

33 Repair and installation of machinery and equipment

- 60 Programming and broadcasting activities
- 61 Telecommunications
  - 62. 01 Computer programming activities
- 63 Information service activities
  - 71.2 Technical testing and analysis
- 72 Scientific research and development

### 9.2.2.2 Digital economy and digital content<sup>264</sup>

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved on 17 February 2016 and was approved by the Digital Economy and Cultural and Creative Industries Committee of the C&EG Council.

A/ R&D&I topics identified through the EDP:

- **Development of high-quality infrastructure providing fast or superfast Internet access.**
- **Support for the development of digital content industries, introduction and utilisation of new technological concepts**
  - Especially complementing existing strategies with support for services and with development of CCIs using a digital platform
  - Support for new applications (including streaming) on the Internet, development of e-commerce, support for communication with customers in geographically distant markets, deployment of digital technologies in culture, sophisticated services in exports
  - Provision of access to the public administration's open data
  - Support for the introduction and utilisation of new technological concepts such as the cloud, Internet of Things, big data, artificial intelligence and others
- **Ensuring the government's coherent approach to the provision of loans, borrowings and/or guarantees for loans, including development of venture capital financing.**
- **Support for the development of technological concepts and their application in national economy sectors**
  - Vertical integration of information and knowledge systems and processes in industrial enterprises (from real-time management to ERP systems and systems of strategic decision-making at the top management level)
  - Horizontal integration of information and knowledge systems and processes (from contact with suppliers to engineering activities and actual manufacture to a distribution network)
  - Computer/digital integration of all engineering activities within an enterprise
    - Pre-manufacturing stage (modelling, virtual prototyping and 3D printing, simulation, visualisation, analysis of big data for production, prediction of material and system properties, testing)
    - Manufacturing stage using robotics, cybernetics, cyber-physical objects or adaptive systems (automation and control of technological processes, integrated intelligence for operation productivity enhancement, human-

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This part also makes use of outputs from the Cultural and Creative Industries NIP – New CCIs.

machine interaction, robotic solutions leading to automatic self-learning operations)

- Maintenance of data and the entire life cycle of a product or service
- Internet of Things and cyber-physical systems, robotics, methods and techniques for cybernetics and artificial intelligence (agent systems, service-oriented architectures, learning and self-organising systems, machine perception systems, intelligent robotics), development of new algorithms and analytical tools for working with large quantities of data, tools for working with the Czech language in ICT, digitisation of the distribution system
- Adaptation of technological concepts to the needs of national economy sectors
  - Innovation of technological concepts for the specific conditions of national economy sectors
  - Solutions based on the principles of the sharing economy, e-commerce, technological interconnection of digital content, the Internet of Things, assistive technology
  - Digitisation of the distribution / transmission system, distribution network – Smart Grids
  - New solutions for electronic communications systems
  - Self-driving car technology (development and application of sensors and algorithmic control technologies)
  - Unmanned aircraft systems, including their autonomous operation
- **Cybersecurity**
  - Protection of ICT infrastructure and data against attacks, data and network security
  - Secure data storage and backups
  - Modern and secure digital communications
  - Defence against malware propagation
  - Cybercrime prevention
- **Social impacts of society digitisation**
  - Monitoring negative social phenomena associated with society digitisation
  - Developing measures to eliminate them
- **Research into technology impacts on society and individuals within new creative industries**
  - Research into social impacts of technology, especially in law, social media and citizens' participation in democratic processes in the Czech Republic
  - New fields and opportunities for research with potential significant impact on innovation brought about by new technologies in digital humanities, language

technology, computer and corpus linguistics, gaming industry technologies, digital technologies for support for creative production and new audiovisual formats

- Text and data mining in humanities and social sciences
- Preparation of necessary data resources for applied research in social sciences and humanities
- Language technology, computer and corpus linguistics
- Access to cultural heritage and support for cultural identity, support for applications with economic impacts in industry and services
- Access to methodologies such as personas, prototyping and others
- Service user behaviour (area studies, ethnology and anthropology)
- Research into copyright and intellectual property in relation to new technologies

- **Media production:**

- New techniques for the creation of media content
  - Innovative procedures for efficient creation of media content (efficient and available means for animation, sound/text/image synthesis, etc.)
  - Creation of new forms of interactive media content
  - Tools for the creation of new forms of non-visual content
- Development of media content presentation techniques
  - New techniques and technologies for media content searching and presentation
  - New interactive search and presentation tools and procedures
  - Innovative techniques for non-visual content searching and presentation
- Innovation in media content archiving
  - New methods for identification, description, indexing, cataloguing and reinterpretation of media content and their application
  - Innovative procedures for the recycling (reuse) of existing media content
- Development of media content applications
  - Methods for the evaluation of new approaches in creation, presentation and archiving in terms of creative media categories
  - Application of new approaches in the context of specific media (TV, theatre, ...)
  - Presentation of new scientific outputs
- Performing arts and architecture – work with space:
  - Application of new presentation techniques in space

- Use of new interactive techniques for work with space
  - Use of new properties of materials suitable for improving space utility from a media perspective (visual, acoustic, haptic properties, etc.)
  - Application of advanced technologies in space design
  - Application of advanced technologies to enhance space utility (deployment of virtual reality and visualisation technologies as part of architecture, a stage design project, etc.)
  - Research, development and use of new communication technology for remote collaboration in performing arts and architecture
- Taking advantage of the Czech Republic's unique locations for the film industry
- **Memory institutions**
  - New methods for the restoration and archiving of memory collections
    - Application of advanced methods, new scientific knowledge and materials in the restoration of media and artefacts
    - Restoration of artefacts and architectural works using digital restoration
    - Use of new technologies in archiving (new-generation repositories and archiving standards – improving content preservability in archives)
  - Media content archiving and searching
    - Automated classification, indexing, cataloguing and annotation techniques (metadata) for media content
    - New methods for media content searching, including the use of automated methods of progressive extraction of information from media content and its interconnection with open data
  - Innovative use of memory collections
    - Innovative methods for the re-use of content in memory collections
    - Use of new technologies in work with memory collections
    - New technologies for providing access to memory contents, including access for the inclusion of disadvantaged groups and minorities
    - Research, development and use of technology for the creation and visualisation of digitised cultural content, including remote access

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

- 26 Manufacture of computer, electronic and optical products
  - 26.1 Manufacture of electronic components and boards
  - 26.2 Manufacture of computers and peripheral equipment
  - 26.3 Manufacture of communication equipment



- 26.4 Manufacture of consumer electronics
- 26.5 Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
- 26.6 Manufacture of irradiation, electromedical and electrotherapeutic equipment
- 26.7 Manufacture of optical instruments and photographic equipment
- 26.8 Manufacture of magnetic and optical media
- 46 Wholesale trade, except for motor vehicles and motorcycles
  - 46.5 Wholesale of information and communication equipment
- 47 Retail trade, except for motor vehicles and motorcycles
  - 47.4 Retail sale of information and communication equipment in specialised stores
- 58 Publishing activities
  - 58.2 Software publishing
    - 58.21 Publishing of computer games
    - 58.29 Other software publishing
- 61 Telecommunications
- 62 Computer programming, consultancy and related activities
  - 62.0 Computer programming, consultancy and related activities
    - 62.01 Computer programming activities
    - 62.02 Computer consultancy activities
    - 62.03 Computer facilities management activities
    - 62.09 Other information technology and computer service activities
- 63 Information service activities
  - 63.1 Data processing, hosting and related activities; web portals
- 77 Rental and leasing activities
  - 77.3 Renting and leasing of other machinery, equipment and tangible goods
    - 77.33 Renting and leasing of office machinery and equipment (including computers)
- 95 Repair of computers and personal and household goods
  - 95.1 Repair of computers and communication equipment
    - 95.11 Repair of computers and peripheral equipment
    - 95.12 Repair of communication equipment

### **Main relevant CZ-NACE items within new creative industries**

Note: The CZ-NACE categories may overlap with the CZ-NACE categories of the Digital Economy NIP, as NIPs are defined by subject and in mutual relations, and formal reporting does not allow such subject-based classification. The CZ-NACE classification has some limitations and may not correspond to newly emerging industries.

### **Cultural heritage**

- 91.01 Library and archives activities
- 91.02 Museums activities
- 91.03 Operation of historical sites and buildings and similar visitor attractions
- 47.78 Other retail sale of new goods in specialised stores (part)

Includes, among others: retail sale of photographic equipment, souvenirs, craftwork; activities of commercial art galleries; retail sale of stamps and coins; retail trade services of commercial art galleries; framing of pictures.

47.79 Retail sale of second-hand goods in stores (part)

Includes: retail sale of second-hand books, retail sale of other second-hand goods, retail sale of antiques, activities of auctioning houses (retail)

**Performing arts**

90.01 Performing arts

Production of live theatrical presentations, concerts and opera or dance productions and other stage productions: activities of groups, circuses or companies, orchestras or bands; activities of individual artists such as actors, dancers, musicians, lecturers or speakers; activities of stuntmen

90.02 Support activities to performing arts

Activities of directors, producers, stage-set designers and builders, scene shifters, lighting engineers, etc.; activities of producers or entrepreneurs of arts live events

90.04 Operation of arts facilities

Operation of concert and theatre halls and other arts facilities

**Creative art**

74.20 Photographic activities

Commercial and consumer photograph production, videotaping of events; film processing, developing, etc.

90.03 Artistic creation

Activities of individual artists such as sculptors, painters, cartoonists, engravers, etchers, etc.; activities of individual writers; activities of independent journalists; restoring of works of art

**Motion picture and video**

59.11 Motion picture, video and television programme production activities

59.12 Motion picture, video and television programme post-production activities

59.13 Motion picture, video and television programme distribution activities

59.14 Motion picture projection activities

77.22 Renting of video tapes and disks

47.63 Retail sale of music and video recordings (part)

**Music**

59.20 Sound recording and music publishing activities

47.63 Retail sale of music and video recordings (part)

**Radio and television, news agencies**

60.10 Radio broadcasting

60.20 Television programming and broadcasting activities

63.91 News agency activities

**Books and press**

58.11 Book publishing

58.13 Publishing of newspapers

58.14 Publishing of journals and periodicals

47.61 Retail sale of books

47.62 Retail sale of newspapers and stationery

74.30 Translation and interpretation activities

18.11 Printing of newspapers

18.12 Other printing

18.13 Pre-press and pre-media services

18.14 Binding and related services

18.20 Reproduction of recorded media

**Entertainment software**

58.21 Publishing of computer games

**Educational and research activities – part**

85.52 Cultural education

Provision of instruction in the arts, drama, music and dance (“schools”, “studios”, “classes”, etc.) for hobby purposes without a professional diploma (baccalaureate or graduate degree); drama schools, performing arts schools, fine arts schools (except academic); photography schools (except commercial)

**Natural heritage**

91.04 Botanical and zoological gardens and nature reserves activities

91.04.1 Botanical and zoological gardens activities

91.04.2 Nature reserves activities

**Architecture**

71.11 Architectural activities

**Advertising**

73.11 Advertising agencies

73.12 Media representation

73.20 Market research and public opinion polling

**Design**

74.10 Specialised design activities

**INFORMATION AND COMMUNICATION**

**Section J – Information and communication**

58.12 Publishing of directories and mailing lists

58.19 Other publishing activities

58.2 Software publishing

58.29 Other software publishing

62.0 Computer programming, consultancy and related activities (the whole field  
62.00 can be included)

62.01 Computer programming activities

62.02 Computer consultancy activities

62.03 Computer facilities management activities

62.09 Other information technology and computer service activities

63 Information service activities

63.11 Data processing, hosting and related activities

63.12 Web portals

63.9 Other information service activities

63.99 Other information service activities n.e.c.

**Downstream CZ-NACE items, functional relations**

60 Programming and broadcasting activities

72.2 Research and experimental development on natural sciences and engineering

## 9.2.3 Transport means for the 21st century, outputs of National Innovation Platform III, “Manufacture of Transport Means”

### 9.2.3.1 Automotive

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved by government resolution No. 135 of 17 February 2016 and responds to priorities contained in the Strategic Research Agenda (SRA) of the “Vehicles for Sustainable Mobility” Technology Platform, 2nd edition, February 2013, which was confirmed to be up-to-date by the Automotive Industry Association after the platform’s meeting.

A/ R&D&I topics identified through the EDP:

- **Chassis systems**
  - New chassis conceptions with advanced powertrains and integrated control with respect to vehicle dynamics, active safety and comfort and noise, application of intelligent power elements, lightweight body and frame construction, vehicle exterior and interior aerodynamics
  
- **Powertrain and fuels**
  - Internal combustion engines with improved efficiency using fossil fuels, second-generation biofuels, later-generation biofuels, materials and components for alternative powertrains, alternative fuels and vehicle fluids
  - Alternative-fuel power units
  - Hybrid drives (power electronics, electric motors, generators, batteries, flexible-fuel internal combustion engines for innovative powertrains using synthetic fuels, etc.)
  - Electric drives (power electronics, electric motors, generators, batteries, etc.)
  
- **Vehicle electrics and electronics**
  - Vehicle communication networks, adaptive and predictive control of powertrain parameters, integrated and hierarchical vehicle control systems, including the automation of routine processes, electrics components aimed at reducing power input a price, ensuring robustness and high operating reliability to enhance safety, reducing energy demands, resolving EMC issues and reducing noise, diagnostic means to ensure the reliability of integrated control systems with new appliances
  
- **Ecology**
  - Use of materials based on recycled products or renewable sources
  - Research into efficient recovery of materials from transport equipment after its useful life
  - Research objectives focusing on emission parameters (EURO 6+)

- **Safety**
  - Elements to enhance active and passive vehicle safety, vehicle optimisation in terms of integrated safety, measures supporting road transport safety
- **ITS, mobility and infrastructure**
  - Cooperative systems for online information sharing among vehicles and other types of transport and between a vehicle and its surroundings, systems for optimum utilisation of data on the road network, traffic and travelling as well as on recharging facilities for electric and hybrid vehicles
  - Research, development and implementation of driver assistance systems
  - Research, development, legalisation and implementation of autonomous driving systems
- **Material processing**
  - Nanotechnology for multifunctional materials, advanced metal, plastic and composite materials, application of modern methods for material machining, parting and joining, productivity enhancement methods including Design4x, R&D of manufacturing process optimisation and flexibility enhancement and disposal methods
- **Virtual development**
  - Research into simulation techniques and virtual reality (VR) techniques for parametric optimisation of products, for conceptual optimisation of higher-order innovation, VR for faster preparation of the manufacturing stage in the production chain, use of VR in manufacturing line design, applications for designs usable during the implementation of Industry 4.0
- **Manufacturing processes**
  - Link the virtual cyber world with the world of physical reality
  - Develop industrial and operating intelligence based on information and cybernetic technology
- **Energy**
  - Vehicle power management for the management of electric buses and hybrid buses
  - Infrastructure and transport systems for electric mobility
  - Infrastructure for advanced transport – Smart Grids, hydrogen infrastructure
- **Research and development of related components**

B/ Indicative relation to the CZ-NACE classification

**Main relevant CZ-NACE items**

- 29 Manufacture of motor vehicles, trailers and semi-trailers
  - 29.1 Manufacture of motor vehicles
  - 29.2 Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
  - 29.3 Manufacture of parts and accessories for motor vehicles
    - 29.31 Manufacture of electrical and electronic equipment for motor vehicles
    - 29.32 Manufacture of other parts and accessories for motor vehicles
- 71 Architectural and engineering activities; technical testing and analysis
  - 71.1 Architectural and engineering activities and related technical consultancy
  - 71.12 Engineering activities and related technical consultancy

**Downstream CZ-NACE items, functional relations**

- 13 Manufacture of textiles
- 20 Manufacture of chemicals and chemical products
- 22 Manufacture of rubber and plastic products
  - 22.2. Manufacture of plastics products
- 23 Manufacture of other non-metallic mineral products
  - 23.1 Manufacture of glass and glass products
- 26 Manufacture of computer, electronic and optical products
  - 26.1 Manufacture of electronic components and boards
- 27 Manufacture of electrical equipment
  - 27.1 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
- 30 Manufacture of other transport equipment
- 46 Wholesale trade, except of motor vehicles and motorcycles
- 49 Land transport and transport via pipelines
  - 49.4 Freight transport by road and removal services
- 72 Scientific research and development
  - 72.1 Research and experimental development on natural sciences and engineering

### 9.2.3.2 Aircraft and spacecraft industry

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved on 17 February 2016 and responds to priorities contained in the Strategic Research Agenda (SRA) of the Czech Aircraft and Spacecraft Industry (until 2025), which was confirmed to be up-to-date by the Aircraft Industry Association after the platform's meeting.

A/ R&D&I topics identified through the EDP:

- **Aerodynamics, thermomechanics, flight dynamics**
  - SW for aerodynamic calculations
  - Aerodynamic profiles
  - Boundary layer control
  - Efficient high-lift devices
  - Active elements for aircraft aerodynamic controls, flight dynamics analysis
  - Flight characteristics and performance
  - Simulation of icing impacts and elimination
  - Prediction of cabin interior environments
  - Optimum aerodynamic design of VTOL/STOL aircraft
  - Hydrodynamics optimisation in floatplanes and flying boats
  - Thermodynamics of suborbital aircraft
  - Optimisation of flow paths in turbine engines
  - Optimisation of bladed parts for turbine engines
  - Optimisation of the aerodynamic design of propellers
  - Aeroelasticity, simulation of aeroelastic effects with the influence of the environment
  - Aeroacoustics
  
- **Modern designs and technologies**
  - Progressive structural designs reflecting new technologies and materials
  - Optimisation tools for progressive design reflecting manufacturing technology
  - Aircraft structure assessment in terms of load capacity, fatigue and durability, limit states and modes of failure in aircraft structures, fatigue failures, more precise residual life prediction



- Research into the impact of structural, material or technological changes on structural failures in aircraft, increasing aircraft service life
  - New composite technology
  - Joining of structural parts, manufacture of integral structures, alternative methods for assembly and installation (3D metrology, augmented/virtual reality)
  - Casting of aircraft structural parts from aluminium and magnesium alloys, including computer simulations
  - Bulk and sheet metal forming and machining of unconventional materials, high-strength steels and non-ferrous alloys
  - Modern surface protection of materials, efficient technology for 3D metrology
  - ADM – Additive Layer Manufacturing
  - Noise prediction, means to reduce external and internal noise
- **Materials**
    - Materials with new properties – corrosion protection, heat resistance, flammability, etc., new types of smart materials, application of composite and nanocomposite materials
    - Materials with sliding properties (moving parts)
    - Materials with anti-icing properties
    - Materials reducing surface friction
    - Materials capable of absorbing high energies (landing gear)
    - Materials with programmable and smart properties, etc.
    - Materials with nanofibres and nanofillers
    - Development, testing and machining of advanced aerospace materials and application of existing advanced materials
- **Propulsion**
    - Alternative fuels
    - New propulsion systems – propulsion for small aircraft, powertrains for gliders, restartable rocket propulsion, electric and hybrid powertrains, hydrogen fuel cells
    - Combustion chambers
    - Diagnostic systems for propulsion units
    - Design and modelling of aircraft engines and their components
    - Optimisation of lightweight propeller and fan designs
    - Dynamic simulations of turbine engine regulation and control systems, modelling and optimisation of thermodynamic processes in combustion chambers, design and optimisation of high-speed gearboxes

- **Aircraft systems**

- Integration of operating (hydraulic, fuel, air-conditioning) systems
- Optimisation of automatic movement control (autopilot function)
- Secure data communications
- Integrated electric supply distribution system
- Increase in the precision of low-cost aircraft inertial measurement units using GPS and magnetometers
- Particle filters
- Identification and control algorithms of dynamic systems
- Integrated satellite navigation receivers, automated control system
- Integrated stabilised aircraft optical systems

- **Unmanned aerial vehicles**

- Research on the use of drones for physical protection of critical infrastructures, perimeter security
- Research on the use of drones for agriculture and forestry – fire protection, forest damage monitoring
- Research on the use of drones for orthophoto mapping
- Research on the use of drones for linear structures (power lines, pipelines, borders)
- Research on the use of multiple UAVs in a single area – this includes tactical, planning and collision avoidance, ability to carry out various tasks – tracking, surveillance, monitoring, patrolling, etc., using GT for multiple UAVs

In **space activities**, research and development will concern especially the following:

- **Space technologies:**

- Sensorics and instrumentation
- Space transportation technologies and components<sup>265</sup>, satellite communications, Earth observation and satellite navigation
- Development of optical components, (and related) precision mechanisms
- 3D (three-dimensional) printing
- Technologies for on-board electronics
- HW (hardware) platforms for data processing
- Satellite on-board and SW (software) systems (e.g. on-board software, power management)

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<sup>265</sup> E.g., space activities for Ariane or Vega.

- Automatic and robotic systems (including vibration-damping systems and launching equipment)
  - MEMS (microelectromechanical system) technology and parts of stabilisation equipment (gyroscopes, reaction wheels), materials with enhanced characteristics for use in space, composite and glued laminated materials, adhesives and coatings
  - Structural and thermal analysis, thermal management, simulation of aerothermoelastic effects
  - Optical and optical/photonic systems for space research, modelling of space research objectives, and supporting ground observations
- **In the use of data from space systems, research and development will focus on:**
    - Open and secure communication protocols
    - Compression algorithms for data transmissions
    - Algorithms for the processing of Earth observation data (including big-data algorithms)
    - Advanced methods for GNSS (global navigation satellite system) signal processing
    - Development and application of GNSS-based correction systems and position finding algorithms
    - Increasing GNSS receiver resilience in combination with suitable anti-jamming and anti-interference technology
    - Autonomous driving algorithms

Attention should also be paid to trends in processes, such as Industry 4.0, IoT (Internet of Things), model-based enterprise, advanced simulation and testing.

- **Safety and reliability**
  - Operating safety and reliability of structures
  - Civil applications of unmanned aerial vehicles
  - Enhancing the durability of aircraft structures – aircraft damage evaluation, experimental equipment for monitoring, measuring and evaluating the load and deformation of aircraft structural parts in operation
  - Advanced cockpits
  - Low-cost aircraft structural elements
  - Efficient use of aircraft interior
  - Technical systems for the provision of air traffic services, including remote provision technology
  - Aviation information and communications technology

- Reduced-crew aircraft and unmanned aerial vehicles, including drone detection in the vicinity of big airports
- “Antiterrorist” features
- Passive safety of crews and passengers
- Pilot stress reduction
- Transmission and sharing of large quantities of structural data between remote users
- Virtual reality in designing activities
- Advanced deicing systems, protection from the effects of lightning
- Aircraft rescue systems, ejection seats

B/ Indicative relation to the CZ-NACE classification

**Main relevant CZ-NACE items**

30.3 Manufacture of air and spacecraft and related machinery

**Downstream CZ-NACE items, functional relations**

20 Manufacture of chemicals and chemical products

22 Manufacture of rubber and plastic products

23 Manufacture of other non-metallic mineral products

23.1 Manufacture of glass and glass products

26 Manufacture of computer, electronic and optical products

51 Air transport

71.20 Technical testing and analysis

72.1 Research and experimental development on natural sciences and engineering

### 9.2.3.3 Railway and rail vehicles

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved on 17 February 2016 and reacts to the discussion with members of the sector group held under the auspices of the Association of the Czech Railway Industry.

#### A/ R&D&I topics identified through the EDP:

- **Advanced materials**
  - Application of new materials in the construction of rail vehicle bodies and chassis
  - Materials with new properties for the reduction of emissions and noise and vibration propagation in railway operations
  - Development of materials for railway wheels and axles with higher durability and safety in operation, including heat treatment technology, research and verification of new metal and non-metal materials
  - Development of new designs of rubber-cushioned wheels for urban and suburban rail transport
- **Advanced manufacturing technology**
- **Products**
  - Design of railway vehicle interiors, to achieve maximum energy savings, minimise emissions and noise and vibration distribution, enhance functional and fire safety of rail vehicle interiors
  - Implementation of new EU legislation's requirements for rolling stock – interoperability, safety and operational efficiency and compliance demonstration system
  - Development and construction of rolling stock prototypes in order to verify achievement of the required level of interoperability
  - Design and optimisation of new wheels and axles for high speeds above 300 km/h
  - Development in the field of increasing the service life of the infrastructure and its components, new diagnostic methods for the railway infrastructure and rolling stock
  - Enhancing the technical parameters of components and assemblies
  - See also “Environmentally Friendly Propulsion” under Emissions/Noise
  - Rolling stock aerodynamics, including the effect of crosswinds, drafting and preparation of a wind map of the Czech Republic's areas covered by the TEN-T network and considered for the construction of high-speed lines

- **Emissions/noise/energy**
  - Development of wheel damping systems for noise reduction
  - Future environmentally friendly propulsion in railway transport and corresponding related railway infrastructure technologies
  - Research and development of advanced complete energy recovery systems
  - Systems for automatic control of rolling stock and traffic with respect to energy use optimisation
  - Improvement in the energy and traction parameters of traction equipment components for railway vehicles
  - Drive control methods aimed at reducing the energy consumption of components and rail vehicles and optimum utilisation of adhesion conditions
  - Research and development of low-emission propulsion
  
- **Control systems/electronics**
  - Application of satellite positioning to safety systems with particular focus on ETCS, enhancement of safety on regional lines, telematic applications, including diagnostics
  - Development of the European train protection system (ERTMS – ERTMS/ETCS and ERTMS/GSM-R) with focus on introducing functional key online management
  - ETCS implementation in railway vehicles
  - Integration of sophisticated solutions for automatic train control linked to traffic control systems
  - Development of ETCS mobile parts according to new specifications and finding an optimum engineering and financial compromise for application to regional lines
  - Development of detection means for identifying clear/occupied track sections in accordance with the development of locomotive traction drives, development of jointless track circuits allowing wider application of continuous welded rails
  - Development of full traffic control automation, including integration with rolling stock (SW, HW)
  - Optimisation of automatic railway traffic control in terms of efficient management of energy sources
  - Development of the fixed infrastructure for automation of vehicle operation control, including online data transmissions
  - Development of secure radio transmission systems
  - Information systems for passengers – providing visual and audio information, including multimedia for both passengers and train staff
  - Centralised data management and data distribution to operators' vehicles
  - Solutions for safer railway crossings

- **Test engineering**
  - Test engineering and engineering activities; technical tests, analyses, simulations, verification, evaluation, certification (demonstration of compliance with legal requirements) and engineering consultancy relating to the verification of achievement of the required level of interoperability and safety for the verification of research results and their applicability
- **Standardisation and standard making**
  - Development and support of the standard-making process and accompanying activities in relation to the state of the art and research results
- **Personnel development of development and engineering capacities**
  - Addressing lack of expert capacities by developing and supporting available capacities through lifelong learning; purposeful vocational targeting of this form of education in accordance with the sector's needs
- **Safety and environmental friendliness**
  - Development and support of the system of rolling stock maintenance and modernisation with a view to enhancing operation safety and environmental friendliness

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

- 30 Manufacture of other transport equipment
  - 30.2 Manufacture of railway locomotives and rolling stock
- 71 Architectural and engineering activities; technical testing and analysis
  - 71.20 Testing and engineering activities; technical testing, analysis, simulation, verification, certification and technical consultancy

##### **Downstream CZ-NACE items, functional relations**

- 20 Manufacture of chemicals and chemical products
- 22 Manufacture of rubber and plastic products
- 23 Manufacture of other non-metallic mineral products
  - 23.1 Manufacture of glass and glass products
- 26 Manufacture of computer, electronic and optical products
  - 26.1 Manufacture of electronic components and boards
- 27 Manufacture of electrical equipment
  - 27.1 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
- 72 Scientific research and development
  - 72.1 Research and experimental development on natural sciences and engineering

## 9.2.4 Health care, advanced medicine – outputs from National Innovation Platform IV – “Medicinal Products, Biotechnologies, Medical Devices and Life Sciences”

### 9.2.4.1 Medicinal Products, Biotechnologies, Medical Devices and Life Sciences

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved by government resolution No. 135 of 17 February 2016 and reacts to discussion with members of the sector group.

A/ R&D&I topics identified through the EDP:

- **Innovative medicinal products (for both human and veterinary use)**
  - New low-molecular drugs and targeted therapeutics
  - New formulation techniques in the development of original and generic drugs
  - Targeted therapy products (drug delivery systems) using nanotechnological, biomolecular and macromolecular carriers
  - Biological drugs, including therapeutic and preventive vaccines
  - Development and therapeutic use of advanced cell therapy medicinal products (ATMPs)
  - Disinfectants
  
- **New diagnostic methods and personalised medicine products (for human and veterinary use)**
  - New technologies for in vitro diagnostics
  - Research and development of diagnostic, prognostic and predictive biomarkers of diseases
  - Diagnostic methods using in vivo imaging
  - Point-of-care diagnostics
  - Screening technologies for diagnostics of major diseases in the population
  
- **Medical devices**
  - Replacement tissue and organs (made of biopolymers, alloys, etc.)
  - Instrumentation engineering products for use in health care, biotechnological production and veterinary medicine
  - Material research in biotechnology
  - Progressive robotic systems for medical applications
  - Progressive imaging and other systems for non-invasive applications in medicine



- Intelligent and feedback systems, instruments and equipment for diagnostics and therapy
- Innovative medical instruments and implants made of new materials, including nanotechnology applications (e.g., nanofibre structures for regenerative medicine, tissue engineering, targeted distribution of drugs in nanocapsules, micro- and nanotechnology methods to change the physical properties of dietary supplements or medicines in order to enhance their efficacy and decrease toxicity and adverse reactions, nanofibre barrier textiles for protection against allergens, bacteria and viruses, etc.)
- Progressive devices improving medical aftercare
- New materials, devices and instruments for anatomic replacements and medical applications
- New mobile devices for disaster medicine
- Progressive systems and instruments for effective physical therapy
- Personal protective equipment
- Innovative devices for the prevention and timely indication of diseases
- New devices improving the quality and effectiveness of provided medical care
- **Information and communications systems in medicine, telemedicine**
  - Development of advanced information systems in health care and veterinary care
  - Products for telemedicine and remote patient monitoring using electronic systems

B/ Indicative relation to the CZ-NACE classification

**Main relevant CZ-NACE items**

- 20 Manufacture of chemicals and chemical products
- 21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
- 26 Manufacture of computer, electronic and optical products
  - 32.5 Manufacture of medical and dental instruments and supplies
- 72 Scientific research and development
  - 72.11 Research and experimental development on biotechnology

**Downstream CZ-NACE items, functional relations**

- 01.2 Growing of perennial crops
- 01.4 Animal production
- 02 Forestry and logging
  - 13.3 Finishing of textiles
    - 26.60 Manufacture of irradiation, electromedical and electrotherapeutic equipment
- 62 Computer programming, consultancy and related activities
  - 71.2 Technical testing and analysis

75 Veterinary activities  
86 Human health activities

## 9.2.5 Creative Czech Republic – outputs from National Innovation Platform V “Cultural and Creative Industries”<sup>266</sup>

### 9.2.5.1 Traditional cultural and creative industries

The R&D&I topics were updated using the EDP process involving representatives of enterprises and research, which took place in connection with the preparation of the National R&D&I Policy and National RIS3 Strategy and provides input for the debate on applied research.

The EDP process followed up on discussions about R&D&I priorities held in connection with the preparation of the National R&D&I Policy approved by government resolution No. 135 of 17 February 2016 and reacts to discussion with members of the sector group.

A/ R&D&I topics identified through the EDP:

- **Research into materials and technologies**
  - Utilisation of the properties of new materials and new methods for working with such materials
  - Search for and utilisation of new materials from basic and applied research
  - Research on the life cycle of materials and products made of them
  - Materials intended for repairs of protected historic buildings
  - Innovation and modification of traditional methods for material processing and application
  - Innovative methods for the processing and application of traditional materials, including research and application of results in the development of new products
  - Modification and development of technologies for the processing of new materials
  - Innovative use of advanced technology in the process of design
  - And creation (including ICT)
- **Manufacture of glass, ceramics and porcelain**
  - Development of glass in respect of safety and environmental responsibility (lead-free glass, internal stress, protective surface finish – nano-paint)
  - Glass surface finish in line with requirements set by business trends and legislation (protective and anti-adhesive coatings)
  - Glass integration into final products (fixing tubes, telescopic suspension systems)

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<sup>266</sup> Outputs from the Cultural and Creative Industries NIP – New CCIs are implemented in the outputs of Digital Economy and Digital Content.

- Technologies combining glass and illumination (nano-paint, light sources such as LED/oLED technology or compact fluorescent lamps)
  - Advanced principles of glass preparation and robotisation of glass manufacture with favourable energy, environmental and quality impacts (renovation of existing technologies and application of new manufacturing procedures and preparations)
  - New raw materials and glass with properties relevant to mass and special-purpose applications and their original treatment (new natural materials, waste, new types of glass with outstanding physical, chemical and aesthetic properties, their bulk and surface treatment)
  - New applications of glass and glass products (glass as a replacement of metals, plastics and building materials, glass in combination with other materials, glass in medicine, glass as a design element, glass for disposal of radioactive waste, special glass applications in stamp and document security)
  - Coloured glazes, glaze properties and oxide effects
  - Development of ceramic granules
- **Manufacture of textiles**
    - Manufacture and use of nanofibres and nanofibre structures
    - In textiles, application of nanoparticles for special effects (e.g. nanofibre membranes and special textiles for functional clothing), development of composite structures containing inorganic fibres and textile reinforcements, smart textiles
    - Application of optical fibres and shape-memory materials in technical products
    - Textile sensors and sensors suitable for use in textiles
    - Modification and development of technologies for the processing of new materials, environmental aspects of new technology
- **Manufacture of wood and manufacture of musical instruments**
    - Technology for joining wood-based materials
    - Mathematical simulations of wood structure stiffness
    - Development of wood-based materials with high resistance to biotic agents and fire
    - Glued laminated wood and its use in the architecture of wood-frame buildings
    - Environmental aspects of the processing of wood and wood-based materials
    - Musical acoustics and technical physics (research into the acoustic quality of musical instruments and their uniformity)

B/ Indicative relation to the CZ-NACE classification

**Main relevant CZ-NACE items**

Architecture

71.11 Architectural activities

## Design

### 74.10 Specialised design activities

Artisanal handicrafts relating to the following fields:

Section C and F – clothing (fashion) industry and crafts

Section C – Manufacturing

#### 14 Manufacture of wearing apparel (all of 14)

14.11 Manufacture of leather clothes

14.12 Manufacture of workwear

14.13 Manufacture of other outerwear

14.14 Manufacture of underwear

14.19 Manufacture of other wearing apparel and accessories

14.20 Manufacture of articles of fur

#### 14.3 Manufacture of knitted and crocheted apparel

14.31 Manufacture of knitted and crocheted hosiery

14.39 Manufacture of other knitted and crocheted apparel

#### 15 Manufacture of leather and related products (all of 15)

15.11 Tanning and dressing of leather; dressing and dyeing of fur

15.12 Manufacture of luggage, handbags and the like, saddlery and harnesses

15.20 Manufacture of footwear

15.20.1 Manufacture of footwear with leather uppers

15.20.9 Manufacture of footwear of other materials

16.29 Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials

17.24 Manufacture of wallpaper

23.13 Manufacture of hollow glass

23.19 Manufacture and processing of other glass, including technical glassware

23.31 Manufacture of ceramic tiles and flags

23.41 Manufacture of ceramic household and ornamental articles

23.7 Cutting, shaping and finishing of stone

31.01 Manufacture of office and shop furniture

31.02 Manufacture of kitchen furniture

31.09 Manufacture of other furniture

#### 32.1 Manufacture of jewellery, bijouterie and related articles (include all of 32.1)

32.11 Striking of coins

32.12 Manufacture of jewellery and related articles

32.13 Manufacture of imitation jewellery and related articles

32.20 Manufacture of musical instruments

32.40 Manufacture of games and toys

32.99 Other manufacturing n.e.c.

## 9.2.6 Agriculture and the environment

### 9.2.6.1 Sustainable management of natural resources

- **Biodiversity and its function in an agroecosystem for sustainable management of natural resources**
- **Land management systems (conventional, organic, etc.), conservation of land stock and its functions in the landscape:**
  - Assessing the impact of erosion processes and protecting soil from erosion
  - Preserving and increasing the amount of organic matter in soil and enhancing carbon sequestration
  - Innovative methods, technologies and techniques for irrigation
- **Research into landscape and land utilisation and management designs leading to the restoration and enhancement of soil retention properties**
- **Rational utilisation of water sources in a sustainable landscape management system**
- **Systems of protection of (surface and ground) water quality against pollution**
- **Systems of natural resources management and utilisation under the conditions of changing climate**
- **System of adaptation measures to reduce the unfavourable consequences of climate change**
- **Machinery and technology in agriculture for efficient use of natural resources:**
  - Innovative methods and technologies for utilising biomass for energy use (production of fuels, thermal and other energy) and as a raw material for the manufacturing industry
  - Cultivation techniques for non-food crops
- **Research and development of unmanned control systems for mobile agricultural machinery**
- **Remote sensing and soil and vegetation monitoring**
- **Development of biometrics and bioeconomy using natural resources in agriculture**
- **Application of modern biotechnologies in environmental protection**

Note: Detailed information on the individual topics can be found in the Research, Development and Innovation Policy of the Ministry of Agriculture for 2016–2022, which is published on the ministry's website: <http://portal.mze.cz/public/web/mze/poradenstvi-a-vyzkum/vyzkum-a-vyvoj/koncepce-a-strategie/koncepce-vyzkumu-vyvoje-a-inovaci.html>

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

- 01.6 Support activities to agriculture and post-harvest crop activities
- 28.3 Manufacture of agricultural and forestry machinery

36.0 Water collection, treatment and supply

37.00 Sewerage

72.11 Research and experimental development on biotechnology

72.19 Other research and experimental development on natural sciences and engineering

**Downstream CZ-NACE items, functional relations**

28.93 Manufacture of machinery for food, beverage and tobacco processing

35.21 Manufacture of gas

35.30 Steam and air conditioning supply; production of ice

38.11 Collection of non-hazardous waste

38.21 Treatment and disposal of hazardous waste

38.3 Materials recovery

52.1 Warehousing and storage

### 9.2.6.2 Sustainable agriculture and forestry

- Genetic diversity, plant breeding and creation of varieties
- Phytosanitation, plant health control, including the protection of products in storage
- Sufficient, high-quality and safe crop production
- Non-food production
- Sustainable production of safe and quality foodstuff and animal feedingstuffs of plant origin
- Crop production adaptation to climate change impacts and relevant measures to mitigate climate change
- Genetics and genomics, breeding of high-performance types of livestock
- Reproduction and reproductive biotechnologies
- Technologies for animal production, welfare and livestock farming systems
- Development and deployment of low-emission technologies
- Reduction in the total production of emissions
- Optimisation of livestock nutrition and feeding
- Feedingstuff sources, alternative components
- Health, resistance to diseases, immunity, high level of adaptability, immunotherapy, pharmacology, chemistry and toxicology
- Production and preventive medicine
- Active creation of health and production
- Control of antimicrobial resistance, biosecurity
- Monitoring and inventory of forest ecosystems
- Game and game management
- Application of modern biotechnology methods in agriculture (both crop and animal production)

Note: Detailed information on the individual topics can be found in the Research, Development and Innovation Policy of the Ministry of Agriculture for 2016–2022, which is published on the ministry's website: <http://portal.mze.cz/public/web/mze/poradenstvi-a-vyzkum/vyzkum-a-vyvoj/koncepce-a-strategie/koncepce-vyzkumu-vyvoje-a-inovaci.html>

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

- 01.1 Growing of non-perennial crops
- 01.2 Growing of perennial crops
- 01.3 Plant propagation

- 01.4 Animal production, veterinary medicine (active creation of animal health)
- 01.7 Hunting, trapping and related service activities
- 02.1 Silviculture and other forestry activities
- 02.2 Logging
- 02.3 Gathering of wild growing non-wood products
- 02.4 Support services to forestry
- 03.1 Fishing
- 03.2 Aquaculture
- 20.1 Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
- 20.2 Manufacture of pesticides and other agrochemical products
  - 72.11 Research and experimental development on biotechnology
  - 72.19 Other research and experimental development on natural sciences and engineering

**Downstream CZ-NACE items, functional relations**

- 01.6 Support activities to agriculture and post-harvest crop activities
  - 08.91 Mining of chemical and fertiliser minerals
  - 08.92 Extraction of peat
  - 13.00 Manufacture of textiles
  - 16.00 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- 20.6 Manufacture of man-made fibres
- 21.1 Manufacture of basic pharmaceutical products
- 21.2 Manufacture of pharmaceutical preparations
- 52.1 Warehousing and storage
- 75.0 Veterinary activities



### 9.2.6.3 Sustainable food production

- **Composition of new food raw materials, foodstuffs and their bioactive ingredients and their effect on human health**
- **Technologies for food manufacture and preparation**
- **New foodstuffs and manufacturing processes and special foods for defined population groups**
- **Development of nanotechnologies and nanotechnology-based products**
- **Modern methods for hygiene and sanitation in the food chain**
- **New methods for analysing the composition of food raw materials, foodstuffs and their properties**

Note: Detailed information on the individual topics can be found in the Research, Development and Innovation Policy of the Ministry of Agriculture for 2016–2022, which is published on the ministry's website: <http://portal.mze.cz/public/web/mze/poradenstvi-a-vyzkum/vyzkum-a-vyvoj/koncepce-a-strategie/koncepce-vyzkumu-vyvoje-a-inovaci.html>

#### B/ Indicative relation to the CZ-NACE classification

##### **Main relevant CZ-NACE items**

- 10.1 Processing and preserving of meat and production of meat products
- 10.2 Processing and preserving of fish, crustaceans and molluscs
- 10.3 Processing and preserving of fruit and vegetables
- 10.4 Manufacture of vegetable and animal oils and fats
- 10.5 Manufacture of dairy products
- 10.6 Manufacture of grain mill products, starches and starch products
- 10.7 Manufacture of bakery and farinaceous products
- 10.8 Manufacture of other food products
- 10.9 Manufacture of prepared animal feeds
- 11.0 Manufacture of beverages
  - 28.93 Manufacture of machinery for food, beverage and tobacco processing
- 52.1 Warehousing and storage
  - 72.11 Research and experimental development on biotechnology
  - 72.19 Other research and experimental development on natural sciences and engineering

##### **Downstream CZ-NACE items, functional relations**

- 01.1 Growing of non-perennial crops
- 01.2 Growing of perennial crops
- 01.3 Plant propagation
- 01.4 Animal production
- 01.7 Hunting, trapping and related service activities

03.1 Fishing

03.2 Aquaculture

#### 9.2.6.4 Ensuring a healthy and quality environment and efficient use of natural resources

- **Natural resources**

- Obtaining expert documentation based on the results of applied research for the protection and utilisation of the rock environment, soil, groundwater and mineral resources and reducing their load resulting from the effect of anthropogenic factors in the landscape (e.g., land appropriation, contamination, aggravation of conditions for the identification, inventory, utilisation and evaluation of geological conditions, natural resources and geo-factors)
- Effect of anthropogenic influences and geo-factors on environmental compartments
- Support, protection and considerate and efficient use of raw material resources and groundwater and use of secondary raw materials
- Obtaining expert documentation for soil protection in terms of preserving the biological, physical and chemical properties of soil in relation to enhancing the quality and restoring the functions of soil
- Expert support for planning in the field of groundwater and surface water and for the optimisation of landscape water regime
- Expert support (documentation, inventory, monitoring, data analysis and synthesis of new findings) for medium- and long-term evaluation of the condition of and effect of changes on environmental compartments, natural resources and landscapes
- Sustainable provision of the non-production and production functions of soil
- Expert support for planning in the field of water

**Research focusing on natural values, combined with the provision of knowledge and expert documentation for efficient conservation of nature, especially for:**

- Protecting biodiversity at the level of communities, species and genetic variability of specimens
- Fulfilling the Czech Republic's obligations under international agreements and treaties
- Ensuring the implementation of Natura 2000 and/or implementation of Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora and Directive 2009/147/EC on the conservation of wild birds
- Restricting the adverse impact of invasive species and/or implementing Regulation (EU) No 1143/2014 of the European Parliament and of the Council on the prevention and management of the introduction and spread of invasive alien species and Council

Regulation (EC) No 708/2007 concerning use of alien and locally absent species in aquaculture

- Fulfilling the National Action Plan to Reduce the Use of Pesticides, increasing the effectiveness of special territorial protection of nature and landscapes on a long-term basis, especially for methods and procedures for keeping protected ecosystems and their constituents, species biotopes and species populations in good condition and for the collection and evaluation of information about their condition and development in terms of the achievement of goals for special territorial protection of nature and landscapes
- **Global changes (and adaptation to climate change)**
  - Climate scenarios and changes, identification and monitoring of their impacts
  - Analysis of the future impacts of climate change on ecosystems, biotopes and individual species, methodology for evaluating the degree of their susceptibility and threat and the related environmental and social risks
  - Planning, preparation and execution of adaptation measures; synergy and antagonism of measures
  - Monitoring and assessment of the efficiency of adaptations and evaluations – environmental aspect; economic analysis and evaluation of the benefit of adaptation measures, including the aspect of preserving the scope or minimising the loss of ecosystem services
  - Assessment of the impact and prediction of natural hazards and anthropogenic risks and options for their prevention in relation to climate dynamism
  - Research into water-rock-air biochemical interactions and modelling of critical loads and development scenarios
  - Research into the migration, accumulation and release of elements and compounds in an anthropogenically affected environment and their natural geochemical cycles in the rock and soil environments
  - Methodical research on and identification of sophisticated indicators of the quality of environmental compartments
  - CO<sub>2</sub> storage in rock structures to reduce the impact of climate change
  - Economic analyses of climate change impacts – quantifying financial impacts if no action is taken and the cost of adaptation (cost & benefit analyses)
- **Sustainable development of the landscape and human settlements (and environmental security)**
  - Preserving the natural properties (functions) of the landscape (ecological stability, landscape water regime, soil-forming processes, biodiversity, migration penetrability of landscapes)

- Restoring and preserving ecosystems providing ecosystem services as an integral part of landscape uses
- Predicting the impact of various effects and their combinations on the functional use of landscapes
- Introducing a continuously functional system for assessing the condition of environmental compartments and landscape constituents
- Improving the effectiveness of predicting the effects of natural phenomena and processes, utilising natural potential and evaluating their impact on environmental compartments, landscapes and society
- Obtaining expert documentation for the efficient conservation of species, implementation of Natura 2000 and fulfilling obligations under international agreements and treaties, as well as preparing scientific documentation for the implementation of the Regulation (EU) of the European Parliament and of the Council on the prevention and management of the introduction and spread of invasive alien species and fulfilment of the National Action Plan to Reduce the Use of Pesticides
- Providing new methods, procedures and solutions for increasing the resistance of municipalities to the impacts of crisis situations (disasters) of anthropogenic and natural origin
- Analysing the impact of anthropogenic effects and actions on landscape ecological stability; options for preserving and restoring the natural properties (functions) of the landscape – ecological stability, landscape water regime, soil-forming processes, biodiversity, migration penetrability of landscapes
- Methodologies for assessing the quantitative and qualitative parameters of the stability of ecosystems and ecological networks and conditions of their sustainability
- Evaluating and appraising ecosystem services
- Restoring and preserving ecosystems providing ecosystem services as an integral part of landscape uses
- Effect of natural and/or near-natural ecosystems and elements in settlements on the ecological and social functions of settlement environments (a range of ecosystem services – microclimate, discharge conditions, population health), comprehensive assessment of the functional condition of settlement greenery for the purposes of strategic planning
- Sustainable model of functional use of landscapes
- Modern methods and systems for building smart human settlements with minimum energy and material intensity and research into methods for achieving adequate self-sufficiency in food and raw materials
- Sustainable model of monitoring and evaluating the condition of landscapes and their constituents (a set of indicators, data sources, information systems) Improving the effectiveness of predicting the effects of natural phenomena and processes and

natural potential utilisation on the evaluation of their impacts on landscapes, society and the quality of environmental compartments

**Environmental security:**

- Creating tools and technologies for identifying, monitoring, predicting, preventing and mitigating the risk of crisis situations (disasters) of anthropogenic and natural origin and monitoring their impacts
  - Protection against the adverse effects of extreme weather phenomena (floods, drought, heat waves, extreme wind) and exogeodynamic processes (erosion, sedimentation, retention, slope instability, acidification of water, soil and rock environment) and proposals for mitigation of their impacts
  - Protection of the environment from the adverse impacts of crisis situations (disasters); prevention, mitigation and adaptation tools
  - Creating methodologies and tools for identifying, evaluating and preventing anthropogenic risk
- **Environmental technology and eco-innovation (and sustainability of the energy industry and material resources)**
    - Decreasing energy intensity and reducing atmospheric emissions
    - Evaluating the impacts of meteorological and anthropogenic processes on emissions and pollution with special regard to determining the toxicological properties of dust particles and enhancing the precision of air pollution modelling
    - Designing tools/methodologies for fulfilling measures from strategic documents concerning waste, air protection, climate and water
    - Developing environmentally friendly technologies and procedures in mining, transporting and processing raw materials and replacing primary resources with secondary resources in relation to strategic documents concerning waste and the circular economy
    - Research and innovation in the field of the circular economy
    - Developing best available techniques and newly emerging techniques for industrial activities, providing a higher level of environmental protection and higher cost savings
    - Research into non-traditional and unconventional energy sources and their potential
    - Research and development of methods for energy deposition and storage in the Earth's crust
    - Research and development of smart systems of renewable energy generation, storage and distribution with a view to minimising impacts on nature and landscapes (local potential and consumption)
  - **Environmentally friendly society (and social and cultural development and evolution and the application of human potential)**

- Creating a system for the adequate presentation of environmental knowledge
- Research into inconsistency between attitudes and behaviour in environmental protection in different age groups (including adults) – identifying barriers and the learning, education and mass education options for overcoming them
- Creating and verifying methods for the quantitative economic evaluation of environmental policies' impacts on businesses and households
- Voluntary tools for promoting environmental innovation
- Creating uncomplicated environmental legislation

**Social and cultural challenges:**

- Creating a system of policy assessment based on the principles of sustainable development
- Proposing uses of ICT tools for improving the effectiveness of predicting the effects of natural phenomena and processes, utilising natural potential and evaluating their impacts on landscapes, society and the quality of environmental compartments
- Optimising the use of ICT tools for monitoring environmental compartments, supporting the conduct of administrative activities concerning the environment and evaluating the impacts of environmental policies with the aim of reducing the costs and administrative burden caused by legal regulation
- Developing tools and methodologies for the efficient application of economic, administrative, legal or voluntary tools in environmental protection and minimising the costs of achieving the objectives of conceptual documents concerning the environment
- Developing innovative methods in structured and unstructured environmental data mining with the aim of data reuse, comparison and dependency analysis
- Developing innovative methods and procedures based on progressive digital technology, new data sources (originating, e.g., from remote Earth observation) and combining them with available data, with the aim of establishing standardised support mechanisms for environmental engineering, evaluation and reporting

**Development and application of human potential:**

- Designing updated education models for lifelong environmental learning
- Improving the efficiency of tools for environmental learning, education and mass education
- Researching the potential of the circular economy for the creation of new jobs under the Czech Republic's conditions

Research needs within the purview of the Ministry of the Environment

In line with the National R&D&I Policy 2016–2020 (Government Resolution No. 135 of 17 February 2016)

B/ Indicative relation to the CZ-NACE classification<sup>267</sup>

**Main relevant CZ-NACE items**

- 01 Crop and animal production, hunting and related service activities
- 02 Forestry and logging
- 05–09 Mining and quarrying
- 10–33 Manufacturing
- 35 Electricity, gas, steam and air conditioning supply
  - 35.21 Manufacture of gas
  - 35.30 Steam and air conditioning supply; production of ice
- 36 Water collection, treatment and supply
- 37 Sewerage
- 38 Waste collection, treatment and disposal activities; materials recovery
  - 38.11 Collection of non-hazardous waste
  - 38.21 Treatment and disposal of hazardous waste
- 38.3 Materials recovery
- 39 Remediation activities and other waste management services
- 41–43 Construction
- 49 Land transport and transport via pipelines
  - 52.1 Warehousing and storage
    - 72.11 Research and experimental development on biotechnology
    - 72.19 Other research and experimental development on natural sciences and engineering

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<sup>267</sup> The environment is not a separate item in the CZ-NACE classification of activities – but it overlaps with almost all of the activities.

## 9.2.7 Social challenges

### 9.2.7.1 Security research

R&D&I topics identified through the EDP:

- **Security system development**
  - Security policy and crisis management – developing knowledge and tools for supporting the security policy and crisis management processes in all stages of the political cycle with emphasis on capabilities to monitor and analyse the security environment and related trends and reflect their development accordingly in legal and other regulations and other management or planning mechanisms; managing interfaces and communication with stakeholders outside the security system using the above-mentioned tools.
  - Effective intervention capabilities – developing tools to support the capability of security and rescue forces and other active constituents of the security system to handle large-scale security incidents or incidents with significant impacts on affected communities or society, especially special intervention resources or procedures, tools for supporting command, control and communication during an incident or supporting tactical situation awareness.
  - Forensic capabilities – systematically developing knowledge and tools supporting the capabilities to document, investigate and clarify the occurrence and course of security incidents, support tools and methods for identifying people and things and tools for exploiting electronic sources of information.
  - Internal development of security system constituents – developing the capabilities of individual security system constituents to make preparations for, ensure the security of and create the conditions for effective action by their members and to internally evolve in the long term based on experience and technological advancement.
  
- **Security of citizens**
  - Secure public space – developing knowledge and tools supporting stakeholders' capability to programmatically guarantee public space security, including the security-relevant properties of the design of such space, communication, warnings and notifications as well as the behavioural aspects of security safeguarding.
  - Early warning and situation awareness – developing the capability of responsible bodies to maintain long-term situation awareness in special areas of interest in respect of serious security risks, including the capability of modelling and predictively oriented analysis in support of early warning in the event of a crisis to make the response of the security system and society more effective.
  - Security of infrastructures – developing tools and procedures for ensuring the reliability, availability and functionality of socially significant infrastructures and preparing systemic measures at the level of the infrastructure itself, a community, a territorial unit or the country in case of their disruption or failure, including



preparations for the side effects of such failures within sectoral and inter-sectoral relations.

- **Security contexts**

- Economic interface – obtaining knowledge and tools for developing private entities' capabilities to ensure the stability and continuity of their own operations in and outside crises, including guaranteeing the reliability of industrial complexes and their parts, adequate protection of the innovation sector in such fields as intellectual property and know-how, development in the study of the legal aspects of technology failures (especially in relation to Industry 4.0 initiatives), to ensure the integrity, stability and availability of supply chains, to work on issues concerning work safety as well as the protection and reliability of services from the end customer's perspective.
- Environmental interface – obtaining knowledge and tools in areas relating to the interaction between communities and the environment, sustainable development and the availability and stability of ecosystem services. Specific focus can be defined for the areas of the monitoring and enforcement of protection regimes, biodiversity protection, monitoring and analysis of climate change impacts, long-term risks arising from technological advancement or the protection of the production capacities of agricultural land.

Societal interface – obtaining knowledge for developing capabilities in areas deserving special social interest, especially ethics, individual rights and freedoms, cultural identity and cultural heritage, social processes with a varying degree of relevance for the area of security or ensuring social stability and democracy and public control.

### 9.2.7.2 Research in health care<sup>268</sup>

- **Disease emergence and progress**
  - Metabolic and endocrine diseases
  - Cardiovascular diseases
  - Cancers
  - Nervous and mental disorders
  - Musculoskeletal disorders and inflammatory and immunological diseases
  - Infections
  - Childhood diseases and rare diseases
  
- **New diagnostic and therapeutic methods**
  - In vitro diagnostics
  - Low-molecular medicines
  - Biological medicines, including vaccines
  - Drug delivery systems
  - Gene and cell therapy and replacement tissues
  - Development of new medical instruments and equipment
  - Innovative surgical procedures, including transplantation
  
- **Epidemiology and prevention of the most serious diseases**
  - Metabolic and endocrine diseases
  - Cardiovascular diseases
  - Cancers
  - Nervous and mental disorders
  - Musculoskeletal disorders and inflammatory and immunological diseases
  - Additions
  - Infections

### 9.2.7.3 Labour, social services and pension system

- **Research on family policy:**
  - Families' socio-economic situation
  - Families' demographic situation
  - Families' value positions and preferences

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<sup>268</sup> Medical research priorities according to the Medical Research Strategy up to 2022.

- Child care
- Equal opportunities, gender issues
- Senior population's quality of life
- **Research on social policy:**
  - Social work
  - Social services
  - Social housing and social inclusion
- **Research into occupational safety and health**
  - Base data and assessment methods for the socio-economic aspects of labour
  - Scientific data and methods for assessing health risks from exposure to hazardous chemicals and nanoparticles
  - Study of the effects of exposure to selected working environment and working condition factors (physical, physiological and psychological factors)
  - Study of the effects of mental and socio-psychological stress at work
  - Selected occupational diseases, their diagnostic and assessment criteria
  - Education and training
  - OSH management
- **Research into employment**
  - Employment and further professional learning in relation to the labour market
  - Employment of and aid for the disabled
  - Benefit systems of state welfare, poverty relief, benefits for the disabled and care allowances
- **Research into social insurance systems**
  - Pension system and pension insurance
  - Health insurance, social security contributions and accident insurance
  - Employee's incapacity for work
  - Medical assessment service
  - Demographic development in relevant population groups
  - Monitoring of changes in foreign pension systems

- **Research into new societal challenges**
  - Social changes in European and Czech society resulting from internal and external structural shifts
  
- **Research into internal departmental processes**
  - Improvement in the efficiency of public administration performance

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