National Research, Development and Innovation Policy of the Czech Republic 2009–2015

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I. Background to the NRDIP

I.1. Reform of the research, development and innovation system in the Czech Republic

A fundamental basis of the National Research, Development and Innovation Policy 2009–2015 ("NRDIP") is the Reform of the Research, Development and Innovation System in the Czech Republic, approved by Government Resolution No 287 of 26 March 2008 ("Reform"). Although most of the reform measures were implemented in 2008 and 2009, they will not actually come to fruition until subsequent years (2012, or in some phases even later). Therefore, the implementation of the Reform is just the first stage in the process of putting the NRDIP into action. The Reform sets out seven basic objectives:

1. To simplify R&D aid – to assist institutions on the basis of results and teams on the basis of their projects.
2. To make a significant reduction in the current 22 budget headings that channel aid into R&D in the Czech Republic; to simplify the paperwork.
3. To promote research excellence, to favour such excellence and to capitalize on the results for innovation.
4. To make R&D programme assistance contingent on cooperation between public research and the users of R&D results, based on proportionate funding from public and private sources.
5. To install a more flexible public research organizational structure.
6. To secure the experts required for research, development and innovation.
7. To steep the Czech Republic in international cooperation in the field of research, development and innovation.

The preparation and course of the Reform includes certain restrictions reducing the effects of various measures in achieving the objectives listed above. One important limitation of the Reform was the time constraints placed on preparation, which prevented the drafting and sufficient consultation of deeper changes in the research, development and innovation system. Another major restrictive factor hampering the Reform is the political situation, which is not inclined to the reform of public administration in research, development and innovation ("RDI"). In particular, there are barriers preventing the amendment to the Competence Act which is needed to unify responsibility for RDI (currently scattered among bodies of state administration) and to deploy a model for the management of the national innovation system that has been successful in countries where innovation is more advanced. A clear definition of RDI responsibilities, which the Reform has failed to provide, is also an important prerequisite for the transfer of new knowledge into innovation.

However, at the time the NRDIP was being prepared, a number of reform steps had been taken which, as a whole, have contributed to the gradual cultivation of RDI in the Czech Republic. In particular, an amendment to Act No 130/2002 on the promotion of research and development was drawn up and subsequently approved under Government Resolution No 1145 of 10 September 2008. The amendment was approved as Act No 110/2009 and entered into force on 27 April 2009; it will enter into effect on 1 July 2009.

Another important Reform measure was a proposal for changes to the state administration of research, development and innovation (approved under Government Resolution No 1305 of 20 October 2008), which, following the reduction in the number of RDI budget headings to eleven, regulates (reduces) the number of positions and simplifies paperwork in the system of RDI state administration. The Reform was also reflected in departmental and interdepartmental policies, the draft Research and Development for Innovation Operational Programme and the concept of the Research and Development Information System, which were also approved by the Government during the second half of 2008. Not least, the Reform was reflected in the draft expenditure earmarked in the Czech national budget for research and development in 2009, with a projection for 2010 and 2011, which was approved under Government Resolution No 793 of 27 June 2008 and became part of Act No 475/2008 on the national budget of the Czech Republic for 2009 and forms a basis for draft national budget expenditure on research and development in 2010 (the preparations for which are now being rounded off), with a projection for 2011 and 2012.

I.2. Amendment to Act No 130/2002 on the promotion of research and development

The NRDIP is based on provisions laid down in the amendment to Act No 130/2002 on the promotion of research and development from public funds and amending curtained related laws (the R&D Promotion Act) and the activities proposed in this policy reflect the situation following the entry into force of this amendment (Act No 110/2009). The amendment to the R&D Promotion Act aligns Czech national law with EC law, simplifies the system for the support of research and development (institutional and special-purpose) and reduces the number of budget headings under which research and development is supported in the Czech Republic. There is also a change in RDI responsibilities (with no need to amend the Competence Act), mainly involving the Ministry of Education, Youth and Sports, the Council for Research, Development and Innovation, the Czech Science Foundation and the newly established Technology Agency of the Czech Republic.

I.3. Priorities of applied research, development and innovation

In 2008, expert commissions of the Research and Development Council ("R&D Council") drew up the priorities of applied research, development and innovation[1] (the updated Long-term Research Guidelines), which were approved as a basis for the preparation of this policy at the 237th R&D Council meeting on 14 November 2008. In the preparation of these priorities, a greater emphasis was placed on the active involvement of the user community, including the financial terms of its participation; this will increase the potential for the use of R&D results in applications. The Czech Republic's priorities in applied research, development and innovation foe 2009–2011 are set out in Part III.2. of the NRDIP.

I.4. Interdepartmental RDI concepts

The NRDIP draws on the Interdepartmental Concept of International Cooperation in Research and Development up to 2015, approved by the Czech Government under Resolution No 852 of 9 July 2009, which itself follows up on the document "European Research Area: New Perspectives" (other strategy documents prepared by the EU are presented in more detail in section I.8). The NRDIP also takes account of the Interdepartmental Concept of the Support of Major Infrastructure for Research

[1] The previous term, Long-term Research Guidelines, was replaced by the standard European term "priorities for applied research, development and innovation" under an amendment to Act No 130/2002.

and Development, approved by the Czech Government under Resolution No 1585 of 16 December 2008.

I.5. Amendment to Act No 586/1992 on income tax

Government Resolution No 531/2007 ordered the Minister for Finance to prepare a new draft law on income taxes, with the aim of making it much simpler. To accomplish this task, the Ministry of Finance has been carrying out legislative work on the preparation of an articled version of a new income tax bill against a backdrop of the continuing aim to encourage research and development projects by means of income tax advantages (a policy introduced in 2005) combined with a multiple increase in research and development costs compared to a fixed point in time and then compared to the previous tax period in order to promote an increase in expenditure on R&D from private sources. The purchase of research from the public universities and public research organizations should also be supported. No date has been set for the submission of the draft amendment to Act No 586/1992 on income tax to the Government.

I.6. EU Structural Funds

The bulk of the period over which the NRDIP is in effect falls within the 2007-2013 programming period, when the Czech Republic will use resources from the EU Structural Funds. RDI will be supported by EU Structural Funds primarily through three operational programmes for regions under the Convergence objective and two operational programmes for Prague within the scope of Regional Competitiveness and Employment:[2]

- The **Research and Development for Innovation OP (R&DI OP)**, which is the responsibility of the Ministry of Education, is aimed at strengthening the research, development and innovation potential of universities and research institutions and at increasing their cooperation with the private sector. To this end, the R&DI OP is used to aid the furbishing of research centres with modern technology, the building of new research centres, the creation of a system for the commercialization of R&D results, and an increase in the capacity of tertiary education for R&D. The main part of the total allocation for the R&DI OP, EUR 2070.68 million, is earmarked for R&D infrastructure supported under Priority Axis 1 – European Centres of Excellence (EUR 680.2 million) and Priority Axis 2 – Regional RDI Centres (EUR 680.2 million). Further support is channelled into the formation and development of centres for the transfer of technology from research organizations and investment projects aimed at popularizing Priority Axis 3 – R&D Commercialization and Popularization (EUR 229.8 million), and into the development of infrastructure for research-related teaching at universities with a direct impact on increasing human resources for research and development activities provided under Priority Axis 4 (EUR 414.1 million).
- The **Education for Competitiveness OP (EC OP)**, the managing authority of which is also the Ministry of Education, focuses on developing human resources by improving and modernizing systems of initial, tertiary and further education, their integration in a comprehensive system of lifelong learning, and improving conditions in research and development. The system for the education and development of human resources is a very important part of the innovation environment. The RDI policy objectives under the EC OP are

[2] A description of the current state of implementation of the individual operational programmes can be found in Annex 3.

implemented mainly through Priority Axis 2 – Tertiary Education, Research and Development, which is earmarked EUR 626.5 million (35% of the EC OP allocation).

- The **Entrepreneurship and Innovation OP (EI OP)**, managed by the MIT, is a key tool for the support of the development of research and innovation activities in the business sector. The EI OP, with a total allocation of EUR 3.040 million, is aimed at supporting the development of the business environment and encouraging the transfer of research and development results into business practice. It supports the creation of new firms, the development of the innovative potential of existing businesses, and the use of modern technologies and renewable energy sources. It also promotes improvements in infrastructure and services for entrepreneurship and networking between businesses and research institutions.
- The **Prague Competitiveness OP (PC OP)**, managed by Prague City Hall, is focused on the support of investment projects in numerous fields in Prague. RDI policy is implemented under the PC OP mainly through Priority Axis 3 – Entrepreneurship and Innovation (EUR 96.7 million, i.e. 35% of the PC OP allocation), where support is provided, inter alia, for the creation of innovation infrastructure, partner links between research organizations and businesses, and, on a general level, the development of innovative small and medium-sized enterprises.
- The **Prague Adaptability OP (PA OP)**, also managed by Prague City Hall, supports the implementation of non-investment projects focused on education, social integration, employment aid and the development of human resources in research and development. The closest link to the RDI policy under the PA OP can be found in Priority Axis 1 – Support for the Development of the Knowledge-based Economy (EUR 41.4 million, i.e. 38.2% of the PA OP allocation), which promotes human resources capacity building in research and development and further education linked to Prague's innovation development.

In pursuit of the objectives of the operational programmes, the steady development and modernization of research and innovation infrastructure in the public and private sector and the intensification of RDI cooperation at regional, national and international level can be expected. However, the newly built infrastructure will also place increased demands on the financial sustainability of its operation. Therefore, the NRDIP will take this fact into account and prepare appropriate measures to establish mechanisms for the sustainable financing (including partial self-funding) of the emerging RDI infrastructure. In connection with the support of innovative development in the regions via the EU Structural Funds, the stress will be on creating and implementing strategies and policies aimed at enhancing competitiveness based on the use of knowledge (Regional Innovation Strategies).

I.7. White Paper on Research, Development and Innovation in the Czech Republic

One of the important bases for the preparation of the NRDIP is the White Paper on Research, Development and Innovation in the Czech Republic, with contributions by the relevant leading experts from research institutions, universities, and the public and corporate sectors. The White Paper proposes RDI policy goals and measures that reflect the Czech Republic's current position in this area and the weaknesses of the national innovation system identified on the basis of a thorough analysis in the preceding Green Paper on Research, Development and Innovation. The proposed measures have been extensively discussed by an expert group and in the follow-up review procedure, which paved the

way for the entire process of NRDIP preparation. The formulation of NRDIP activities is also based on foreign experience described in the Book of Foreign Good Practice in the Implementation of Research, Development and Innovation Policy.[3]

I.8. European strategy documents

The NRDIP also reflects European documents setting out the EU's current orientation and strategy for RDI and the building of a knowledge society. The main EU documents are:

- The European Research Area: New Perspectives. COM(2007) 161
- Working together for growth and jobs. A new start for the Lisbon Strategy. COM(2005) 24
- Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013), EU Official Journal, 18.12.2006
- Decision No 1639/2006/EC of the European Parliament and of the Council of 24 October 2006 establishing a Competitiveness and Innovation Framework Programme (2007 to 2013)
- Community framework for State aid for research and development and innovation No 2006/C 323/01, EU Official Journal, 30.12.2006
- Commission Regulation (EC) No 800/2008 of 6 August 2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General block exemption Regulation)

I.9. Trends in State RDI aid abroad

Prior to work on the preparation of the NRDIP, studies were conducted to analyse current foreign trends in RDI policy and State RDI aid.[4] There is no uniform RDI model policy abroad. Policies differ in their level of centralization and in the proportion of State-aided R&D, the focus of which is selected independently (the bottom-up proportion). The following general conclusions can be drawn from an analysis of RDI strategy documents and policies:

- The process of creating RDI strategy documents is based on a broad national debate of representatives from public administration, the business sector, the research community and other interest groups.
- Strategy documents concerning RDI (defined in a broader context) also include R&D priorities in determining those disciplines that are crucial for the development of a country's competitiveness.
- Policymaking and the strategic management of innovation is a continuous process based on the systematic evaluation of implemented measures, analysis of the background and advances in the development of the knowledge-based society, forward studies on technological,

[3] Green Paper on Research, Development and Innovation in the Czech Republic, White Paper on Research, Development and Innovation in the Czech Republic, and the Book of Foreign Good Practice in the Implementation of Research, Development and Innovation Policies, drawn up in 2007-2008 by the Technology Centre of the ASCR. These texts can be found at www.vyzkum.cz (under National R&D Policy).
[4] The texts of these studies can be found at www.vyzkum.cz (under NRDIP).

regional and national development and, not least, conceptual proposals and modifications of economic-policy measures.

- Research teams and, where appropriate, independent research centres are set up and funded from public resources in order to prepare supporting documents for RDI strategy papers and policies.

Studies reveal the following main trends in the focus of State aid for RDI:

- In the field of infrastructure, the focus is currently on building larger infrastructure units from resources where research teams from academia collaborate with businesses on joint (usually extensive and long-term) research projects. Regional centres specializing in applied and commercial research with a view to increasing regional competitiveness are also supported. An important part of State aid in the field of RDI comprises initiatives fostering the development of knowledge transfer. These centres are set up either as part of knowledge institutions or as part of all-round innovation centres. Finally, advisory services to innovative companies are fully supported in order to assist with the introduction of research and implementation of innovations; there is a growing emphasis on services for the protection of intellectual property.
- Another prominent subject of current RDI policy issue is the development of cooperation and strengthening of ties between the business sector and research organizations. In addition to promoting cooperation through the creation of adequate infrastructure (see previous section), thematic research programmes are advertised where a prerequisite for participation is collaboration between public research institutes and businesses. At regional level in particular, there is support for the creation of innovative clusters, technology platforms and other forms of cooperation. Direct tools used to encourage inter-sector collaboration include innovation vouchers provided to businesses for the purchase of research from knowledge institutions, and bonuses granted to research organizations if they work together with enterprises on research projects. In accordance with the principles of “open innovation”, there is now a considerable emphasis on the development of international cooperation.
- In the field of RDI human resources development, there is support for the increased quality of education in a differentiated higher education system, with a particular stress on doctoral studies. Furthermore, specific tools and measures are used to promote horizontal and international mobility, brain-gain, and, not least, improvements in innovation culture and greater public awareness of RDI.
- Access to financial resources for RDI is improved by across-the-board fiscal instruments and selective programmes of direct aid. Fiscal instruments include items deductible from the tax base or tax abatements, and these advantages can also be used for external R&D (i.e. R&D purchased from research organizations, including universities). Direct instruments are used primarily as a catalyst for further private investment in innovation. Emphasis here is placed on the support of innovative enterprises (SMEs) during start-up or the early stages of business development, i.e. where the effects of market failure are greatest. There are also efforts to create a favourable environment for venture capital.
- The development of innovative activities is also boosted by measures intended to improve the business environment (on-line information systems and consulting, more accessible State aid for innovation, etc.).

A very important current trend in State aid for RDI is an increasing emphasis on the evaluation of support programmes and/or the entire system of State aid. Strengthening the evaluation culture is featured in virtually all RDI strategies and policies prepared in recent years abroad. A great emphasis is placed on quantifying the benefits to business productivity, employment and competitiveness for enterprises, sectors, regions and the State. There are also efforts to quantify the benefits to health and other indicators of the quality of life. Evaluations of the R&D system and science disciplines typically apply quantitative methods, i.e. indicators, including bibliometric indicators. Quantitative evaluation is often combined with an evaluation of the structure of the scientific system or discipline, the management method, funding and resources, and where appropriate future prospects. These qualitative analyses are processed by an evaluation panel composed mostly of review experts (for expert reviews) or experts in the field (for peer reviews).

II. Main principles of the NRDIP

Technological development based on RDI is becoming an integral part of sustainable development (i.e. socio-economic and environmental development) in all developed and developing countries. It is exclusively because of advances in research and development, resulting in innovation, that we can face global challenges such as energy-sustainable growth, a favourable environment and public health. From the national perspective, sufficient innovation performance is a prerequisite for maintaining competitiveness, economic growth and social stability.

The aim of NRDIP is to create a framework for the implementation of RDI-related measures stimulating the development of the knowledge society, which will further increase the competitiveness of the Czech economy and improve the quality of life in the Czech Republic. The NRDIP responds to the shortcomings of RDI in the Czech Republic, and by removing them wants to contribute to the creation of an environment that will stimulate excellent research and the creation of new knowledge for use in applications, and that will also increase demand for R&D results from the application domain and their transformation into innovative products and services. To this end, the NRDIP focuses on nine areas, for which it establishes milestones and a set of related activities that, together, should help achieve the above objective.

The NRDIP complies with the Czech Government's procedures for dealing with the effects of the global financial and economic crisis on the Czech economy and society, and also creates the preconditions for the Czech Republic to resume a path of dynamic economic growth once stability is restored.

II.1. System of RDI management

The basic prerequisite for a stable and efficient RDI policy is a quality management system based on a clear definition of RDI policy responsibilities, and effective coordination between the responsible public authorities at national and regional level. Participation in international RDI cooperation and participation in the development of the European Research Area will be effectively and efficiently coordinated. Besides adequate staffing (from the aspect of both numbers and qualifications) in the field of public administration (which is very important for the effectiveness of the system of RDI policy management), integral elements of strategic management are the systematic monitoring of developments in RDI, the production of analyses, and preparation of background studies for decision-making in the various fields in the competence of the State.

An important part of a functioning system, with close interaction between the providers of new knowledge and its users, is the strategic management of RDI by research organizations (especially public research institutions and universities). Strategic management includes strategies to protect intellectual property and commercialize RDI results. The strategic management of RDI helps to reduce the isolation of research organizations and strengthen their bond with users of RDI results.

A diagram of the RDI system is shown in Annex 5 to the draft NRDIP.

Current situation in the Czech Republic

There is a lack of strategic RDI management at national level in the Czech Republic. Also, in many public research organizations the strategic approach to managing RDI is insufficiently developed. The Czech Republic has not yet created a strategic line for the development of a knowledge-based society, increased competitiveness and improved quality of life.[5] The making of policies forming conditions for the development of a knowledge-based economy is in the competence of several central government agencies; these policies are not particularly mutually coherent, resulting in the mismatching or duplication of measures aimed at achieving the same goal. Centrally, there are no clearly defined competencies in the fields of innovation, which significantly impedes the implementation of innovation policy and its links with other government activities supporting the development of a knowledge society. Also, analytical work has not been widely used for RDI policymaking and there is a lack of long-term financial security for an independent professional body concerned with consistently and systematically monitoring and evaluating developments in this area and with the preparation of supporting documents for strategic decisions by State institutions dealing with the management and support of RDI.

II.2. Priorities of RDI aid from the national budget

An inextricable element of strategic RDI management is the determination of priority guidelines focusing on State aid for research and innovation activities. It is obvious that small countries do not have sufficient capacity to carry out cutting-edge (or at least globally comparable) research in all scientific disciplines. In small countries, there is not enough industrial and service sector capacity to increase competitiveness based on innovation in all fields of economic activity. For these reasons, it is necessary to concentrate RDI policy efforts into the development of areas where there is sufficient capacity in the research and application domain.

Due to the nature of basic research, it is not advisable to for the central government to set priority areas; decisions on how to channel aid for basic research projects are better left to the research organizations themselves.

In contrast, for applied research it is appropriate to focus State aid on areas where there is proven research, development and technological potential highly relevant to fundamental issues of society and offering opportunities for use in new products, technologies and services.

Current situation in the Czech Republic

In the current system of State aid for RDI, ministries have announced thematic programmes (National Research Programmes) based on the priorities of applied research, development and innovation (previously known as Long-term Research Guidelines – LTRG, the preparation of which is the responsibility of the R&D Council). However, the link between the thematic focus of RDI support programmes and these priorities has often only been formal, and the supported activities frequently

[5] The Economic Growth Strategy from 2005 comes closest to this objective.

failed to reflect the set priorities of Czech RDI. Experience also shows that these priorities were defined too broadly and encompassed a very wide range of research fields, which often poorly reflected the needs of RDI users. The National Research Programmes did not address cross-cutting research priorities such as human resources development. The drawing-up of applied research, development and innovation priorities in 2008, in which representatives of the application sphere were more intensively involved than in previous years, was a step forward in the preparation of research priorities. The output of this process was the identification of eight priorities, which are presented in more detail in Part III.2. of this document. Even so, it will be important to pay more attention to proper methodology for the process of preparing applied research priorities and their links to the needs of society, and to ensuring that State aid programmes for applied research, development and innovation are directly linked to the identified priorities.

II.3. Greater dependence of the amount of aid on the results achieved

The system of State aid will significantly stimulate the research and development at the global level (excellence in RDI) the practical utility of RDI results. The distribution of funds will therefore be sufficiently connected with the evaluation of R&D results (ex-ante and ex-post), taking into account the qualitative standard of research and the link between R&D results and the needs of the application sphere and sustainable development in general. An important prerequisite for an effective system for assessing the results of RDI is a quality information system that will allow for the monitoring of the results of research and innovation activities supported by public funds and which will also ensure effective checks of the results evaluated. Similarly to the significance of the rigorous evaluation of the results of research activities and the institutions carrying out these activities with support from public funds realized, the whole system of State aid for RDI will undergo detailed evaluation at regular intervals as a basis for the ongoing review and adjustment of the system.

When decisions are made on State aid for RDI, the relevance and appropriateness of the aid must be carefully considered and the possible negative effects in the form of undue distortions of competition must be assessed in keeping with the Community Framework for State aid for research and development and innovation.

Current situation in the Czech Republic

Although public spending on R&D in the Czech Republic is growing faster than in other European countries, the amount (relative to the population and economic maturity) is still below average in comparison with the EU. The allocation of funds in the form of institutional support is not yet sufficiently linked to evaluations of the results of research work. The consequence is not only a lack of quality in RDI outputs, which is reflected in a lower number of scientific publications and citations thereof, in a lower number of patents, new technologies, products and services, and also in weaker incentives for research staff to engage in high-quality research work. While systematic reviews of research financed by public funds have been carried out at some providers in different forms since 1993 in the Czech Republic (evaluations of research projects were introduced in 1999 and the first single assessment methodology was approved by the Government in 2004), the distribution of financial resources is not yet sufficiently conditional on ex-post evaluations of the results of research work.

II.4. Use of R&D results in innovations as an indicator of the effectiveness of State aid

Although quality research is a necessary condition for the country's development towards a knowledge-based society, it is not enough. It is important to ensure the transfer of RDI results into practical applications (innovations) which will push forward the growth of the corporate sector's competitiveness and contribute to the sustainable development of the country. RDI policy in this regard will help create an attractive environment both for the creation of knowledge in basic research and for the rapid transfer of new knowledge between different players in the innovation process; the key is a close link between the research and application domains. Experience shows that coherence and collaboration among the various players in the innovation process accelerates innovation significantly. It is therefore necessary to treat the creation, transfer and use of knowledge as an open process (open innovation) involving multiple players at national and international level. With this approach to innovation, the role of IPR protection clearly has a higher profile and will become an obvious part of research and innovation activities.

Another important part of the milieu for the application of new knowledge in innovation is sufficient access to financial resources for the implementation of generally high-risk innovation projects. Although subsidies from public sources can facilitate the innovation and the development of new technology-oriented firms, the effectiveness of such aid, given the high demands placed on peer reviews of individual innovation projects, is uncertain. The creation of an environment conducive to private investment, venture capital and the stimulation of capital investment in innovative enterprises appears to be more efficient. Public funds should, in this context, be considered a "catalyst" that, by appropriate and sufficient means, will stimulate the corporate sphere to increase spending on RDI Significant space in this area exists for cooperation between the public and private sectors.

Current situation in the Czech Republic

R&D results in the Czech Republic are not yet consistently used in innovation. The main causes include the lack of new RDI knowledge relevant to commercialization, the application sphere's lack of interest in R&D results from the public sector (thanks in particular to the use of other comparative advantages, such as cheap labour), generally little interest among numerous academic institutions in transferring their knowledge, or their lack of awareness about this issue. This is also reflected in the limited number of emerging spin-off companies in the Czech Republic, which tend to be the natural partners of research organizations and the beneficiaries of their knowledge. A serious problem is the lax protection of intellectual property rights in the public and private sector, which is reflected in the low patent activity in the Czech Republic. Also, RDI cooperation between public research and enterprises, as in many other countries, remains low.

Although, since 2004, contributions of resources from the EU Structural Funds have spurred on the emergence of numerous new innovation infrastructure entities, their activities are not sufficiently effective and major shortcomings remain the absence and poor quality of support services for the use of knowledge in applications and weak support for technology transfer. Czech companies invest in RDI less than businesses abroad, and focus more on adapting products to the local market and exploiting the weakening comparative advantages of the Czech Republic (especially cheap labour). The funding of innovation activities in the form of venture capital is practically non-existent in the Czech Republic. Also, cooperation within the business sector in joint innovation activities is still insufficient; research conducted in clusters does not produce the expected results, and poles of excellence in the Czech Republic, with few exceptions, are virtually non-existent. The horizontal mobility of workers is inadequate and aid to strengthen it has been earmarked but not used.

II.5. Internationalization of RDI

The approach to innovation as an open process is related to the development of cooperation at regional and national level, and to intensive involvement in international research and innovation activities. Small open economies must use all the opportunities arising from international cooperation in research and technological development. RDI policy will seek to ensure that the country becomes an attractive location for international research activities, that domestic research teams become sought-after partners for cooperation in research, and that national research institutes become an attractive proposition for foreign researchers. An emphasis will be placed on the specific economic benefits of international cooperation in RDI. At a political level, there will be greater stress on active involvement in shaping the European Research Area and creating conditions for the increased participation of domestic research teams in European RDI support programmes (FP7, CIP and others). The creation of an environment conducive to the international mobility of researchers and skilled workers could also further the country's active involvement in international research.

Current situation in the Czech Republic

Despite the high degree of openness of its economy, the Czech Republic does not make sufficient use of the options or resources offered by the European Research Area. Although the Czech Republic is one of the most successful countries in the international EUREKA initiative, the participation of Czech teams in EU Framework Programmes is low compared to EU-27 countries, and the amount of aid received per capita and per RDI employee lags behind the EU-27 average. The participation of Czech representatives in the technology platforms set up thus far has also been low. Evaluations of participation in the Framework Programmes also indicate that the Czech Republic has the lowest number of project coordinators anywhere in the EU-27. The limited participation of Czech research teams in international research projects may be influenced to some extent by a lack of motivation resulting from easier access to State aid for RDI from national sources. On the other hand, a positive factor is that the Czech Republic's participation in EU Framework Programmes and the resources received are increasing, which can be attributed to the Czech research community's growing interest in international activities and to the activities of institutions that have assisted the participation of research organizations in Framework Programmes for many years.

II.6. Delivering quality human resources for RDI

The task of RDI policy is to establish close interaction with education policy in order to develop human potential with the qualifications and structure to meet the demands arising from the development of a knowledge society. An important role in this respect can be played by the system for the financing of research centres and teams, which should be reflected in the attractive financial remuneration of quality researchers, thereby stimulating (especially among young workers) research work. Well-configured mechanisms for the provision of institutional support for research activities should also be reflected in the greater differentiation of universities (and their individual centres) in terms of the educational or research focus.

Current situation in the Czech Republic

In comparison with the EU-15, there are much fewer researchers relative to the size of the population; middle-aged (35–55 years) management researchers with international experience are in particularly short supply. One of the main reasons for this is the lack of differentiation in the appraisal of researchers based on the quality and benefits of the research work. The result is a lack of interest among bright young people in a long-term scientific career and the drain of quality researchers going

abroad or leaving research to take on other jobs. The limited differentiation of salaries in RDI also hampers the arrival of researchers from abroad and fails to stimulate Czech scientists enough for them to return from foreign institutions. The dearth of skilled researchers is already a major limiting factor for the further development of industrial R&D.

Although the number of students and graduates, including doctoral students, in the Czech Republic is increasing, it remains low compared to most European countries. The structure of subjects studied by graduates does not correspond to the needs of the Czech Republic's knowledge economy and labour market demands. Graduates' skills often fall short of the application sphere's expectations, graduates lack the autonomy necessary to address problems and offer sufficient flexibility.

II.7. RDI and society

In order to achieve the balanced development of the national innovation system, the development of not only the supply side (the creation of knowledge and its use in innovations), but also on the part of demand for innovation, will be systematically promoted. To this end, the NRDIP will contribute to a general pro-innovation climate in society (an innovation culture), and disseminate adequate public awareness about the importance of RDI in increasing competitiveness and the quality of life.

Current situation in the Czech Republic

In the Czech Republic there is insufficient public awareness of the significance of RDI for the development of competitiveness and the quality of life. This is also accompanied by a certain reticence in society towards new developments and an unwillingness to risk, which is negatively reflected in the lack of demand for innovation. The relatively low "entrepreneurial spirit" of the Czech population is another factor. The media, for its part, still fails to sufficiently promote research, new research findings and their contribution to the economy and quality of life.

II.8. Links to policies (concepts) covering other fields

The priorities, objectives and activities set out in the NRDIP, as a basic strategic document for the development of society based on the creation and use of knowledge, will be reflected in other conceptual and policy documents created for the development of sub-areas. A close between the NRDIP (at material level and at the level of institutional security) is required primarily with educational policy, because education is a key element of and a prerequisite for the development of a knowledge society. In the implementation of the NRDIP, continuity and coordination with industrial policy, regional policy and other sectoral concepts (health, defence, security, energy, environmental protection, agriculture, culture, etc.) are also important.

Current situation in the Czech Republic

The preparation of the strategies and policy documents of government departments in the Czech Republic is largely carried out in isolation and lacks substantive and temporal continuity, which is reflected in a stark lack of coordination in the formulation and implementation of economic-policy measures. The process of preparing conceptual documents often lacks systematic evaluation of development trends and the impacts of previous policies, and new concepts are shaped on the basis of ad hoc requirements. In those cases where the realization of conceptual documents is evaluated, this is mostly a formality; the real benefits of the implemented measures are not evaluated using appropriate sets of indicators and the corresponding updates are not performed.

II.9. Periodic evaluations of the Reform, NRDIP and State aid system

A key part of an effective RDI policy is the monitoring and regular evaluation of the impacts of the measures implemented. Only on the basis of a thorough analysis of the effectiveness of the activities undertaken in relation to objectives is it possible to correct the existing measures or adopt further measures and adapt RDI policy to current trends and the needs of the national innovation system. Another essential element of the RDI management system is the regular evaluation of the whole system of State aid in order to assess the effectiveness of public spending on RDI.

The NRDIP will be updated following the results and recommendations of an external centre responsible for conducting evaluations of the entire system of State aid for RDI (see Measure A 9.3). The recommendations of the "2020 Vision for the European Research Area", which was adopted by the Competitiveness Council in December 2008 will be used and gradually implemented.

Current situation in the Czech Republic

Evaluations of the RDI system in the Czech Republic are not carried out systematically; instead, they are administrative in nature and the new measures under the RDI policy are formulated without sufficient evaluation of the impact of previous actions. The Czech Republic also lacks long-term financial capacity for an independent expert body responsible for continuously evaluating the impact of RDI-related policies and State aid and, on the basis of comprehensive analyses, preparing supporting documents for the modification of existing or creation of new measures, the better targeting of State aid for RDI, and for the overall strategic management of RDI at national level.

III. NRDIP objectives and activities

OBJECTIVE 1: ESTABLISH RDI STRATEGIC MANAGEMENT AT ALL LEVELS

The aim is to establish the strategic management of RDI centrally, based on a thorough systematic evaluation of the impact of the National RDI Policy and the systematic analysis of activities in this area. All of these components of strategic management will be used effectively so that the RDI policy can respond flexibly to changing conditions in the development of the knowledge society. The introduction of strategic management by individual research organizations is also crucial, particularly in the context of strengthening the third role of universities (or second role of research institutions).

A 1-1: Establish a single coordinating body at the central level of State administration to be responsible for RDI

Deadline: 2013; Responsibility: Government, on a proposal by the R&D Council

In order to implement the RDI strategic management and make the system of State aid for RDI more efficient, a coordinating body will be set up with responsibility for the strategic management of RDI, including the coordination of State aid for RDI. The coordinating body will be created in 2013 by transforming the current R&D Council, which already carries out many of these activities. In the field of RDI policy, this body will mainly coordinate the activities of central government agencies related to RDI policy; in the field of State aid for RDI, the coordinating body will make proposals to the Government regarding the allocation of government spending on RDI (institutional and special-purpose), evaluate cost-effectiveness in relation to the results achieved, and set priorities in the targeting of State aid for applied research. The coordinating body will have a board composed of leading experts in basic and applied research, development and innovation. The head of the coordinating authority, who will also be a member of the Government, will have sufficient human and financial capacity for the strategic management of the RDI system and will carry out the routine agenda associated with the coordination of State aid for RDI.

A 1-2: Launch of the Czech Technology Centre in accordance with an amendment to Act No 130/2002

Deadline: 2010; Responsibility: R&D Council

An important part of an effective system of State aid for RDI is an effective implementation structure. Although the targeted support of basic research in the Czech Republic is sufficiently concentrated (with the Czech Science Foundation playing the key role), the targeted support of applied research is very fragmented. In order to concentrate (and thus streamline) the support of applied research, the amended Act No 130/2002 regulates the remit of the Czech Technology Agency (CTA). In accordance with this Act, Technology Agency bodies will be set up and will launch operations consisting of the distribution of gradually increasing government spending on the applied research within their competence, which the CTA will start disbursing in 2011. After an evaluation of the CTA's activities, the second stage of development will be prepared, which will encompass the optimization of its operations and organizational structure.

A 1-3: Promote the implementation and updating of the NRDIP from the national budget

Deadline: as of 2009; Responsibility: R&D Council to 2013, the newly established coordinating body from 2013

An integral element of the strategic management of RDI policy is the continuous monitoring and evaluation system of the RDI system and the provision of a professional analytical and conceptual background for RDI policy (an RDI policy think-tank). The production of analyses and underlying studies and their efficient use by decision-makers is desirable not only during the making of RDI policy, but also during its implementation; they can form the basis for the implementation of corrective measures. In 2009-2013, this supporting activity for the RDI policy will be aided with funds earmarked for the R&D Council's activities, such as research for the requirements of public administration carried out in accordance with the Public Procurement Act. In the following years, the newly established coordinating body's funds will be used to support the continuous operation of an organization that will systematically deal with the preparation of underlying analyses, evaluation reports, and forward and conceptual studies in RDI. In order to ensure a systematic approach, this specialist activity for RDI strategic management will be carried out by the relevant organization under a long-term contract concluded with the newly established coordinating body, which will then use the outputs for strategic RDI policy management and for the targeting of State aid for applied research, development and innovation.

A 1-4: Strengthen the role of the management of universities and other research organizations

Deadline: as of 2011; Responsibility: MoEYS

Besides the central level of government administration of the RDI system, it is necessary to improve management control at universities and other public research organizations to strengthen the third role of universities and research institutions.[6] Appropriate involvement of representatives of other sectors in the management of universities and other research organizations will help strengthen the management control of universities and other research organizations. An integral part of the strategic management of research at institutions is the conceptual approach to the implementation of R&D results in practice (see section II.4).

OBJECTIVE 2: FOCUS STATE AID FOR RDI ON THE NEEDS OF SUSTAINABLE DEVELOPMENT

With a view to concentrating capacities and resources to achieve practical research results, the needs of society and research priorities that will help meet those needs will be identified in a demanding, professional manner. Special attention will be paid to these research priorities in the formulation of RDI policy and the distribution of public funds for applied research and development.

[6] Universities should therefore play not only an educational and research role, but also cooperate with other bodies of the knowledge society. Other research organizations (outside universities) should mainly play a research role, but should also have an educational function, and cooperate with other bodies of the knowledge society.

A 2-1: Review the priorities of applied research, development and innovation in relation to the needs of sustainable development in the Czech Republic.

Deadline: 2011; Responsibility: R&D Council

State aid for applied research, development and innovation will continue to be provided particularly in relation to the needs of the application sphere embedded in the priority areas of applied research, development and innovation. Priorities for applied research, development and innovation will be set in accordance with the objectives to be achieved by research and in relation to the needs of sustainable development in the Czech Republic in all three of its pillars (economic, social and environmental development), the results obtained, the RDI tradition, existing capacities in the research sphere and trends expected in R&D and technology. The priorities will be determined by independently and professionally. The process of preparing priorities will be open and transparent, the emphasis will be placed on the involvement of RDI users (application sphere) and co-financing from private sources. To identify strategic areas of Czech RDI, thorough research analyses of the Czech Republic's research and innovation potential and forward studies (foresight), developed by an independent agency for the systematic preparation of underlying analyses and foreword studies in the field of RDI (see also Activity A 1-3), will be used. Unlike the current priorities of applied research, development and innovation, priority areas will be reduced (by theme and number) in the future.

A 2-2: As a matter of priority, channel State aid for RDI into priorities corresponding to the needs of society and the knowledge economy in the Czech Republic.

Deadline: 2012 – call for tenders, 2013 – project financing; Responsibility: the CTA in cooperation with the R&D Council (or, as of 2013, with the newly established coordinating body) and the CSF.

The identified priorities will be transformed into programmes of targeted applied research, development and innovation support, which will be advertised by the Czech Technology Agency and other providers of State aid. In setting priorities for applied research, development and innovation (see Activity A 2-1), the proportion of public funds to be earmarked for the targeted support of applied research, development and innovation in the identified priorities will be professionally quantified. At the same time, an emphasis will be placed on linking basic research to subsequent stages of the innovation process (applied research, experimental development and the implementation of their results in innovations), especially in priorities relevant to the needs of society and the knowledge economy in the Czech Republic.

OBJECTIVE 3: IMPROVE THE EFFICIENCY OF THE RDI STATE AID SYSTEM

One of the basic conditions for the balanced development of the national innovation system is an effective system of State aid for research and development. *The aim is to set up mechanisms for the provision, use and evaluation of State aid for RDI so that this assistance contributes to the excellence of Czech research and the usability of RDI results in innovations.*

A 3-1: Distribution institution aid for R&D on the basis of an evaluation of the R&D results achieved by research organizations.

Deadline: 2012/2015; Responsibility: R&D Council to 2012, the newly established coordinating body from 2013

Institutional support forms – and will continue to form (despite the increased emphasis on targeted support) – a significant portion of public RDI expenditure. An important prerequisite in ensuring the effectiveness of public funds invested in R&D as institutional support is the consistent and regular evaluation of the research results reported by the supported institutions. The system of institutional support impact assessments will be transparent and sufficiently stimulating in terms of the volume of aid linked to the results obtained. The Reform establishes methodology for evaluations of results based on the bibliometric data, patent activity and other indicators relating to the use of RDI results. This methodology will be further developed in order to better reflect the quality of results both in terms of excellence and their relevance to applications, and to prevent inflationary growth in the volume of low-quality results. Further the R&D evaluation system will include the results of audits of the RDI State aid system conducted in keeping with activity A 9-2 (section III.9) approximately every five years, which will include not only the results, but also the capacity, strategies and other indicators of potential for the future development of the institutions examined. As of 2012, institutional support will be provided from budget headings[7] further to an assessment of the results achieved, with the exception of research projects ending after 2011.

A 3-2: Increase the proportion of R&D funding granted in the form of targeted support.

Deadline: ongoing until 2015; Responsibility: R&D Council to 2012, the newly established coordinating body from 2013

Public expenditure on R&D must comply with the needs of the knowledge society, not in terms of its growth momentum, but also its structure. Targeted support will rise in importance within the scope of public expenditure on R&D; the increase in R&D funding projected between 2012 and 2015 will primarily be channelled into targeted support. The aim is to achieve, by 2015, a ratio of targeted and institutional support at 60:40; this ratio will differ for basic research and applied research and development. At the same time, a sufficiently competitive environment will be created in the selection of projects in programmes funded from dedicated public resources, boosted by the more concentrated system for the implementation of these programmes (see the following activities). In addition to the rise in the proportion of targeted support for applied research, the share of funding for basic research, available in the form of grant projects, will be increased because spending on basic research will be in keeping with the need to generate new knowledge underpinning other RDI phases. In the Czech Republic, the proportion of resources allocated to support basic research in total State aid for R&D is lower than in other countries. The support of basic research in the Czech Republic differs from developed countries mainly in that targeted support via grant projects still fails to cover a substantial portion of the wages of those staff contributing to the projects. Many years of inconsistency on the part of R&D aid grantors combined with the delayed deployment of a more rigorous system for evaluating the results of R&D led to a situation where the prevailing outcome of applied research was – and is – articles in journals, and

[7] According to Section 7(6) of Act No 130/2002, as amended by Act No 110/2009, the grantor may adjust the amount of aid based on a more detailed evaluation using internationally accepted methodologies.

frequently poor-quality publications at that. The share of public spending on basic research will be increased, especially for targeted support. The modified system for the evaluation of R&D results will increase pressure on aid grantors and beneficiaries to significantly increase both the number and quality of applied research results immediately available for new products, technologies and services.

A 3-3: Rigorously evaluate all targeted support programmes, announce new programmes based on a review of the effects of previous programmes and, following up on the results of ongoing evaluations, guide and modify these programmes.

Deadline: ongoing; Responsibility: R&D Council and all providers of targeted support for RDI; from 2013 the newly established coordinating body

Public procurement and contracts in R&D are (or will be) advertised and administratively managed through the Czech Science Foundation (basic research) the Czech Technology Agency (applied research, development and innovation, with the exception of agricultural, security, defence and health R&D) and other grantors of State aid (the Ministry of Education, Youth and Sports, the Ministry of Industry and Trade, the Ministry of the Interior, the Ministry of Culture, the Ministry of Defence, the Ministry of Health and the Ministry of Agriculture). To ensure the adequate efficiency of public funds invested in R&D, the results and impacts of all targeted support regularly programmes will be periodically assessed in all stages of implementation (ex-ante, interim and ex-post evaluations). New targeted support programmes will be launched following the results of a rigorous evaluation of previous programmes; these programmes will be longer guided or modified on the basis of ongoing assessments. Targeted support programmes for applied research will consistently correspond to priorities in the development of the knowledge society and the needs of the user community (see also section III.2).

A 3-4: Encourage the formation and development of major infrastructure for RDI and set up a sustainable mechanism for the financing of operations.

Deadline: ongoing up to 2015 – implementation of R&DI OP; 2012 – announcement of the National Programme of Support for Major Infrastructure/the Capital Development of Research and Development; 2014 – launch of a programme to promote the putting into operation of the infrastructure procured under the R&DI OP and from other sources; Responsibility: MoEYS

Support for the emergence and development of major RDI infrastructure figures among important Reform objectives and is addressed in legislation by the amendment to Act No 130/2002. In relation to these documents and in accordance with the Interdepartmental Concept of Support for Major R&D Infrastructure up to 2015, prepared by the Ministry of Education, the construction of major infrastructure with aid from the R&DI OP and, in Prague (a region outside the objective of European Convergence Regional Policy), with aid from the Competitiveness OP and, especially, from the National Programme of the Capital Development of Research and Development. During the building of major infrastructure, an emphasis will be placed on how it fits in with the Czech Republic's sustainable development priorities, sustainable funding, the connection with major European research infrastructure, and participation in the training of researchers and students. Under the above-mentioned MoEYS concept, major infrastructure operations will be financed with institutional support, targeted support, resources from international research programmes and private funds.

A 3-5: Expand the current RDI information system to improve knowledge management in the public and private sectors.

Deadline: as of 2009; Responsibility: R&D Council

Information on R&D projects financed from public sources and their outputs are currently available in the Research and Development Information System ("R&D IS"). In line with the Reform and the amendment to Act No 130/2002, the R&D IS will be extended to the monitoring of innovation-related projects. The Results Information Register, which includes data describing the results achieved (e.g. the name and type of result, a description, the year of application and the degree of confidentiality), will be expanded to improve the use of knowledge generated in the public sector; this will enhance the usability of the results in innovation in the corporate sphere. In particular, this concerns details that will enable potential users to obtain essential information about the demands of further R&D necessary for knowledge to reach the stage which it has commercial value, including the timeframe and financial cost of further development. Development targets and deadlines are set out in the Concept of an RDI Information System, approved under Government Resolution No 1335 of 3 November 2008.

OBJECTIVE 4: APPLY R&D RESULTS IN INNOVATIONS AND IMPROVE PUBLIC-PRIVATE COOPERATION IN RDI

Besides achieving excellence in research and development, the use of RDI results in innovations will also be improved in the Czech Republic; this will drive forward the competitive of the business sector, enhance public health and increase the quality of life in the Czech Republic. The aims are therefore to ensure that there is a sufficient volume of knowledge available in practice, the establishment of mechanisms for the quick and easy transfer of this knowledge to practical applications, and an increase in the absorption capacity of the application sphere for the use of new R&D knowledge in innovations.

A 4-1: Promote the creation of strategies at research organizations aimed at implementing R&D results in practice and protecting intellectual property.

Deadline: 2010; Responsibility: Ministry of Education, ASCR and other founders of research organizations.

A basic prerequisite for the successful commercialization of new RDI knowledge emerging at research organizations is effective strategies for knowledge transfer, the drawing-up of which will be financially supported under the Priority Axis 3 of the R&DI OP. These strategies will be an effective way of stimulating the transfer of knowledge into practice, addressing issues related to the handling of intellectual property (including rules for the allocation of funds obtained by selling licences and intellectual property rights) and include principles for the formation of companies (especially spin-offs) based on new R&D knowledge generated in these organizations. An integral part of any strategy will comprise the fundamental principles for implementation and for the evaluation of progress in this area.

A 4-2: Motivate research organization staff to create knowledge in innovations and to cooperate with businesses

Deadline: 2010; Responsibility: Ministry of Education, ASCR and other founders of research organizations.

It is also important for research organizations to create a motivating work assessment system for researchers, which, in addition to the quality of research work, will take the practical applicability of applied research results into consideration. Therefore, effective mechanisms, in the form of rules for the distribution of funds derived from the commercialization of RDI, will be built into the system for the remuneration of research staff; these mechanisms which will be sufficient to motivate researchers to produce knowledge usable in practice, design innovation solutions, market them (i.e. by selling licenses, setting up spin-offs, etc.) and win additional contracts on the ground. Research organizations will be stimulated to create such mechanisms by a system for the evaluation of R&D results, under which institutional R&D support will be distributed (see Activity A 3-1).

A 4-3: Launch a programme to promote the commercialization of R&D results produced at universities and public research institutions.

Deadline: 2013; Responsibility: MoEYS

At universities, research institutes, and associations of multiple research institutions, the R&DI OP (in Prague, the Prague Competitiveness OP and Prague Adaptability OP) is a source of support for the creation of technology (knowledge) transfer centres, the aim of which is to assist the workers of these institutions in the commercialization of new R&D knowledge. To increase the efficiency of the transfer of new knowledge into practice, a programme will be created that provides these centres with resources for their activities (further to A 4-10), i.e. the provision of quality consulting services on the commercialization of R&D knowledge (for example, verification of the potential of knowledge and an analysis of how best to use it), and for marketing purposes, i.e. to support the emergence of new firms (spin-offs), the filing of patent applications, etc. The programme will also provide funding for the R&D necessary to put R&D knowledge into practice.

A 4-4: Promote the construction and development of regional RDI infrastructure in conjunction with major infrastructure on the one hand and the application sphere (innovation) on the other.

Deadline: ongoing up to 2015 – implementation of R&DI OP and EI OP; 2012 – announcement of the National Programme of Support for Major Infrastructure/the Capital Development of Research and Development; Responsibility: the Ministry of Education (R&DI OP and the Programme for the Capital Development of Research and Development), MIT (EI OP)

Investment in RDI infrastructure nationally and regionally will create a dense network of efficient operators with sufficient capacity to carry out their own research activities and meet demand from innovation businesses. Up to 2015, the construction and development of this infrastructure will mainly be supported, in accordance with the National Strategic Reference Framework, from the R&DI OP and EI OP, and in Prague from the Prague Competitiveness OP and the National Capital R&D Development Programme. On completion of the operational programmes, the initial development of the infrastructure will be covered by a

specific programme. In building the infrastructure, the emphasis will be on interconnecting it with major RDI infrastructure, on the intensity of cooperation (including the use of this infrastructure) with the application community, and on financial sustainability. The primary purpose of the infrastructure will be research for the requirements of the application sphere and the use of research results generated in major infrastructure for the development of specific applications.

A 4-5: Launch a programme of support for larger-scale projects covering the whole RDI cycle, with the involvement of research organizations and enterprises.

Deadline: 2011; Responsibility: CTA

For more intensive use of RDI results from the public sector and better collaboration between research teams from universities and institutes and businesses, the Czech Technology Agency will develop and launch multidisciplinary and problem-oriented programmes to foster larger-scale technology-focused projects covering the whole innovation cycle (i.e. projects involving components of basic and applied research, development and subsequent testing for use in practical applications). These programmes, involving research teams from the public sector as well as the application domain (businesses), may also constitute an important financial source for infrastructure, research and development (see Activity A 3-4). The focus of these larger and longer-term programmes will systematically correspond to the priorities for the development of the knowledge society and will be based on the consensus of experts from the public sector and corporate sector, which guarantees better use of R&D knowledge in practice and the financial sustainability of research centres. An administratively transparent support system will also be created for the implementation of these programmes; this system will ensure the effective pooling of funds from multiple sources and the professional selection of projects.

A 4-6: Launch a programme to support the implementation of innovations by SMEs, with a stress on promoting prototype testing.

Deadline: 2014; Responsibility: MIT

As it is mainly small and medium-sized enterprises (SMEs) that are exposed to the effects of RDI market failures in the corporate sector, State aid will be the stimulus SMEs need to engage in research and innovation activities. Up to 2014, existing programmes for the promotion of industrial research and development (TIP) and the EI OP (Innovation Programme) will be used for this purpose. Further to an assessment of the impact of these programmes, a follow-up programme will be drawn up to support research and innovation at SMEs, which will place an emphasis on promoting the phase on the boundary between the development and implementation of innovations (especially prototype testing).

A 4-7: Promote collaboration between SMEs and research organizations by providing vouchers for joint RDI.

Deadline: up to 2011, assessments of the necessary legislative changes; 2012 implementation of legislative changes and the launch of a programme to be addressed as of 2013; Responsibility: CTA

The CTA will announce a programme of innovation vouchers for SMEs, which are intended to cover the costs associated with product or service innovation. The vouchers will be valid for

use at research organizations and will provide SMEs with a quick and easy way to make contact with these organizations and to enter into small-scale contracts aimed at acquiring external know-how (e.g. external R&D, knowledge transfer, etc.). Prior to implementing this programme, which will be administratively simple for both users and providers of State aid, the necessary changes to legislation will be assessed, the financial value of the vouchers will be set (the vouchers may have varying values depending on the type of innovation activity and the contribution by the enterprise) and the number of vouchers to be issued will be decided.

A 4-8: Assess the possibility of setting up venture capital funds with private and public financial resources.

Deadline: 2011; Responsibility: R&D Council

In addition to a favourable tax environment and reasonable regulation, it would be appropriate to encourage venture capital investment in innovation start-ups offering high growth potential by creating specialized financial infrastructure (including in conjunction with "pre-seed" funds created under the R&DI OP). In this regard, a proven model abroad is the establishment of venture capital funds focused largely on investments in new technology-oriented SMEs with the participation of private and public funds. Therefore, the legal, financial and other possibilities of applying this model in the Czech Republic will be evaluated in detail.

A 4-9: Encourage the development of quality consulting services geared towards stronger R&D and innovation activities at businesses and the use of R&D results in practice.

Deadline: 2011; Responsibility: MIT

In parallel with the development of the innovation infrastructure, the accessibility and quality of supporting advisory services for SMEs related to R&D and the introduction of innovations, RDI management and knowledge transfer from public research into practice will also be improved. The development of this "soft" infrastructure is currently supported under the EI OP (Consulting Programme). Following an interim evaluation of the effectiveness of the Consulting Programme, involving users of the consulting services on offer, measures will be proposed for the further development of quality consulting services for SMEs.

A 4-10: Encourage the creation of national and international technology platforms.

Deadline: 2010; Responsibility: MIT and CTA

In line with the open innovation approach which is beginning to form as R&D and innovation globalization progresses, an important driver of innovation, especially in terms of the efficiency of investments in RDI and the faster transfer of knowledge between various entities in the innovation process, is the mutual cooperation of all players in the national innovation system at regional, national and transnational levels. For this reason, the emergence of technology platforms involving research organizations (including universities), enterprises and business associations, representatives of public administration, financial intermediaries and other stakeholders in the national innovation system will also be initiated and financially supported; these platforms will promote cooperation between all participants nationally and internationally. In this context, the potential of clusters will also be used. These activities will be supported under the EI OP (Cooperation Programme).

OBJECTIVE 5: IMPROVE THE CZECH REPUBLIC'S INVOLVEMENT IN INTERNATIONAL COOPERATION IN RDI

An essential requirement for maintaining competitiveness and keeping step with world technological developments in all areas is international RDI cooperation. The aim is therefore to increase the participation of Czech research teams in international research and the active participation of the Czech Republic in creating a European Research Area, which will strengthen the competitiveness of the Czech economy and the development of the knowledge society in the Czech Republic.

A 5-1: Continue to support the activities of organizations that will provide background information on the possibilities of participating in European programmes and provide comprehensive services that will help involve Czech teams in international programmes.

Deadline: ongoing; Responsibility: MoEYS, MIT

The work of the organization which helps research teams join the European Community framework programmes for research, technological development and demonstration activities and provide relevant information and guidance has been supported by the Ministry of Education, Youth and Sports for many years. Similarly, Commission and MIT resources are used to aid the activities of the network providing support services and information for the development of innovation entrepreneurship. The work of these organizations will continue to be encouraged, and their activities and services will be further improved and expanded, thus creating additional conditions for the greater involvement of Czech entities in international research and innovation activities. Guidance on funding and the protection of intellectual property rights, consulting on the opportunities for participation in the ERA, and specialized training activities to improve the quality of project proposals submitted in international R&D programmes by Czech entities. The benefits and impacts of international programmes on the development of Czech RDI will be assessed. Analytical and strategic documentation for the preparation of the opinions of the Czech Republic's official representatives and experts in the relevant Commission committees will be provided.

A 5-2: Foster conditions in research organizations for the greater involvement of research teams in international programmes.

Deadline: 2011; Responsibility: MoEYS, ASCR

Along with the provision of advisory services to help research teams participate in international programmes, the right background will be created at research organizations for research teams involved in international cooperation in order to provide the necessary administration and accounting, help address financial and legal issues, provide co-financing for approved projects, etc. The strategic management of R&D at research organizations will also include the effective motivation of researchers to engage more intensively in international R&D cooperation, especially in EU framework programmes.

A 5-3: Actively participate in the development of the ERA and the work of significant international research institutions

Deadline: 2009; Responsibility: MoEYS

The creation of an information system that will make information available about the results of negotiations at the European level, including the Czech Republic's opinions and positions,

and improve the coordination of the relevant activities, is set out in the Reform. The Czech Republic's involvement in the development of a European Research Area (ERA) will be further reinforced through its active participation in the creation of conceptual documents and the preparation and implementation of RDI strategies (e.g. the reform of the patent system in Europe and the harmonization of rules for the financing of national and European projects), or participation in major international research organizations (CERN, EMBL, ESA, etc.). In addition, where appropriate, the Czech Republic will actively participate in the preparation of EU Member States' international research programmes focusing on current issues of sustainable development at supranational level (Joint Programming). The lines of research to be developed by CR through this international cooperation will also be specified.

OBJECTIVE 6: ENSURE QUALITY HUMAN RESOURCES FOR RDI

The creation of new research findings and the ability to absorb and make effective use of this new knowledge is a key condition for the development of a knowledge society. The aim of RDI policy is therefore to guarantee sufficient numbers of high-quality researchers and to increase the number of university graduates whose profiles and skills will reflect the increasingly sophisticated demands placed on abilities in connection with the development of a knowledge society.

A 6-1: Develop a system of post-doctoral positions filled in public competitions.

Deadline: until 2013 – implementation of the EC OP; 2014 – start of handling of the programme

A programme of post-doctoral places to be filled on the basis of tenders will be set up to improve education and ensure the development of young researchers. These positions will offer excellent opportunities for talented, high-quality doctoral graduates to continue their scientific careers at leading Czech research institutes, and will thus be an alternative to the foreign positions to which these graduates often accept after completing their doctoral studies in the Czech Republic. The programme will also be open to foreign graduates, offering the prospect of obtaining talented, quality young researchers from different backgrounds.

A 6-2: Launch of a programme to encourage researchers (especially doctoral students and young researchers) to undergo internships at significant European and world centres.

Deadline: 2013; Responsibility: MoEYS

Gaining experience in research abroad, participating in international research cooperation and international networking are important prerequisites for the further development of young researchers' scientific careers and for maintaining direct contact with global trends in their field. To this end, the Ministry of Education will announce a programme intended as an effective conduit to encourage young researchers and PhD students go on foreign internships and then return to the Czech Republic ("return grants"). The grant will allow these researchers to create their own research group (consisting of young researchers) at their parent centre on returning home to the Czech Republic and to continue the research they have begun abroad.

A 6-3: Promote university graduates' prospects in fields related to applied R&D and to the introduction of innovations, or in knowledge-intensive disciplines.

Deadline: 2010; Responsibility: MoEYS

An important factor in the career development of graduates is their first job placement. With this in mind, the Ministry of Education will prepare a programme for SME projects which financially support the placement (i.e. fixed-term employment) of fresh university graduates and doctoral students in knowledge-intensive industries (especially in activities related to RDI), during which these workers are involved in a specific project important for the strategic development of the SME that has taken them on. Collaboration between an SME and university can also secure the further training of a new employee in connection with the handling of the project.

OBJECTIVE 7: CREATE AN RDI-STIMULATING ENVIRONMENT IN THE CZECH REPUBLIC

An important goal for the development of RDI is to create a pro-innovation environment that will not only stimulate business and research activities, but also create favourable conditions for the cultivation of interest in RDI results (i.e. in terms of the supply of new products and demand from the user community) and have a positive impact on all players in the innovation process and their cooperation.

A 7-1: Improve the quality of RDI media coverage.

Deadline: 2013; Responsibility: R&D Council

Besides improving the innovation environment on the supply side, it is also important to reinforce the general perception of innovation in society; an important role in this process is played by RDI publicity. As improved RDI publicity will contribute significantly to greater RDI awareness among journalists, financial support will be channelled into the establishment and operation of an information system (web portal) where journalists will have access to high-quality, up-to-date and reliable RDI information (e.g. information about new discoveries, the benefits of R&D, upcoming conferences and other activities). At the same time, a link will be formed with similar sites abroad (AlphaGalileo). Education for Competitiveness OP funds will support projects offering training courses for journalists in order to improve the quality of innovation-oriented journalism. The Czech Republic's involvement in international initiative "Innovation Journalism" will also be financially supported.

A 7-2: Promote activities designed to popularize RDI and its benefits to society.

Deadline: ongoing; Responsibility: MoEYS

It is also important to support activities (programmes, projects) which clearly illustrate to the public the use and application of science, and its benefits to society. Although numerous activities of this type have been running for many years in the Czech Republic (e.g. "Night of Scientists", "Science on Stage", "Museum Night", "Week of Science and Technology", "INNOVATION, Week of Research, Development and Innovation in the Czech Republic", "Innovation of the Year Award", etc.), improvements in their publicity and a targeted focus on significant weaknesses in the national innovation system in the Czech Republic (such as a lack of interest among young people in studying natural sciences and engineering, and science in

general) are key opportunities. For this reason, Education for Competitiveness OP funds are used on an annual basis to support the organization of selected activities of this in all regions of the Czech Republic. At the same time, they will be promoted (be given media coverage) at national level. The R&DI OP will also support the activities of specialized facilities to win children and young people over to engineering and natural sciences, and to force a sound relationship with science and creativity (Science Centre, Techmania, etc.).

A 7-3: Present the results of Czech RDI abroad.

Deadline: ongoing; Responsibility: MoEYS

It is also important to guide media activity towards an image of the Czech Republic as a technologically advanced country. For this reason, activities that suitably present the results of Czech RDI abroad will be financially supported by the Ministry of Education. In the preparation and implementation of these promotions, it will work with the Czech Republic's foreign missions and organizations that represent the CR abroad, such as CZELO and CzechInvest. Financial support will be granted, for example, to secure the right experts, to draw up promotional materials, to provide media coverage of these activities abroad, etc.

OBJECTIVE 8: ENSURE EFFECTIVE LINKS TO POLICIES IN OTHER AREAS

As, in addition to the NRDIP, strategies and concepts related to the development of a knowledge-based society are also formed by individual ministries, it is important to strengthen the synergies arising from the implementation of these concepts. Therefore, the aim is to effectively coordinate the activities of various government agencies, implementing agencies and other providers of State aid for RDI so that the various measures are complementary and synergistically contribute to the growth of the Czech economy's competitiveness and the quality of life in the Czech Republic.

A 8-1: Strengthen the role of the coordinating body in the preparation and implementation of RDI-related policies and concepts.

Deadline: ongoing; Responsibility: the Government, on a proposal by the R&D Council and the Government's National Economic Council (NERV)

Coordination in the making and implementation of policies related to the development of a knowledge society will be based primarily on the creation of institutional and methodological ties. A key factor is the close link between RDI policy and education policy, based on strong cooperation between the responsible central government authorities. However, it is important also to ensure the coordination of activities carried out under the NRDIP with industrial, regional and social policies and concepts related to RDI (e.g. health care, defence, security, agriculture, etc.). An important role in the coordination of bodies responsible for policies in these areas will be played by the newly established coordinating body (see section III.1), which, in addition to preparing RDI policy, will be responsible for coordinating RDI-related State aid in all relevant areas (a more detailed description of the role of the coordinating body can be found in A 1-1).

A 8-2: Strengthen the development and use of analyses and underlying studies for the preparation of conceptual documents and related policies.

Deadline: as of 2009; Responsibility: R&D Council to 2012, the newly established coordinating body from 2013

In the creation of all strategic and conceptual documents in related areas, meticulous use will be made of evaluation results (see also section III.9), analyses, and further underlying studies characterizing the current situation, as well as forward studies applying modern methods, such as foresight. In addition, research geared towards the interaction of social, economic and environmental issues, with particular reference to the ongoing support of decision-making in public administration, will be supported. These activities will be provided by individual providers, who may, for this purpose, commission an independent professional organization whose activities will be supported by the newly established coordinating body (see section III.1).

OBJECTIVE 9: RIGOROUSLY EVALUATE THE RDI SYSTEM

The aim is to establish a system for continuous evaluation of RDI in the Czech Republic at all levels in order to ensure that public funds invested in RDI are suitably efficient. At the same time, an institutional backdrop containing clearly defined responsibilities will be set up for this evaluation.

A 9-1: Continuously evaluate the implementation of the Reform of the RDI system and NRDIP, and the impacts of their sub-measures on the set targets

Deadline: as of 2009; Responsibility: R&D Council to 2012, the newly established coordinating body from 2013

The first step in establishing a system for the continuous evaluation of RDI is to assess the progress and impact of the Reform approved by the Government in March 2008, the implementation of which is an essential prerequisite for the successful realization of the NRDIP. It is necessary to systematically monitor and evaluate the various measures implemented and their interrelations and implications in securing the objectives of the Reform (i.e. not only administrative reviews). Following an evaluation of the Reform, the implementation and fulfilment of all measures set out in the NRDIP will be continuously evaluated in the same manner, and an emphasis will be placed on assessing the impact that various measures have on meeting the stated objectives. Implementation of the NRDIP will be assessed continuously (the terms and responsibilities are outlined for each measure). The initial evaluation will be submitted to the Government in 2011/2012 (in relation to the findings of the international RDI audit – see next activity) and will set out the next steps in the implementation of the NRDIP. Along with the NRDIP , all relevant horizontal and sectoral policies (or strategies and concepts) and strategies developed by provinces (regions) will also be rigorously evaluated. In connection with the implementation of the NRDIP and the preparation of new strategy documents in this field, the importance of systematic evaluation, analyses and forward studies for RDI policy will be reinforced in order to guarantee a continuous process encompassing evaluation, analysis, forward studies and the setting of a concept, including the forging of links between activities.

A 9-2: Finalize methodology for the evaluation of R&D results and introduce a scheme for the periodic and objective evaluation of system for RDI support at all levels.

Deadline: as of 2009; Responsibility: R&D Council to 2012, the newly established coordinating body from 2013

The ultimate aim is to introduce periodic, systematic and objective evaluations of the RDI support system in the Czech Republic at all levels. Apart from evaluations of the RDI support system at the level of providers, which are defined in Government Resolution No 644 of 23 June 2004, comprehensive evaluations of the entire RDI support system in the Czech Republic at national level will also be carried out (a comprehensive audit of RDI-related State aid in the Czech Republic). In this comprehensive RDI audit, to be conducted periodically at intervals of about five years, it is necessary to make the switch from the currently prevailing administrative assessment to assessments of the results and impacts of aid on the achievement of excellence by Czech R&D, the usability of R&D results in practical applications, improved competitiveness, quality of life and the advancement of society in the Czech Republic. These evaluations will provide conclusive information about the benefits of RDI support. In addition to national and provider evaluations, public resources will also be used to support (create a programme for) evaluations of beneficiaries (the auditing of research organizations), which will not only compare the quality of research work by individual units (departments, groups) and create a basis for the allocation of funds based on the quality of research, but will also guide the strategic path to be followed by research organizations in the future.

A 9-3: Assess the RDI system at national level, with the involvement of a reputable foreign organization.

Deadline: 2011; Responsibility: MoEYS

To increase objectivity, a reputable, sufficiently experienced foreign centre will be involved in the comprehensive evaluation (audit) of the whole system of RDI-related State aid at national level, as described in Activity A 9-2. The foreign centre will be selected on the basis of a call for tenders addressed to multiple potential foreign partners. The foreign institution will carry out this audit in cooperation with a national centre, again selected through a competitive process.

IV. Main principles of the NRDIP after 2015

Intensifying globalization is increasing competition on world markets, and the application of new knowledge will remain a central precondition for a sustainable competitive advantage. RDI will therefore remain a high priority for social development and will significantly contribute to economic growth and improvements in the quality of life of society.

IV.1. Background to the new NRDIP

The post-2015 NRDIP will be based on a coherent strategy for sustainable development, the implementation of which will be the central objective of all sub-policies and initiatives undertaken in various areas. RDI will thus become a key cross-cutting area of governmental economic policy in the broad sense, and will be regarded as a pivotal factor in the growth of competitiveness, sustainable development and the general quality of life. The creation and successful implementation of a new RDI policy after 2015 will therefore, in addition to the consistent coordination of sub-policies, also require

the social consensus of all central government agencies, regional authorities, associations, unions and other participants in the national innovation system as regards a single innovation strategy of sufficient political weight and authenticity.

Another important starting point for the new NRDIP after 2015 will be the consistent evaluation of the implementation and impacts of measures taken in the 2009-2015 period. The measures under the new NRDIP will be proposed by reference to the results of this evaluation.

Another important basis for the formulation of the new NRDIP will be the results of a comprehensive audit of the innovation system in the Czech Republic, conducted in 2010 and 2011. Beside the direct use of this audit for the purposes of allocating institutional R&D support, the results will be used to propose changes to the system for the granting of State aid and the management of the national innovation system.

Not least, the new NRDIP after 2015 will be based on current expert analyses of the national innovation system, which will provide an insight into the relationships and links in the innovation process, and the role of R&D in this process, and will be able to identify gaps and challenges that the new NRDIP will respond to.

Unlike the policies approved in previous years, and unlike the current policy, sufficient time will be set aside in the preparation of the new NRDIP to discuss the objectives and measures proposed under the new NRDIP. Representatives of the professional public will also be much more closely involved in the preparation process, making it possible to reach a universal consensus; this is an essential prerequisite for the successful implementation of this policy.

IV.2. Financial aspects of the new NRDIP

The new NRDIP after 2015 will be formulated for a period when, compared to the present, the Czech Republic will have limited access to resources from the EU Structural Funds. It is necessary to respond to this situation promptly by setting mechanisms for the sustainable financing of national R&D resources. Most attention will therefore be paid to the financial sustainability of major infrastructure for RDI, the bulk of which will be newly built between 2009 and 2015. In order to concentrate financial and human resources in RDI to ensure the critical mass required for cutting-edge research, it will remain necessary to set priority directions and areas based on the needs of sustainable development. Sustainability is one of the main criteria for the acceptance of project proposals within the scope of R&DI OP calls (the condition that a third of resources must come from funds other than the national budget etc.); as of 2015 (or depending on the speed of construction as of 2014, albeit on a lesser scale) the launch of capacities built under the R&DI OP will be supported by the R&D programme with national budget expenditure on research, development and innovation amounting to CZK 2.5 billion per year. A specific proposal will be included in the progress report on the implementation of the Czech Republic's NRDIP for 2009-2015, which will be submitted to the Government by 30 November 2012.

The new NRDIP will further strengthen the involvement of private funds in the financing of research and innovation activities, the foundations of which are being laid by the 2009–2015 NRDIP and its activities.

IV.3. International aspects of the new NRDIP

Ensuring the effective sharing of knowledge nationally and internationally is essential for the development of a knowledge society. The production of the NRDIP was closely bound up with

strategy documents prepared by the EU and was incorporated into the framework of European policies aiming at developing the European Research Area. The post-2015 NRDIP will further strengthen ties to the European Research Area and will develop the European research guidelines identified in the EU Framework Programmes and other initiatives to support RDI (e.g. CIPs). The new NRDIP will therefore take more account of the Czech Republic's position in the international (and especially European) research area and stress measures aimed at exploiting the possibilities of international RDI cooperation. The need for the Czech Republic's active involvement in the shaping of the European Research Area and international research projects will also be reinforced as part of the search for alternative financial resources to ensure the quality and growth of Czech R&D (in the context of limited access to resources from the EU Structural Funds after 2015).

IV.4. Regional aspects of the new NRDIP

An important part of the post-2015 NRDIP will be the regional aspects of innovation development. The new NRDIP will have to respond both to the limited public resources for the financing of regional development (up to 2013 resources from the EU Structural Funds are available in the Czech Republic for this purpose), and, in conjunction with the increasing complexity of RDI, to the rising importance of cooperation between different actors in the innovation process at regional level. In order to enhance the development of regional innovation systems, it will therefore be necessary to place an emphasis on creating more or less formal ties, e.g. on the principle of partnerships encompassing entities from the educational, research, corporate and public sectors (the "triple helix"). All these regional innovation system entities will work together to formulate a vision for the development of the region, as well as strategies and concrete steps to achieve that vision. The new NRDIP will motivate the development of this cooperation in particular by cultivating competition in the allocation of State aid for the innovation development of the regions.

V. Demands and ramifications

The NRDIP will have a significant impact on the development of the Czech Republic's economy and competitiveness, the quality of life and social development, and other areas such as public health, the environment and security. However, the successful implementation of the NRDIP will require some modifications to existing legislation and the national budget.

V.1. Demands on Czech law

The NRDIP is designed to require minimal intervention in the existing legal system of the Czech Republic. Amendments to existing legislation required by the NRDIP are:

(a) Activity A 1-1 requires the establishment of a coordinating body at central government level that will be responsible for the strategic management of RDI. This body will be formed by the transformation of the current R&D Council, which will require an amendment to Act No 130/2002 and related implementing regulations, and to Act No 2/1969 (the Competence Act).

(b) Activity A 1-4 sets out the reinforcement of powers wielded by the boards of universities and the involvement of representatives from the corporate sector and regional authorities. This conferral of greater powers will require an amendment to Act No 111/1998 on higher education and amending other laws.

(c) Under Activity A 3-5, the R&D IS (specifically, the results register) is expanded to include additional information on the usability of results. As the content of the results register is defined, in accordance with Act No 130/2002, by an implementing regulation (currently Government Decree No 267 of 29 May 2002), the content of the results register will be supplemented by a new government decree.

(d) Under Activity A 4-7, a scheme is to be created under which SMEs will be granted innovation vouchers to carry out RDI in collaboration with research organizations. In connection with this programme, the necessary changes to legislation will be assessed and made.

V.2. Demands on the Czech national budget

To carry out the proposed activities and provide financial support under the proposed programmes, maximum use is made of funding from EU Structural Funds, which can be used for the development of the knowledge-based economy in the Czech Republic (i.e. under the R&DI OP, EI OP, EC OP, PC OP and PA OP) in the 2007–2013 programming period (part of the funds will be drawn up until 2015). R&D support from the EU Structural Funds is 15% co-financed from the national budget expenditure earmarked for R&D. In the period up to 2013 (or where appropriate 2015), the funds provided in accordance with the amended Act No 130/2002 on the promotion of research and development (amended by Act No 110/2009) in the form of institutional support, which is already reflected in the Czech Republic's draft national budget expenditure on research and development in 2009, with a projection for 2010 and 2011, approved under Government Resolution No 793 of 27 June 2008. In Prague, which is included in the Regional Competitiveness and Employment Objective, the national Capital R&D Development programme will be used to develop research infrastructure.

The realization and implementation of the NRDIP in 2009–2015 requires the following resources from the national budget of the Czech Republic:

(a) Activity A 1-1 requires the establishment of a coordinating body at central government level that will be responsible for the strategic management of RDI by the end of 2012, which will be formed via the transformation of the R&D Council. After this body is established and while it is operated over the duration of the NRDIP (i.e. from 2013 to 2015), funding will be earmarked from the national budget for research, development and innovation.

(b) Under activity A 1-3, financial support is defined for the implementation and updating of the NRDIP. Until 2012, the resources for this activity are covered by the operating expenditure of the R&D Council, which is responsible for the NRDIP.

(c) Activity A 3-4 sets out the announcement of a programme to promote the start-up of infrastructure acquired under the R&DI OP and other sources. To implement this programme from 2014 or 2015, the corresponding funds from the national budget for research, development and innovation will be earmarked for the Ministry of Education for this purpose.

(d) Under Activity A 3-5, the development of the RDI Information System will be secured with funds intended for the activities of the R&D Council, which is responsible for the system.

(e) Activity A 4-3 covers the creation of a programme to promote the commercialization of RDI results achieved by universities and public research institutions. To implement this programme in the period up to 2013, funds from the R&DI OP (Priority Axis 3) will be used; as of 2013,

funding from the national budget for research, development and innovation will be earmarked for the Ministry of Education for this purpose.

(f) Activity A 4-5 sets out the launch of programmes supporting large-scale projects that cover the entire innovation cycle. For these programmes, the CTA has been allocated funds from the national budget for research, development and innovation in 2011.

(g) Activity A 4-6 sets out the launch of programmes to support the introduction of innovations by small and medium-sized enterprises. Up to 2014, resources from the TIP programme will be available to support these activities; up to 2013, the EI OP (Innovation Programme) will also be used. As of 2014, funding from the national budget will be earmarked for the MIT in order to carry out these activities. For these programmes, the CTA will be allocated funds from the national budget for research, development and innovation as of 2014.

(h) Under Activity A 4-7, a scheme is to be created under which SMEs will be granted innovation vouchers to carry out RDI in collaboration with research organizations. For this programme, the CTA will be allocated funds from the national budget for research, development and innovation as of 2013.

(i) Activity A 4-9 sets out the support of RDI consulting services. Until 2013, the support of advisory services will be funded by the EI OP (Consulting Programme), and as of 2014 the relevant funding from the national budget for research, development and innovation will be earmarked for the MIT in order to implement this programme.

(j) Activity A 5-1 defines support for organizations assisting the involvement of Czech participants in international RDI programmes. These activities are financed in the form of project aid from the EUPRO programme (until 2012), from the Framework Programme for Competitiveness and Innovation and from MIT funds (until 2010). In subsequent years, funds are (or after 2012 will be) earmarked for the Ministry of Education and the MIT from the national budget for research, development and innovation in order to carry out these activities.

(k) Activity A 6-1 provides for the creation of a programme to encourage the creation of post-doctoral positions. Up to 2013, these activities will be covered by the EC OP resources; as of 2014, funds from the national budget for research, development and innovation will be earmarked for the Ministry of Education for this support.

(l) Activity A 6-2 sets out the launch of programmes to support young researchers as they take internships abroad. Up to 2013, this programme will be covered by EC OP resources; as of 2014, funds from the national budget for research, development and innovation will be earmarked for the Ministry of Education for this purpose.

(m) Activity A 6-3 sets out the announcement of a programme providing support for the placement of university graduates in knowledge-intensive industries. Up to 2013, this programme will be covered by EC OP resources; as of 2014, funds from the national budget for research, development and innovation will be earmarked for the Ministry of Education for this purpose.

(n) Activity A 7-1 sets out the establishment of an information system (web portal) on current RDI-related events for journalists and the of support innovation journalism. For these activities, the R&D Council will be allocated funds from the national budget for research, development and innovation as of 2013.

(o) Activity A 7-2 sets out the support of activities aimed at mainstreaming RDI. Up to 2013, EC OP resources will be used for this purpose; as of 2014, funds from the national budget for

research, development and innovation will be earmarked for the Ministry of Education in order to popularize RDI.

(p) Activity A 7-3 defines support for the presentation of the results of Czech R&D at home and abroad. To support these activities, the Ministry of Education will be allocated funds from the national budget for research, development and innovation as of 2013.

(q) Activities A 9-2 and A 9-3 encompass the introduction of evaluations of the RDI system at national level and the level of individual beneficiaries approximately every five years, including the involvement of a reputable foreign centre. The first audit (in 2010 and 2011) is funded by the EC OP. To conduct further audits, the R&D Council will be allocated funds from the national budget for research, development and innovation.

All activities listed under points (a) to (p) will be supported from the national budget for research, development and innovation, and from private resources where this is required by the conditions of the Community Framework for State aid for research, development and innovation.

V.3. Other requirements

To achieve the objectives of the NRDIP, and thus the successful completion of the NRDIP, it is also necessary to ensure that:

(a) the NRDIP proposes, in Chapter III.1, the creation of a central government coordinating body for the strategic management of RDI, which will be formed by the transformation of the R&D Council and which will coordinate the activities of individual government agencies in relation to RDI policy. The coordinating body's work will be managed by a board composed of leading experts in basic and applied research, development and innovation.

(b) To ensure that the coordinating body carries enough clout and to ensure that its decisions are enforced, arrangements will be made so that the representative (chairman) of the coordinating body is also a member of the Czech Government.

V.4. Impacts on the Czech economy

Developing the competitiveness of enterprises and the Czech economy is one of the main objectives of the NRDIP. The proposed milestones and individual activities are aimed not only at achieving excellence in research, but also at the more effective creation of new, practically usable, RDI knowledge, and its commercialization and use in business innovation, and thus at improving the competitiveness of enterprises on foreign markets, increasing export performance and driving forward the growth of the Czech economy. The following specific points are at issue:

(a) The priorities of applied research, development and innovation, which are the basic input for the NRDIP and which are included as Part VI of this document, are priority areas for applied R&D. Their focus was established with the involvement of the application sphere; the main objective was to define promising research areas in terms of the benefits most important to the economy and its competitiveness and to sustainable development. In the coming years, public R&D funding will be channelled into these areas as a matter of priority, which will be clearly reflected in the improved competitiveness of enterprises and the further development of the Czech economy.

(b) Research relevant to the Priorities for the Development of Czech Society (see section VI) will have a significant impact on the economic development of the Czech Republic. The main goal is the transformation of Czech society into a competitive society in the international context; research will address, for example, the impact of increased RDI spending (both public and private) on productivity, economic standards and employment, the formation of economic ties in Czech society, concepts of regional development, consistency between the labour market and the development of key skills, and improvements in regulation.

(c) In Objective 2, the NRDIP focuses on the better targeting of State aid for sustainable development needs using sophisticated methods, including the further involvement of potential users of RDI results from the corporate sector. This process is reflected in the modification (updating) of the above-mentioned priorities, which will be better at reflecting potential opportunities for further economic development and further growth of the Czech economy.

(d) In Objective 3, the NRDIP sets out an increase in the share of dedicated funding and an increase in funding for applied R&D, the focus of which will correspond to the above priorities. An improved R&D focus on the needs of sustainable development creates more of a framework for the Czech Republic's economic growth and competitiveness.

(e) Under Objective 4 of the NRDIP, which focuses on the use of R&D results in innovation, activities are proposed for the increased production of knowledge that is usable in practice, the commercialization thereof, RDI development in companies, and improvements in corporate access to private financial resources for these purposes, which will drive forward the economic performance of enterprises. The Czech Republic's greater involvement in international RDI cooperation, as set out in Objective 5 of the NRDIP, will also have a significant impact on the further development of the Czech economy.

V.5. Impacts on Czech society

Equally important objectives of the NRDIP are to increase the benefits of RDI for health, safety, social security and well-being, to better understand the changes taking place in the world, and to improve relations with national history, traditions and culture. In addition to the effects specified in section V.4, the following benefits of NRDIP in the development of society and the quality of life in the Czech Republic can be expected:

(a) One of the priorities of applied research, development and innovation in the socio-humanities is the Czech Society Development Priority. The focus of this priority, and therefore of the research supported, addresses the current problems of the Czech Republic, and the goals include improving the process of government, improving demographic development in the Czech Republic, creating better regulation in numerous areas (e.g. social, family, pension, health, migration, security and education policy), examining the significance of Czech identity, changing society and identifying relationships in society.

(b) RDI supported by other priorities will also have a significant impact on Czech society. R&D supported under the priority Molecular Biology and Biotechnology will contribute significantly to the further development of diagnostic methods and therapeutic procedures in medicine, which will have a major impact on improving public health. R&D under the Information Society priority will also influence the development of society; inter alia, support will be guided towards

R&D focused on the use of information systems in the everyday life of society. Another priority affecting this area will be Biological and Environmental Aspects of Sustainable Development, which concerns economic, demographic and sociological aspects. In light of the multi-disciplinary nature of current research, socio-humanitarian aspects are also an element of other research areas (e.g. Competitive Engineering – transport safety, Energy Sources – nuclear safety, etc.), which is reflected positively in a further increase in the quality of life in the Czech Republic.

(c) A certain shift in societal values can be expected as Czech society develops. Under Objective 2, the NRDIP lays down the better targeting of State aid for sustainable development needs and hence further, more detailed identification of the needs of society and the relevant avenues of research that will help meet those needs.

(d) The development of society in the Czech Republic is also affected by activities aimed at providing quality human resources for RDI and activities that will lead to greater media coverage and mainstreaming of RDI in Czech society; this will have an greater impact on the greater openness of Czech society to innovation and the use of better quality products in the everyday life of Czech citizens.

V.6. Impacts on the environment in the Czech Republic

Although the environment is not explicitly named in the new NRDIP, the aim of the NRDIP, besides increasing competitiveness and developing society in the Czech Republic, is to improve the quality of life; this is closely bound up with environmental improvements. The NRDIP's most significant impacts on the environment can be summed up as follows:

(a) The focus of two priorities of applied research, development and innovation, i.e. Biological and Environmental Aspects of Sustainable Development and Energy Sources (or Support for the Sustainable Security of Energy Sources), directly concerns environmental issues. The main objectives of Biological and Environmental Aspects of Sustainable Development includes improved environmental protection and ecosystem services, the handling of issues related to global changes, the sustainable management of land, reduced contamination risks and improvements in public safety. The aims of Energy Sources include the handling of issues related to more efficient and more environmentally friendly use of fossil fuels, reduced CO_2 emissions, expanded use of renewable energy sources, and advances in environmentally friendly biofuels.

(b) Other priorities also address environmental issues – the objectives of Competitive Engineering include reduced consumption of non-renewable sources in the transport sector, reduced emissions, and the reduced energy consumption of machinery, goals of the Materials Research priority include the lower energy and material intensity of industrial production.

(c) One of the objectives of the NRDIP (Objective 2) is a further update of the priorities of applied research, development and innovation, the main goal of which will be the greater focusing of priorities based on the needs of sustainable development, using modern methods such as forward studies (foresight). It can reasonably be assumed that the focus of priorities, and hence the thematic focus of applied R&D, will be more in line than current priorities with current environmental issues in the Czech Republic and their timely solutions.

VI. Priorities of applied research, development and innovation in the Czech Republic in 2009–2011

In most fields of applied research, the concentration of human, financial and other resources is needed to achieve more pronounced progress.[8] Applied research covering the full range of disciplines can only be afforded by large, economically developed countries. In small and medium-sized countries, the priorities of applied research are set out in policy documents. Priorities are set with regard to the circumstances and opportunities of R&D in the country and of the users of R&D results. The socio-economic and environmental needs of the country are a key criterion for the selection of priorities.

In the Czech Republic, the first efforts to set R&D priorities emerged in the late 1990s. The following provisions were incorporated into Act No 130/2002 on the promotion of research and development from public funds:

- the R&D Council sets R&D guidelines and proportions through its expert committees (Section 35(2)(a)),
- the Ministry of Education draws on these long-term guidelines and proportions in the drafting of the National Research Programme (Section 5(1)).

The Government, on a proposal from the R&D Council, approved the first set of Long-term Research Guidelines under Resolution No 661 of 1 June 2005, and the updated guidelines under Resolution No 1192 of 18 October 2006. Both sets of long-term guidelines were still too broad and their transfer to follow-up research programmes was not particularly successful. The user community was not involved enough in the preparation of the two drafts of the Long-term Research Guidelines. The Long-term Research Guidelines were sometimes erroneously interpreted as also applying to basic research.

The R&D Council, again through expert committees, prepared a new set of priorities for applied research, development and innovation, which is presented as part of the draft NRDIP. The preparations drew on experience of the drafting and application of the two previous sets of research guidelines. The amendment to Act No 130/2002, which entered into force as Act No 110/2009, incorporated the fact that the R&D Council is responsible, inter alia, for proposing the priority areas of applied research, development and innovation.

The various priorities of the draft priority areas of applied research have been processed according to a uniform outline:

- Brief description of the problem
- Reasons and criteria serving as a basis for the selection of a particular area
- SWOT analysis, including the readiness of users to absorb and use the results of research

[8] Foreign policy documents on R&D indicate the need to create a critical mass of resources.

- The current state of the issue abroad and in the Czech Republic, in particular the preparedness of R&D and users of R&D results
- The benefits projected
- The financial requirements.

The following eight priority areas were preserved:

1. Biological and Environmental Aspects of Sustainable Development
2. Molecular Biology and Biotechnology
3. Energy Sources
4. Materials Research
5. Competitive Engineering
6. Information Society
7. Security and Defence
8. Priorities for the Development of Czech Society

When deciding on the support of applied research, aid grantors will have to respect these priority areas. The priority areas will be the basic requirement for research programmes coordinated by the Czech Technology Agency.

In 2011, the R&D Council will present the Government with the new set of priorities for applied research, development and innovation, Measure A 2-1 of the draft NRDIP.

Biological and Environmental Aspects of Sustainable Development

Summary

The applied RDI priority "Biological and Environmental Aspects of Sustainable Development" integrates the trends of modern society in the environmental and agro-environmental fields, including relevant aspects of the Czech Republic's foreign development assistance.

This priority encompasses environmental and applied biological research and development in the field of environmental protection (including biotechnological aspects of water, soil, and air protection and waste management), research related to production and non-production aspects of agriculture and forestry, and research linked to the integration of science and engineering with applied humanities disciplines for the optimal use of ecosystem services and their sustainability. The priority gives the Czech Republic the possibility to connect to ongoing changes in the field of applied ecological-biological and environmental sciences, in which the Czech Republic boasts a long tradition and, in some respects, very sound standards. On the other hand, the gap between modern environmental knowledge and practices in agriculture, forestry, mining and extraction, urbanism and water management is widening, so much so that many relevant policies do not reflect the findings and recommendations of successful R&D projects, and even directly contradict them. The main causes of this negative situation are departmental fragmentation in environmental education and research, the separation of basic and applied research, and the monopoly of certain users, who have no incentive to demand and implement R&D results. An important specific feature of (agro)environmental research, geological research and research on ecosystems is that this issue is largely regionally-specific, so the needs of the economy and society often cannot be met other than by "local" R&D. A critical analysis of the possibility of achieving declared objectives indicates that most of the possible solutions and approaches require domestic handling capacity for application outputs.

From the departmental perspective, this mainly concerns research and development conducted under the **Concept of Applied Agricultural Research and Development up to 2015** (its main thematic areas include the Protection and Exploitation of Natural Resources, the Technological Development of the Agricultural Sector, Food Quality and Safety, Sustainable Farming in the Countryside, and Rural and Countryside Development), and to a lesser extent research carried out by the **Czech Technology Agency**, with the accent on environmental biotechnology, climate protection and environmental protection, and the protection and use of the Czech Republic's hydro and geological resources (where appropriate as a Ministry of the Environment programme implemented by the Technology Agency). This priority is directly related to the priorities "Molecular Biology and Biotechnology" and "Energy Sources", and in part to the cross-sectional area of "Security and Defence".

1. Characteristics

Modern society is characterized by increasing demands on the quality of life and the lower social acceptance of risk of any kind which it creates itself (demographic variations, loss of social cohesion and the impending failure of infrastructure, including supply, migration, international terrorism, epidemics, natural and technological disasters). The concept of the sustainability of life ("a method of development that meets the needs of the present without compromising the ability of future generations to meet their own needs") places an emphasis on research and technological innovation as the path to development

ensuring a higher quality of life while becoming less energy and raw material intensive. The concept of "ecosystem services" includes services that ecosystems provide to us today "free" or "automatically" (food production, wood, water, technical resources and biochemicals, genetic resources, climate regulation, water system and disease control, soil formation, the cycling of nutrients).

Despite their efforts to the contrary, EU economies are drifting further away from sustainability. Efforts to "soften" farming through various subsidies have failed to meet the key expectations – to halt the decline of biodiversity in agricultural and forest land. Intensive farming and the prevailing monoculture in forestry and seemingly logical pressure on the use of post-exploitation residues for energy purposes reduce the fertility and regenerative capacity of soils, extensive pressure on construction leads to the direct grabbing of this irreplaceable resource. A related problem is that land for residential and recreational purposes is becoming steadily less attractive even as consumer demands rise with the advancing education of society. These problems could become much more complicated if predictions of global climate change come to pass. We still know very little about the possible impacts of climate change on the socio-economic context of land use. Even the most modest scenarios of global climate change expect the substantial restructuring of natural populations; the advantages of our geographic positions in terms of commercial crops will change, the replacement of the dominant forest tree species will be accompanied by an increased frequency of insect, fungal and other disasters, there could be a decline in (or replacement of) important species of pollinators, or changes in the species spectrum of pests, pathogens, and also economically beneficial organisms. In this new system, the hydrological regime in the landscape becomes strategically important from a security point of view.

The biotechnology industry and breeding technologies aimed at minimizing environmental risks are being developed on a global scale (e.g. the selection of crop genotypes resistant to immissions and environmental stresses, but not to pesticides). This is in line with the projected changes in European agriculture, which imply a reduction in energy inputs and respect for its landscaping, soil-protection, biodiversity and water features without compromising production. Deepening and broadening knowledge leading to the production of a wide range of quality, safe foods and to the creation of conditions for the healthy nutrition of the population is a priority area for research from the local and global perspective. The current situation on the world market in food and non-food products is highly unstable. We are witnessing cyclical rises in prices of fossil energy sources, increased demand for plant and animal food products as a manifestation of improving standards of living in populous Asian countries, and a boom in energy crops associated with the normative enforcement of bioenergetics. This all leads to significant hikes in food prices, the diversion of capital investments to food commodities and the threatening growth of social tension in many countries. The unstable situation in the market for plant products is leading to the need to maintain a considerable degree of self-sufficiency and to respond adequately to the opening up of export opportunities.

In a globalizing world, it will become increasingly important to constrain the menacing imbalance between countries and regions. A key role here will be played not by direct financial and material transfers and assistance, but, in particular, by the transfer of knowledge. As the economic performance of the Czech Republic improves, so does its ability to participate in such transfers; on the other hand, a realistic assessment of the options open to the Czech Republic necessarily results in the identification of just a few areas (from the perspectives of both geography and content) where development assistance can be targeted. It is very important for Czech foreign development assistance programmes and projects to draw on detailed knowledge of local conditions, and to be environmentally sensitive, socially viable

and economically sustainable. The priority is to promote food self-sufficiency and the development of relevant bio- and agrotechnology, as well as the protection of ecosystems, all unique from a global perspective. In both areas, it is essential to train the relevant specialists and support sectoral research in developing countries.

2. Objectives

In the field of environmental protection and ecosystem services:

- the evaluation and use of the main tools of practical nature protection and countryside conservation in terms of the prosperity of communities and species, and also in terms of the impact on the economy, housing and recreation;
- consistent biologization in the optimization of land use, including rehabilitation and revitalization;
- the use of water courses and reservoirs, including environmentally sensitive and economically rational flood measures, to increase the retention capacity of the landscape;
- the protection of sources of genetic variability of domesticated and wild plants, wild animals and microorganisms; the protection of agricultural land and its fertility.

In the field of global changes:

- the construction of local scenarios for future climate development and the modelling of the impact of climate change on soil, aquatic and terrestrial ecosystems, an assessment of the impact of climate change interaction with existing negative impacts (nitrogen and sulphur deposition, eutrophication);
- quantification of the impact of climate change on the hydrological regime of the landscape and land, both major rivers and river basins of the first order, and a determination of optimal measures to eliminate the influence of expected episodes of droughts and floods.
- the acquisition of more accurate data on climate changes that have already taken place, which is a prerequisite for the testing of models and future scenarios (Quaternary geology, geochemistry);
- growing, operating and processing alternatives to the currently prevalent commercial woody species (the viability of today's prevailing cultures in a changing climate, climate interaction with pollutants, pests and pathogens, alternatives to the current growing practices, analysis of the economic and environmental risks and environmental geofactors);
- the impacts of global climate change on pollinators, species useful in the biological protection of plants, and other species of flora and fauna that are part of the functional biodiversity in the countryside;
- the throughput and attractiveness of the landscape during the migration of organisms.

In the field of agriculture, forestry and food:

- the development of domestic crop genotypes tolerant to biotic and abiotic stress, with reduced demands on agrochemical and cultivation interventions, the genetic improvement of economically important plants and animals to stabilize and increase their productivity;
- the protection and preservation of sources of the genetic variability of cultivated plants and kept animals (old varieties and breeds, conservation of their genetic potential);
- the acquisition of molecular markers and representative genes and the transfer of derived gene materials for breeding purposes (including the use of GM techniques);

- the development of sustainable farming in the countryside, new farming technologies minimizing environmental impacts, including the use of low-input technology and organic farming, the development of economically efficient and environmentally friendly systems and technologies for raw material production on agricultural and forest land for food and non-food use;
- the availability, quality and safety of food, influencing public health via nutrition.

In the field of contamination risk and safety:

- minimization of the industrial burden with respect to current and future land use;
- the correction of inappropriate decontamination action and restoration of the natural function of contaminated areas;
- new opportunities and ways of redeveloping abandoned industrial sites in built-up areas to return them to the life of the urban organism;
- a reduction in the volume and weight of waste dumped in landfills or incinerated, and the design of new technologies for the decontamination and degradation of xenobiotics reducing pollution to a level below permissible limits, effective recycling or biological waste recovery for chemical or energy re-use, the development of methods for evaluating geochemical background (as required by current risk assessment legislation);
- scenarios and modelling of ecosystem services in the context of threats to human safety (chemical, biological, radiological and nuclear weapons, chemical and nuclear accidents), reductions in the negative impacts of natural disasters, operating accidents and attacks targeted against society;
- improvements in the strategy for the identification, management and communication of chemical and microbiological risks associated with food production, the effect of contamination with toxic synthetic substances on ecosystems (endocrine disruptors, the impact of pesticides on pollinators, etc.).

3. Grounds and criteria forming the basis for the drafting of the priority

The priority "Biological and Environmental Aspects of Sustainable Development" reflects the priorities set out in the National Research Programme (NRP) and is in line with the Czech Republic's Economic Growth Strategy. It was drafted based on the growing needs of society, but also against a fairly advanced research and development background. The reason for drawing up this priority was the need to provide research knowledge that would satisfy the current needs of the user community (the government, agricultural and forestry enterprises, breeders, water managers, businesses providing advisory services, companies specializing in environmental services, the manufacturing and food industries); the main criterion for the selection of objectives was the inability to directly collect research findings from abroad. The priority objectives are based on the need to address systemic approaches in the use and protection of the environment, where partial, often limited utilitarian approaches have prevailed so far. The environment, agriculture, forestry and water management are burdened by ingrained, often irrational approaches to problem-solving. The situation is much the same as regards the lack of transfers of research results to the innovation and user community. This priority should eliminate these disparities and lead to synergy between the different types of research institutions and practices. The user public's interest in new and modern knowledge (indicated, for example, by interest in consulting, presentations, fairs, etc.) is large and is not always met with an adequate response from the research community.

An important specific feature of (agro)environmental research is that **the issue of sustainable development is largely regionally-specific, so the needs of the economy and**

society often cannot be met other than by "local" R&D. A critical analysis of the possibility of achieving declared objectives indicates that most of the possible solutions and approaches require domestic handling capacity for application outputs. Even where the Czech Republic is involved in international cooperation, the acceptance of foreign results requires qualified domestic assistance.

4. SWOT analysis

4.1. Strengths

The Czech Republic has strong research and development capacities, represented by a large number of workers and scientifically and environmentally oriented institutes and university departments (including applied research capacities, i.e. engineering, forestry, agriculture, geology, water). Some R&D results in ecological and environmental sciences are fully competitive with the most advanced countries. Strong comparative advantages are sound knowledge of the prevalence of biological species and communities in Czech territory, and a detailed inventory of hydro-, geo-and paedological conditions. It is also worth mentioning the system of environmental education, established as early as the pre-school level. The robust structure being built up in relation to the environment has the potential to further the application of research in practice.

Under the Sustainable Development priority in the EU's Sixth Framework Programme, the Czech Republic's long-term, relatively high competitiveness in R&D was revealed. Scientific teams work here that are involved in European projects aimed at analysing and caring for the environment. The most successful research areas include biodiversity, limnology, biogeochemistry, biological invasion research, industrial landscape ecology, tropical ecology and parasitology. The National Conservation Programme for the Preservation and Maintenance of the Gene Resources of Plants, Animals and Microorganisms is very highly regarded in Europe. At European level, there is research in veterinary medicine, phytosanitary and phytopathology, classical breeding; internationally comparable modern alternatives to production technologies include minimization technology and precision farming technologies. Strong research teams for biochemistry and bioengineering combine classic tradition with excellent chemical and technological facilities and the rigorous monitoring of environmental aspects. There are also strong centres specializing in the recycling and recovery of organic waste, including water purification.

4.2 Weaknesses

General weaknesses in Czech research and development (the lack of a flexible professional career, the fragmentation and poor distinctiveness of excellent research, etc.) are fully relevant to applied agri-environmental fields. The problem is the lack of clarity of environmental study programmes both as regards the subject itself and its methodological background. The graduates produced by many faculties in trendy "green" subjects often have a shallow education that does equip them to engage in high-quality scientific or engineering research.

The gap between modern environmental knowledge and practice in agriculture, forestry, mining and extraction, urbanism and water management is widening, so much so that many relevant policies do not reflect the findings and recommendations of successful R&D projects, and even directly contradict them (often, for example, in forestry, with reference to "centuries-old proven practice", which, however, in terms of degraded habitats and the mild

effects of climate change thus far, is clearly starting to fail). Numerous declaratively "green" measures are proclamatory, factually ineffective and disproportionately expensive. This situation has its roots in the inability of the research community to present rational analyses of problems and propose solutions in the frequent conflicts between "development" and "protection". In the agricultural sector, the fact that part of food production has lost its home breeding base, and foreign companies need not be interested in developing and marketing genotypes compatible with domestic requirements, can have an adverse impact. There is no coordinated research on the quality of the most important crops, including in relation to human health.

The main causes of this negative situation are (1) departmental fragmentation in environmental education and research (agriculture, forestry, water, etc., schools and institutions do not reflect social demand, but work as agencies for the promotion of the specific interests of narrow groups of professionals); (2) the separation of basic and applied research (basic research workers are inherently forced to reflect global trends and ignore the narrow interests of potential users); (3) the monopoly of certain users means they are not forced to demand and implement R&D results (large companies and agencies have their own, or closely related, research base, from which they do not require new or economically optimal solutions, but assurances of the accuracy of long-established solutions).

The importance of acquiring time series of environmental variables in the corresponding time step is not fully appreciated. This importance is growing in light of global changes. For example, precipitation drainage data and water quality data should be collected (quasi) continuously if sensors are in place. In the organization of research, this entails long-term projects/programmes. Evaluations of short series can be highly misleading.

The quantity of *applied* R&D results in these areas is low compared with other European countries. The scientific value of the outputs of agricultural and forestry research is very inconsistent; it falls short of expected standards and is diluted by the dominance "conference proceedings" publications (their importance for the spread of expertise is undeniable, but they should not be the dominant R&D segment).

4.3. Opportunities

Overcoming departmental fragmentation within the priority will make it possible to seek new solutions to existing problems and put these solutions into practice with the aim of achieving: lower energy intensity and higher efficiency in the supply of energy raw materials; more rational use of free space than the current trio of "large-scale agriculture-afforestation-development" (changing the structure of technicality in the landscape, transforming "drained" streams, monocultural forests and large-scale agriculture still focused on maximum production); a more flexible response and lower risk in the face of global changes; supporting documents for rational, purposeful and knowledgeable decision-making on subsidies, environmental legislation and environmental restrictions.

In terms of R&D infrastructure development, it is important to involve existing research potential, including potential outside the majority academic institutions (small businesses, NGOs?), in the handling of strategic near-term issues, to ensure closer integration of schools and research institutes with businesses, to place graduates, and to significantly improve the financing options. Another opportunity is to participate in the transfer of knowledge and technology to handicapped areas of the world, including the until recently very successful search and verification of stocks of strategic materials.

An exceptional opportunity to achieve an increased quality and volume of research and development for sustainable development in the Czech Republic is offered by the prospect of funding from the European Structural Funds under the Research and Development for Innovation Operational Programme (R&DI OP).

4.4. Risks

The main risk is a continuation of the current trend of impoverishment and destruction of nature and the landscape without the simultaneous enrichment of society. In the field of primary agricultural production, the instability of global market trends and changes in EU agricultural policy trends (energy crops, food production) need to be taken into account. There is also a risk of the further degradation of forests and water regime in the landscape. The non-acceptance or inadequate implementation of the priority will reduce the competitiveness of the whole agricultural sector, impede the development of the Czech countryside, and result in disproportions in ensuring the sustainability of the multifunctional nature of the agricultural sector.

Another risk is the failure of many international and national commitments and obligations (Natura 2000, Action Plan for Biodiversity Research, the Nitrate Directive, the Water Framework Directive, the 2007-2013 National Development Plan, the Economic Growth Strategy, the Sustainable Development Strategy, the Strategy for the Protection of Biological Diversity, the National Forestry Programme II for 2007-2012, the EU's forthcoming soil directives), with unpleasant effects on the credibility of political representation.

Considering the highly varied quality of research and development institutions in this field in the Czech Republic, and given the ongoing departmental fragmentation of R*D (universities, the ASCR, the MoA, etc.), there is a risk that some R&D funds will be allocated to institutions offering few prospects. The regionally-specific nature of R&D in the field of sustainable development provides rational justification for the decision to include this area, with all its risks, among the priorities of applied R&D.

4.5. Characteristics of the user community's readiness to absorb and use research results

The prevailing conditions are very diverse. It is hard to find a larger user who would not at least declare an interest in research results. However, the departmentalism running from higher education through politics to ministerial level, contributes to an atmosphere where the big players in particular recognize and use only the results of "their" departmental research capacities; they are reassured that everything of significance has already been investigated and that present research is unnecessary for them because it forces them to change established procedures. Smaller players are pushed by large companies and legislation towards conformism in the use of methodologies and procedures.

Current findings indicate that the user community is interested in new R&D knowledge. The handling of research problems under this priority should enable a group of potential R&D users (agricultural and forestry enterprises, farmers, breeders of plants and animals, government agencies and NGOs, firms providing consulting services, companies specializing in environmental services, the mining industry on the issue of reclamation, the manufacturing industry, and the food industry) to rationally allocate private funds to both research and subsequent implementation. Large state companies, whose position is in terms of

actual business is contradictory (Lesy ČR and the Povodí state enterprises), are a specific user category in terms of R&D results. These undertakings have a significant impact on their sector, where they are dominant economic players, but also have a formally large impact on the defence of state interests relating to nature protection and countryside conservation. For both companies, the State should state clearly the priorities and method for the use of R&D results in their activities.

When communicating the relevance of the declared objectives of this priority, feedback from professional agri-environmental associations is essential. Representatives of agricultural businesses (e.g. the Agricultural Chamber of the Czech Republic, the Union of Agricultural Entrepreneurs, the Association of Private Agriculture of the Czech Republic, the Association of Innovation Entrepreneurship, etc.) and environmentally oriented government agencies and NGOs should, through their professional bodies, create a feedback reflecting the needs of users. It should be borne in mind that in the agricultural sector a significant percentage of users comprises economically weak entities whose share in the financing of certain projects will be strictly limited, at least initially. Some user outputs will be derived from academic research and their customers will be domestic breeding and research organizations in agriculture. Meeting the interest in energy crops and the use of agricultural crop production as an industrial raw material will lead to the emergence of specialized small and medium-sized biotechnology-oriented companies, whose existence is still limited.

5. The situation abroad

Currently, Czech basic and applied research has the opportunity to take part in the ongoing paradigmatic revolution in biology, ecology and environmental sciences, which directly affect the focus of practical applications. Mainly at issue here are (1) a return to the study of nature at the level of organisms and populations, routinely using molecular and population-genetic methods, and the application of still purely theoretical approaches (metapopulation ecology, phylogeography, macroecology) to issues of the practical protection of biodiversity and the management of its resources for direct and mediated use; (2) the transfer of the accent from the “stability of ecosystems” to the momentum of natural and cultural processes in the contemporary landscape, to issues of the emergence and evolution of biodiversity, and the concomitant shift in the focus of interest from environments with limited human encroachment to a search for methods of sustainable development; (3) the experimental simulation and modelling of expected changes in climate, and consideration for the landscape energy flow and the distribution of substances with the aim of the rational and environmentally sound management of the cultural landscape; (4) the decryption of past climate change by methods of Quaternary geology, palaeolimnology and palaeopotamology, palaeontology, palynology, geochemistry, etc.; (5) the development of systems for monitoring the status of natural and cultural ecosystems and their xenobiotic stress by means of a wide range of appropriate groups of organisms, including soil edaphon, as well as abiotic components, such as soil and water chemistry.

This trend is also reflected also in the EU Framework Programmes. European requirements regarding the nature of new products (food and non-food) have been treated in detail in a number of documents, such as “Plants for the Future”, and research incentives for their implementation are created and coordinated by pan-European organizations such as EPSO. A stress is placed in particular on sources of wholesome food diversified in terms of nutrition and diet. There has been increased investment in the development of such crops and livestock using sophisticated techniques of molecular biology.

6. Czech conditions

6.1. Preparedness

Our basis is the existence of high-quality research in relevant fields at certain universities specializing in science and engineering, ASCR institutes and departmental research institutions. The poorly equipped laboratory facilities and field offices are steadily improving. Overarching research viewing sub-departmental and regional problems and concepts through the "territorial prism" is desperately lacking in the Czech Republic.

A considerable number of Czech laboratories are involved in international cooperation, both officially (e.g. in EU programmes or under bilateral international agreements) and – even more – informally. In the majority of cases, however, the leading role in this cooperation is played by partners from developed countries. It is important to interlink the Czech Republic with evolving European initiatives in this area which are more application-oriented, whether they concern the protection of biodiversity or global changes related to the implementation of the Kyoto Protocol.

Issues related to agricultural research are handled in the Czech Republic by a number of specialized research and scientific teams at public and private research institutes. Many of them are involved in broad national (ad hoc "consortiums" on the given issue) and international cooperation. Traditionally, the Czech Republic boasts developed, sound technology for manufacturing, particularly in the food industry, which in several cases has its own research base (brewing, sugar, starch). In general, there is no link to the activities of basic research. Issues related to the quality and safety of food/feed and research in the field of food biotechnology in order to ensure healthy nutrition have been dealt with long term by a number of specialized teams.

6.2. Use

The primary users of research and development results in this priority will be agricultural entrepreneurs, farmers, breeders of plants and animals, companies involved in environmental services, the manufacturing and food industries and central and regional government agencies. For agricultural sector products, the transfer to the manufacturing sector depends on the supply and speed of development of processing technologies, as well as on investment incentives. A prerequisite for the relevant use of results is their quality, coupled with the user's confidence that applying new procedures and approaches will increase or stabilize its market participation. It is essential to tighten requirements regarding the genuine practical usability of declaratively "applied research and development" (R&D co-financing from private sources, the actual production of a type of results that correspond to applied R&D, i.e. not only results that are published in frequently insignificant local media and research reports).

7. Expected results

The results expected under the priority "Biological and Environmental Aspects of Sustainable Development" can realistically include:

- an increase in the effectiveness of measures and costs of environmental, agricultural, water and forestry policies, and their interconnection in objectives and instruments;
- the greater involvement of the Czech Republic in international research structures in the given area;

- the integration of science and technology-oriented research with fields of applied social sciences (economics and environmental law, sociology in relation to the environment and sustainable development, research of socio-economic barriers to optimal use of ecosystem services);
- the creation of database and expert systems in fields of environmental research, applied ecology and agriculture, which will facilitate the prompt transfer and use of findings;
- the establishment of centres for the research and development of new environmental technologies with the necessary infrastructure;
- the introduction of the safety of ecosystem services as part of safety research and strategies in the Czech Republic;
- the preparation of methods for the development and evaluation of the multifunctionality of agricultural and forestry systems, particularly with regard to possible climate changes; the preparation of methodology for the restoration and revitalization of the hydrological network so that aquatic ecosystems and the landscape are able to withstand the impact of climate change as much as possible;
- the preparation and standard implementation of methods for the management of habitats and species in nature protection;
- new technological processes for the treatment of soil, plant nutrition and agricultural machines, storage technology that respects the protection of agricultural and food production, including a reduction in the energy intensity of production systems, verification of benefits and the standard introduction of new forestry technologies enhancing the biodiversity of species composition and resistance to extreme weather situations;
- the development of domestic crop genotypes tolerant to stress, particularly drought and new phytopathogens, with reduced requirements for agrochemical and cultivation interventions, via the broad application of molecular markers (Marker Assisted Selection), the application of new breeding techniques and the development of agrotechnology for intentional production and use of biomass;
- the acquisition of new primary products (varieties) of commercial crops with improved nutritional and dietary properties;
- the development and application of molecular-genetic and cellular methods for the application of effective biotechnology in agriculture, the food industry, forestry and water management;
- the development and application of methods to improve the safety and quality of production, including research into evaluation methods;
- the development of more sophisticated methods of post-mining rehabilitation.

8. Benefits

(a) Improvements in efficiency and competitiveness, in particular among those economic sectors that are closely linked to ecosystem services and natural resources; minimization of the negative impacts of technology on the environment; the decoupling of economic performance and environmental pressures; improvements in transport structures, public spaces, including urban environments, etc.; the saving of space needed for the construction of new civic buildings, transport infrastructure and industrial plants.

(b) Improvements in nature protection and countryside conservation, the more efficient allocation of resources for nature protection, increased efficiency of the current system of financial subsidies, compensation and penalties in environmental protection; the elimination of certain “green” responsibilities which de facto harm biodiversity and the environment, and

the related significant savings for companies and the State; a review of some of the "green" subsidies (conservation-effective solutions need not be the most expensive, and need not be those practised today); a reduction in the harmful and unnecessary tension between the green-minded public and the economic sphere; a faster response to global trends (climate) and regional trends (the decline of agriculture, the changing consumer demands of the population, the transition to a post-industrial society).

(c) Improvements in the competitiveness of agricultural production enterprises and farmers, as well as processing plants and companies dealing with environmental activities, including the food industry; improvements in the health status of the population; the provision of safe and wholesome food; improvements in the quality of inputs into food production with regard to health, dietary and therapeutic effects.

(d) The advancement of a large number of small biotechnology companies developing and producing high-tech products at global level, kits for the research and diagnostic needs of the food industry, methodology to tackle ecological problems with biological means, and standard biotechnology processes to develop new products and efficient energy use of biomass.

(e) Increased involvement of the Czech Republic in international development assistance related to environmental protection and agriculture, and in the approach to solving the global problems of civilization.

9. Financial resources

Fields of research and development within this priority are significant in terms of public expenditure on R&D (about 5% of total public expenditure on R&D under NRP3), but there are no significant direct links to business activity. A positive factor is that these fields can be regarded as stable with good potential for further development and growth. Private expenditure on R&D in the field of environmental protection is relatively low and if anything has actually been falling in recent years. Business sector expenditure on R&D also includes a high proportion of public resources (almost 40% in 2004). The development of private investment can be expected especially in the biotechnological aspects of this priority (environmental technologies, agrotechnology). A necessary precondition for further increases in the volume of private financial resources is the innovation of indirect instruments for co-financing (tax instruments etc.).

The estimate of target funds in 2015 for applied research in the agricultural sector and related sectors is based on the approved medium-term outlook for dedicated resources from the budget of the Ministry of Agriculture earmarked for the programmes announced by this Ministry. Of the Ministry's total dedicated funds, this priority is projected to receive 70%; it is estimated that further funds will be channelled into the priorities Energy Sources (8%) and Molecular Biology and Biotechnology (18%). To secure the research programmes, EUR 395 million is proposed in the target year of 2015. In addition to other factors potentially affecting the allocation of private resources to R&D (indirect subsidies, tax measures, etc.), in the estimate of future private resources for the co-financing of research programmes and projects Annex I of the Treaty establishing the European Community was taken into account pursuant to Article 38 of the Treaty; this annex allows for up to 100% financing for the products listed. The estimate of private resources in the target year of 2015 is 15% of total dedicated funds. Also, foreign resources (FP7) will barely account for more than a few percent of the total funds drawn in this field of research and development in the Czech Republic. It will be possible to draw on European funds under the EC OP, EI OP, and R&DI OP to co-finance

special support programmes. The shift of R&D funds from the Ministry of the Environment to the Czech Technology Agency would correspond to as much as CZK 450 million in the run-up to 2015 (depending on the final institutional arrangement) for applied research in the field of countryside conservation, the impact of climate change, biodiversity protection, the revitalization of the landscape water regime and changes in the structure of forestry and agriculture. External resources for this applied research are quite difficult to access, even though FP7 resources focus on the effects of climate change on ecosystems. In view of their relatively weak organizational and logistical skills, Czech entities may apply solely as co-investigators, not bearers of projects, and infiltrating research consortiums is a matter of workers' personal contacts with foreign colleagues.

Molecular Biology and Biotechnology

Summary

The applied R&D priority "Molecular Biology and Biotechnology" covers one of the fastest developing avenues of research and development, which is a source of revolutionary diagnostic and therapeutic procedures in medicine, is the main source of growth in the world pharmaceutical industry, and opens up the possibility of radical innovations in the chemical industry.

The development of advanced biotechnology is based on understanding the molecular nature of processes occurring in cells and on the approaches of molecular genetics, structural biology, immunology, bioinformatics, genomics, proteomics and gene, protein, tissue and metabolic engineering. It introduces major innovations in medicine, pharmacy, food and agriculture and opens the prospect of the more efficient use of biomass as a renewable energy source. In developed countries, molecular biology and biotechnology is a major source of economic growth, reports a high degree of interaction between academic research and corporate development, and generates a large number of highly innovative start-ups and spin-offs, whose products are marketed globally by large pharmaceutical and chemical corporations. Commercially, high-tech biotechnology products carry exceptional economic importance on the most developed markets; they generate ever increasing turnover, running into tens of billions of US dollars a year, for biological drugs, diagnostics, industrial enzymes and genetically modified (GM) organisms.

In the Czech Republic, there are teams of a good European standard, but, compared to the most advanced countries, molecular biological research and development in the Czech Republic is severely undersized in terms of both material and human resources. There is a major lack of original intellectual property, disinterest on the part of venture capital, and very low numbers of genuinely performing innovative biotech firms. However, the current development of biological research is comparable to the revolution in physics and electronics in the 20th century. The fact that the Czech Republic is lagging behind in modern biotechnology poses a risk of future economic stagnation as a top-class biotech industry is becoming one of the pillars of knowledge-based economies and a source of sustainable growth that is very environmentally friendly and reports low energy intensity.

The Czech Republic is starting to have enough trained staff to exploit an exceptional opportunity to draw on EU Structural Funds (Research and Development for Innovation OP) in order to build new research capacity. There is an increasing number of university graduates in the fields of molecular biology and biotechnology, and the rate at which successful young scientists return from long periods abroad is improving. Targeted support in this line of research and development therefore offers a unique opportunity to make fast, leaping improvements in quality and volume, and to promote the creation of original intellectual property and the development of the segment of innovative small and medium-sized biotechnology enterprises. The domestic pharmaceutical and chemical industries are also beginning to feel the need to invest in biotechnology research and are economically sufficiently consolidated to absorb biotechnological innovation processes and products of basic and applied research in molecular and cell biology and biotechnology. Specifically, this will mainly involve the preparation of recombinant antigens in a new generation of subunit human and veterinary vaccines and diagnostic kits; in the longer term, the production of advanced biological protein-based drugs and gene therapy products will be developed. The

development of the industrial production of recombinant enzymes for biocatalysts in the chemical, food and textile industries is anticipated.

From the departmental perspective, most R&D will be carried out by the **Czech Technology Agency**, partly in accordance with the **Concept of Applied Agricultural Research and Development up to 2015** (the "development and application of molecular genetic and cellular methods, the related development and application of effective biotechnology in agriculture, food, forestry and water management") and the **Concept of Medical Applied Research and Development up to 2015** (support for molecular biological approaches is reflected in research priorities, particularly in oncology, paediatrics, genetics, neurology and psychiatry). This priority is directly linked to the LTRGs "Biological and Environmental Aspects of Sustainable Development" and "Health".

1. Characteristics

This priority integrates research into the molecular basis and fundamental mechanisms of life with the applied research and development of cutting-edge biotechnology processes and products with high utility value. The priorities of applied research here include the research and development of advanced diagnostic procedures, the identification of disease biomarkers, gene, protein and metabolic engineering, the research and development of recombinant biological medicines and vaccines for human and veterinary medicine, research on stem cells for tissue repair, and the research and development of advanced biotech processes and products, including the development of tools for the management of bioremediation processes and the use of organisms in environmental biotechnology. A key feature of the research and development under this priority is the use of molecular and cell biology methods. In this field, it is essential to forge close links between applied R&D and high-quality basic research focused primarily on analysing the relationship between the structure and function of biological macromolecules, function and regulation of genes and genomes, the molecular mechanisms of basic cellular processes and the emergence of disease, the functions and interactions of cells and systems in tissues and whole organisms, and the clarification of the nature and mechanisms of immune response and regulation. In this respect, applied research is characterized mainly by the use of gene manipulation methods for the preparation of knock-out and transgenic cell lines, microorganisms, animals and plants, and the use of genetically manipulated model organisms for research and production purposes (new therapeutic, diagnostic and biotechnology processes and products).

2. Objectives

The priority's objective is to use knowledge of the molecular mechanisms of processes occurring in living organisms for the applied research and development of methods, products and technologies that will improve the quality of life and public health and contribute to the development of the knowledge-based economy, its sustainable growth and the long-term competitiveness of the Czech Republic. A specific objective of this priority is to achieve such a jump in the quality, depth and volume of research into biological processes that original intellectual property is formed in the Czech Republic, and that the foundations are laid for viable start-up and spin-off biotech companies to drive forward the whole of the advanced biotechnology industry in the Czech Republic.

The objective of applied research development in health care will be to improve the life of the population by means of timely prevention, to refine diagnostic methods, and to provide the effective treatment of major diseases through the integration of technical and

medical developments. The starting points must be demographic data and demographic trends in the Czech Republic, morbidity and mortality, and efforts at the healthy development of the population, with an emphasis on prevention, not only for its ethical, but also economic and social context.

The priority's specific objectives are

(i) in terms of advancing the research and development base:

- acquiring new fundamental knowledge of basic molecular mechanisms in biological processes, with the potential for practical application in medicine, pharmacy and biotechnology (including agriculture, forestry and food);
- increasing competitiveness and maintaining contact between Czech scientific teams and the world leaders in the field of molecular and cell biology and biotechnology;
- involving a consortium of academic teams and businesses in technologically cutting-edge biological research, allowing both a deeper understanding of the mechanisms behind the functioning of cells and whole organisms, and the emergence of new high-tech instrument technology;
- establishing scientific teams to create a knowledge and expertise base for applied research and development in enterprises and mediate their access to information and cutting-edge global research methods;

(ii) in terms of applied research and development:

- creating a close, well-functioning link between businesses and academia, and employing a coordinated approach to basic and applied research in the handling of specific scientific and technological issues based on joint projects/programmes in human and veterinary medicine, pharmacy, plant and animal production, and food;
- creating original intellectual property that will facilitate the development of a cutting-edge domestic biotechnology industry based on knowledge;
- creating and developing research-oriented high-tech start-up and spin-off biotech companies that are able to absorb intellectual property generated in the academic sector, or created by its own forces, and transform it into economically viable products, technologies and services that will attract investment from venture capital groups;
- introducing the production of recombinant antigens for use in new diagnostic kits and subunit veterinary and human vaccines, the development of the production of generic biological pharmaceuticals such as "biosimilars" in the Czech Republic, and the development of the production of original industrial enzymes for use in biocatalysts for the chemical, food and textile industries;
- increasing the turnover of the advanced biotechnology industry using GM organisms by at least 20% annually over the next ten years.
- ensuring the development of clinical applied research in the Czech Republic as a basic source of new clinical procedures for diagnosis, treatment and prevention in health care;
- increasing the specific benefits of applied research for health care (especially in diagnosis, therapy and prevention), and reflecting current reviews of the state of health of our population in this research;
- promoting and preferring molecular biological approaches in relevant areas of medical research and development;
- creating conditions for research into the medical issues of the fragile population – ethnic minorities, the elderly and the socially most vulnerable groups;

- using the research results in the pre- and post-graduate training of doctors and other healthcare workers.

3. Reasons and criteria serving as a basis for the proposal of the priority

The priority "Molecular Biology and Biotechnology" reflects the priorities set out in the National Research Programme (NRP) and is in line with the Czech Republic's Economic Growth Strategy.

This path was marked out as a priority for the Czech Republic based on the fact that, following the rapid development of the chemical, engineering and electronic industries in the 20th century, the 21st Century will herald the development of an advanced biotechnology industry. This industry draws on the discovery and introduction of gene manipulation technology, which at the end of the 20th century facilitated the development of molecular and cell biology methods and led to an explosive and groundbreaking development of knowledge about genomes and the molecular principles of processes occurring in living organisms. This research area is currently producing a staggering amount of information about the basic mechanisms of life and offers immense scope for their practical use in medicine, the pharmaceutical and chemical industry, and agriculture. In particular, it encompasses the research and development of new diagnostics, drugs, and tissue repair, and the development of innovative biotechnological production processes based on protein, enzyme and metabolic engineering. The high-tech biotechnology and pharmaceutical industry, based on the use of gene manipulation and molecular biology methods, reported worldwide turnover in 2007 of over USD 100 billion, and provides the market with revolutionary biological medicines and subunit vaccines, thermostable industrial enzymes, nanobiosensors, genetically modified organisms and other products with very high utility value. Major potential for practical application can also be found in the production of a wide range of valuable heterologous proteins via plants, where it is appropriate to support the commercialization of existing and emerging research projects.

It is crucial for research teams and companies in the Czech Republic to be able to draw on targeted support so that they can participate in this process at a sufficiently high level and generate a "positive brain-drain" attracting great minds of domestic origin to the Czech Republic from abroad. The aim is to assist the emergence of a sector of innovative high-tech biotech companies, which would significantly strengthen the Czech Republic's pro-export potential.

The primary criterion for the promotion of this priority is that the top-class biotech industry produces high value-added products with limited energy and raw materials and creates jobs for highly qualified graduates of higher education fields of study. The development of this type of research and industry engenders, as a secondary phenomenon, the development of a high-tech industry of laboratory equipment and unique biotech manufacturing facilities. This also contributes to the country's economic growth and competitiveness.

The expected increase in the number of patents or utility models in the field of molecular biology and biotechnology will undoubtedly contribute to the improved protection of intellectual property rights in the Czech Republic, thus triggering the creation of new start-up and spin-off biotech companies. Licensing in biotechnology will make a considerable contribution to the academic community's budget, with emphasis on interconnecting new ideas with the pharmaceutical or chemical industrial sector at home and abroad. In particular, patent protection of key ideas in basic research will mean an increase in long-term

competitiveness of domestic industrial enterprises, which will be able to use these patents and export the new products thus created to other countries.

Besides academic institutes and enterprises, the process of applied research and development needs to mobilize medical facilities, as the development of new products of this type must go hand in hand with the research and development of new medical techniques and procedures that will be applied by medical facilities and specialized clinics in the provision of health care.

4. SWOT analysis

4.1. Strengths

Traditionally, the Czech Republic has a strong research and educational base in biology and natural sciences in general, the capacity of which in the field of molecular biology has been constantly rising in recent years. After lagging far behind in the 1980s and 1990s, molecular biology research is now a central topic of several academic institutes and university centres and the teaching of these subjects is of a relatively good level. The numbers of master's and doctoral students in fields including cellular and molecular biological approaches in the last decade have grown steadily. Numerous research teams have already reached a sound European level. These groups, which can be found at certain ASCR institutes, universities, in several high-quality departmental research institutes and at a few biotech companies, are able to compete for international grants and cooperate as equals with partners from the most advanced countries. Today, a growing number of teams regularly publish in high-quality, sometimes even in the world's very best, journals and occasionally produce valuable results that can be applied in practice (for example, molecular parasitology and immunology teams are catching up with the world's leaders).

4.2. Weaknesses

Yet in comparison with developed countries, staffing and R&D infrastructure in the field of molecular biology and biotechnology in the Czech Republic is still significantly undersized; in addition, this field's share in the overall financial support allocated to research and development from public funds remains inadequate. General weaknesses in Czech research and development (the lack of a flexible professional career, fragmentation, lack of concept, a low degree of research originality, and a very low incidence of excellent research teams) are fully applicable to this field, which is still dealing with the consequences of international isolation before 1989 and a continued lack of support. Lack of awareness of the real opportunities for the commercialization of intellectual property or products based on the results of intellectual property, accompanied by unfamiliarity with basic marketing rules, leads to a situation where a major portion of intellectual property will never be properly marketed. Applied research and development in the field of molecular biology and biotechnology suffers from a chronic shortage of original intellectual property, as there is no tradition of such rights in this field in the Czech Republic; there is a lack of awareness of its significance and the principles of protection in the academic research community. Financial aid programmes to protect intellectual property do not exist. In the Czech Republic, there is a critical shortage of professionally skilled professionals to protect and commercialize intellectual property and technology transfer in the field of molecular biology and biotechnology. Most academic institutions systematically underestimate the need for these activities and do not develop them, so they do not have specialized units and experts to deal with these issues, or their existence and activities are only formal and the aid granted to

researchers is unprofessional. In the absence of seed capital, legal, knowledge and economic barriers to the formation of spin-off companies at academic institutions continue to prevail. This is also reflected in the very small number of actually operating innovative biotech firms in the Czech Republic. Ultimately, international venture capital appears to show minimal interest in molecular biology and biotechnology research in the Czech Republic.

Unlike developed countries, the Czech Republic has no dedicated programme to support research in the field of molecular biology and biotechnology, which is financed entirely under the standard R&D support programmes and schemes, often in relation to lobbying. Compared to the situation in developed countries (e.g. around 50% of total public expenditure on R&D in the US) spending on biomedical research and development in the Czech Republic accounts for just 20% of the total expenditure, i.e. approximately CZK 3.87 billion, representing about a quarter of the expenditure per capita.

4.3. Opportunities

In view of the high innovation potential of modern biotechnology and medical procedures, the development of this line of research should enjoy strong, rational support. The Czech Republic has significant reserves of personnel and materials in this field which can be mobilized and used after the introduction of the desired system measures related to the organization of research, particularly after the introduction of more strongly differentiated research support based on an effective method of evaluating the results.

In recent years, the rapidly rising domestic living standards, new opportunities in research and the relative stagnation or even decline in revenue and research opportunities in Western European countries and the US have significantly reduced the brain drain from the Czech Republic; conversely, a trend can be observed where a higher percentage of successful young scientists return to the Czech Republic after long-term placements at top-quality institutions. In addition, talent from Third World countries is becoming more interested in pursuing studies and research careers in the Czech Republic following the country’s EU accession.

An exceptional opportunity to achieve a surge in the quality and volume of research and development in the field of molecular biology and biotechnology in the Czech Republic is offered by the prospect of funding from the European Structural Funds under the Research and Development for Innovation Operational Programme (R&DI OP). This unique opportunity to build costly world-class infrastructure for molecular biology and biotechnology research comes at a time when student interest in fields encompassing molecular and cell biology and biotechnology approaches is peaking and there are growing numbers of graduates in these disciplines each year. The synergy generated by such auspicious circumstances creates a unique opportunity to drive up molecular biology and biotechnology research in the Czech Republic to a new level of quality and volume and to narrow, to some degree, the gap in this area with the most advanced countries. The allocation of a substantial part of R&DI OP resources to this area of research and development, for which there is now a sufficient highly skilled workforce in the Czech Republic, could therefore be described as a highly rational way of using European money to support research with innovation potential in the Czech Republic.

4.4. Risks

Failure to latch onto current trends and develop systematic support for research and development in the field of molecular biology and biotechnology would place the Czech

Republic at significant risk of continuing to lag behind other countries and of suffering future economic stagnation. Since biotechnology is a field of production which does not place great demands on sources of energy and raw materials, but requires a highly skilled workforce, the careful choice of aid priorities is an opportunity to develop at least a few exportable high-tech biotechnology products, thus countering imports of products which cannot be made in the Czech Republic.

Owing to international isolation during the birth and revolutionary development of molecular biology and biotechnology (1975–1990), research and development in this field in the Czech Republic fell significantly behind the advanced world. The development of an advanced biotechnology sector in the Czech Republic is approximately 20 years behind the US and the UK and 15 years behind the EU-15. As such, there is a risk that significant R&D funds will be allocated to an area where there is extremely strong international competition and in which the Czech Republic has a weak starting position. Developed and developing countries alike are investing increasing resources in this area. There is every possibility, then, that in such a competitive and dynamic environment no amount of financial support will help the Czech Republic's biotechnology research and industry catch up with the international competition.

Expectations of the extraordinary significance of the biotechnology sector in the future development of the economy, however, provide rational justification for such a strategic decision. It is arguable that lack of support for the development of the biotechnology industry in the Czech Republic is likely to create structural problems for the Czech economy in the future. It is generally accepted that the development of an advanced biotechnology industry worldwide is becoming – globally – one of the main pillars of knowledge economies and will be a particularly important source of further sustainable economic development with low demands on energy consumption and high levels of environmental friendliness. Only through domestic research output and the cultivation of conditions for the development and introduction of high-tech production can room be created to reduce the Czech Republic's dependence on imports of often very expensive high-quality biological agents and technologies.

4.5. Characteristics of the user community's readiness to absorb and use research results

In terms of the user community's readiness to absorb and use R&D results, the Czech Republic is limited by the still very small number and economic weakness of innovative small and medium-sized biotechnology enterprises and the lack of domestic producers of products other than the generic drugs who would have the economic clout to fund clinical trials of original bio-products and place them on the market. The Czech Republic has no real coordinated policy of support for an advanced biotechnology sector, or at least a specific working group for high-tech biotechnology at the Economic Chamber or the relevant ministries. The situation is somewhat better regarding products for biotransformation in the pharmaceutical, chemical, food and textile industries, where there is already considerable demand among domestic enterprises for original research results that will lead to new manufacturing processes and products (e.g. processes in chemical synthesis and biotransformation). A major opportunity lies in developing the production of recombinant veterinary medicines and vaccines, as their testing and launch of production is not as costly as preparations for human use, and the Czech Republic has several established producers exporting their veterinary products to many countries around the world. Specifically, there is the preparation of recombinant antigens in the new generation of subunit human (Sevapharma

a.s.) and veterinary vaccines and diagnostic kits (Dyntec a.s., Bioveta a.s., Biopharm VÚBVL a.s., BioVendor laboratorní medicína a.s., Immunotech a.s., VIDIA s.r.o., and Test-line s.r.o.). In the longer term, as the expiration of numerous patents draws near we are bound to see the development, in the Czech Republic, of the production of advanced biological drugs such as "follow-on biologics" by domestic producers of generic drugs (Zentiva a.s., Teva - Ivax Pharmaceuticals CR, s.r.o.). The development of the industrial production of recombinant enzymes for biocatalysts in the chemical, food and textile industries is anticipated.

5. The situation abroad

In the US, Canada, Japan, the most advanced European countries, as well as South Korea and Singapore, research and development in molecular biology and biotechnology is advancing extremely quickly. Molecular biology and biotechnology is also the subject of much attention in countries such as Estonia and Hungary. Also, due to specific programmes to support the development of this field, research in molecular biology and biotechnology is taking up a constantly growing share of the public and private funds spent on research, which is a source of growth for the segment of the advanced pharmaceutical and biotechnology industries. For example, in the US the NIH budget for biomedical research has increased over 20 years (1998–2008) from about 8 to 24 billion US dollars and now represents about 50% of total public expenditure on research and development. On a par with this in the US is the private expenditure of the biotechnology and pharmaceutical industry (USD 25.8 billion in the US in 2007), especially on biological drugs, which now represent the fastest growing segment of the pharmaceutical market (a global annual turnover of USD 75 billion, 25% of all the R&D expenditure of the global pharmaceutical industry, worth about USD 84 billion in 2007). The EU reports turnover of USD 12.9 billion and R&D expenditure of USD 4.6 billion in 2007.

In the field of molecular biology and research related to human health, there is an increased focus primarily on the molecular mechanisms of the function and interaction of human cells and the immune system, with particular reference to mechanisms triggering cancer, pathogen-host interactions, the molecular nature of aging and neurodegenerative diseases, with a view to discovering and developing new biological medicines and diagnostic resources. A virtually independent and rapidly growing sub-branch of biotechnological research and development is the research and development of vectors and the engineering of optimized mammalian, insect and plant cell lines and eukaryotic microorganisms for the production of biologically active recombinant proteins. In other areas, special attention is paid to the research and preparation of enhanced GM crops and livestock and improvements in GM organisms for the production of industrial enzymes for bio-catalysis in the food, pharmaceutical and chemical industries, for the degradation of biomass in order to produce biofuels, and for environmental purposes (bioremediation).

A characteristic feature of molecular-biological and biotechnological research and development in developed countries abroad is the high level of interaction between academic research and corporate developments, and the emergence of numerous research-oriented small and medium-sized start-up and spin-off companies, which are a centre of attention for venture capital . The segment of advanced biotechnological production generates billions in turnover and the standard of research in the field of molecular biology and advanced biotechnology is one of the good indicators of the overall maturity of a country.

The development of this area is one of the most important priorities of European research and development and is supported under the FP7 priorities "Health" and "Food, agriculture, fisheries and biotechnology".

6. Czech conditions

6.1. Preparedness

The Czech Republic is beginning to have the conditions required for future research and development in the field of molecular biology and biotechnology thanks to the steadily increasing scientific level of existing research teams and thanks to the ever-increasing number of graduates from the relevant fields of study and qualified personnel in basic and applied biological research. Although university study programmes continue to lag behind trends in knowledge in this field in many respects, there is keen interest in doctoral studies in molecular biology and biotechnology in the Czech Republic. There are also growing numbers of young workers returning from post-doctoral placements at high-quality foreign institutions, and interest among foreign talent from third countries in working in the Czech Republic. However, the experts needed to scale up the biotechnological processes are lacking, which has an impact on the usability of research results in practice.

A positive factor is that many Czech centres in this field are becoming quite well equipped with modern instruments and information technology. However, the costly devices that are becoming standard in the most developed countries and that help achieve the necessary efficiency in research are out of reach. The technological progress made by equipment for molecular biology and related fields is advancing rapidly round the world, and the cost of this equipment continues to grow. The possibility of using a significant part of the EU Structural Funds under the R&DI OP to acquire cutting-edge equipment and the construction of new research infrastructure is a unique opportunity to strengthen the Czech Republic's preparedness to advance its research and development of molecular biology and biotechnology, because expensive high-tech instruments are becoming essential for international competitiveness. If the Czech Republic is to strengthen its preparedness for the exploitation of R&D investment in the field of molecular biology and biotechnology, it must modify and improve the curricula of universities in order to engage experts from enterprises in the teaching process on a broader scale, and make the theory of the study programmes less estranged from the real needs of research and production in practice. This will require the development of student internships at enterprises and higher numbers of university graduates trained in genetic and cell engineering for skilled jobs in modern biotechnological production facilities.

6.2. Use

Despite the very low number and economic weakness of innovative small and medium-sized biotech firms, they are beginning to show a willingness to invest in new technologies, thus creating demand for original research results and establishing the readiness of enterprises to absorb them and, by means of their own development procedures, to carry research results to the production stage. The situation is most promising in the field of veterinary medicines and vaccines; in the Czech Republic, there are several prosperous manufacturers successfully exporting to competitive markets such as Southeast Asia and, in order to maintain their competitiveness, starting to express an interest in the results of research into recombinant veterinary vaccines and immunotherapeutics. Another promising area for the application of research results is the production of molecular diagnostics for human and veterinary use and biotransformation in the pharmaceutical, chemical, food and textile industries. Also, agricultural companies are becoming prepared to cooperate with

research in the biotechnological breeding of plants and livestock, in the production of special food, and in the non-food (pharmaceutical, energy and technical) use of plants.

Necessary conditions for the use of research results will be special support programmes to fund the international protection of the intellectual property created, the organization of special courses to train human resources in the protection and commercialization of intellectual property, and the building of sites for individual research institutions to focus on this issue. Another important factor for the use of research results in this field will be the creation of a regional network of incubators, start-up firms and specialized technology transfer centres, which will require the uptake of funds from the EI OP and R&DI OP.

7. Expected results

The results that can realistically be expected under this priority include:

- the preparation of numerous highly efficient production cell lines and organisms;
- the preparation of organisms for the biodegradation of environmental pollutants and waste;
- stable GM organisms (animals and plants) for agriculture;
- the development of new biocatalysts for chemical and pharmaceutical production;
- the discovery of new potential biological medicines and vaccines;
- the design of transgenic and knock-out animal models for studying the pathophysiological mechanisms of human disease;
- the synergy of molecular biology approaches with the tradition and base for organic synthesis in the Czech Republic, for the development of new cell models to test the biological effects of chemical substances;
- the development of new diagnostic methods for the early detection of diseases and predispositions to disease;
- a reduction in the consumption of pesticides by introducing biotechnological procedures in the protection of agricultural crops and forest crops with positive environmental consequences;
- the discovery of indicators of failure or adverse effects of pharmacotherapy;
- the preparation of new biocompatible materials for tissue engineering;
- the development of recombinant vaccines for human and veterinary use;
- the identification of genes determining various congenital pathologies and predisposition to disease;
- the practical application of knowledge about the mechanisms of enzyme reactions;
- the discovery of new biomarkers of health and illness;
- the definition of new therapeutic targets and the stimulation of the development of new treatments;
- the use of specifically modified signalling pathways in biotechnology applications;
- the development of resources that can identify mechanisms and prevent the spread of new types of infectious diseases.

8. Benefits

The benefits of support under this priority will include the development of human resources and the emergence of innovation centres and small and medium-sized start-up biotech companies. Thanks to the mobilization of funds from the R&DI OP to acquire unique equipment and infrastructure, one of the benefits of targeted support under the priority “Molecular Biology and Biotechnology” will be major enhancements in the quality and

volume of the basic and applied research of biological processes. This will fundamentally encourage the creation of a significant number of new jobs for highly skilled workers and the creation of original intellectual property that will facilitate the formation of start-up and spin-off biotech companies. These will then develop the whole advanced biotechnology industry as a sector of the knowledge economy in the Czech Republic. This will strengthen the competitiveness of the Czech Republic and promote the development of the knowledge economy as a source of sustainable growth and future prosperity.

An indicator of the success of support channelled into the poorly developed biotechnology industry in the Czech Republic, corresponding to the situation in the US in around 1990, could be an annual rise in the turnover generated by the biotechnology industry in the Czech Republic over the next 10 years by at least 15% per year (which corresponds to the minimum year-on-year growth reported by the global biotechnology industry over the past 20 years).

9. Financial resources

Initially, due to the minimum number and size of advanced biotechnology enterprises in the Czech Republic and in the absence of original intellectual property, research and development in molecular biology and biotechnology will be financed primarily from public funds for the support of R&D. Also, foreign resources (FP7) will barely account for more than a few percent of the total funds drawn in this field of research and development in the Czech Republic. Of the European funds available under the EC OP, EI OP, and R&DI OP, some resources can be used for special support programmes to fund the international protection of the intellectual property created, the organization of special training courses for human resources in the protection and commercialization of intellectual property, the setting-up of research institution departments focused on this issue, and the creation of a network of incubators for start-up companies and specialized technology transfer centres.

The co-financing of development programmes in the field of molecular biology and biotechnology from private sources will be quite negligible in the near future because of the weakness of this industrial segment in the Czech Republic (it would be appropriate to provide incentives to small businesses in particular). In the long term, following the emergence of a critical mass of highly trained workers, international capital and multinational pharmaceutical companies can be expected to enter the corporate biotechnology sector in the Czech Republic and set up R&D centres in order to exploit the continuing positive relationship between skills and the labour costs. A precedent for this trend exists in the already successfully operating production facilities of Lonza (Lonza Biotec s.r.o.) and Baxter (Baxter Czech s.r.o.) in the Czech Republic, which enjoy significantly lower production costs than their other plants in developed countries. However, venture capital will only arrive and start-ups and spin-offs will only develop if there is an increase in the volume of original intellectual property as a result of the improved quality and originality of basic research in this field. Aggregate data on private spending on biomedical and biotechnology research in the Czech Republic are not available. Thanks mainly to the Czech manufacturing plants of the multinational corporations Lonza and Baxter, the estimated turnover of biotech enterprises in the Czech Republic in 2007 was approximately CZK 2.5 billion.

Energy Sources

(Promoting the sustainable security of energy sources)

Summary

Energy is the backbone of the economy, and its security, as a result of declining reserves of energy resources, is becoming a strategic commodity of maximum priority. The Czech Republic's energy is heavily dependent on imports of raw materials, including from risk areas. Electricity is generated in coal-fired and nuclear power plants and, on a small scale, from renewable sources. After 2010, we will start to see a rapid loss of energy sources as existing capacities reach the end of their service life and, with regard to the territorial mining limits, the availability of steam coal dwindles. This situation applies not only in the Czech Republic, but also in those EU countries that have not implemented an alternative strategy of energy sector development after deciding on the stagnation of nuclear energy. The purpose of energy research and development activities is to ensure that the Czech Republic has sustainable, reliable and cost-effective energy sources and infrastructure networks, and thus to promote growth and competitiveness across the economy. At the same time, it is necessary to ensure that the Czech energy sector develops in a way that is as environmentally friendly as possible and in line with the objectives of the emerging European energy policy, as contained in the package of measures to establish a new Energy Policy for Europe of 10 January 2007.

The "Energy Sources" priority includes research in the field of power plants using fossil fuels, nuclear fission and fusion energy facilities, renewable and distributed resources and energy distribution networks and other infrastructure elements. Energy research under this priority is closely linked to materials research, competitive engineering, security and defence, environmental research, etc.

In the coming decade, a number of existing blocks of thermal power plants will reach the end of their lives and will have to be replaced by efficient facilities with parameters capable of underpinning the economy and meeting the environmental needs and demands of the 21st century. Energy developments globally, and in Europe in particular, will seek to expand the share of renewables in total energy consumption. In accordance with the European Commission's energy package of 10 January 2008, the Czech Republic's energy mix will gradually be expanded to encompass renewables where this is feasible and economically efficient. It will be necessary to identify the optimal proportion of second-generation biofuels in transport under economically acceptable conditions and on a scale that does not endanger the environment or the food industry. A viable objective, having a significant positive environmental impact, will be the gradual introduction of hydrogen technologies in energy and transport.

In addition to large energy plants, it will be necessary to address the effectiveness and proper integration of additional sources of distributed energy, increasing the flexibility of the network, responding to current demand, facilitating the cogeneration of electricity/heat/cold at the supply point, and adapted to the use of alternative energy sources, including local energy accumulation.

A decisive role in the streamlining and upgrading of energy fuel complexes (nuclear power plants with greater security and a resolved fuel cycle, advanced technologies for the use of fossil fuels, carbon capture, economically feasible renewables, the expansion of hydrogen technology) is played in this process by the scientific research base. All the above areas require cutting-edge research with a synergistic effect for the whole of the Czech economy.

1. Characteristics

The purpose of energy research and development activities is to ensure that the Czech Republic has sustainable, reliable and cost-effective energy sources and infrastructure networks, and thus to promote growth and competitiveness across the economy. At the same time, it is necessary to engage the energy industry, for which significant export opportunities are opening up, in this process. Also, it is necessary to ensure that the Czech energy sector develops in a way that is as environmentally friendly as possible and in line with the objectives of the European energy policy,[1] as contained in the package of measures to establish a new Energy Policy for Europe of 10 January 2007. The three key objectives of this package are: combating climate change, increasing the efficiency of the EU energy market, and ensuring a safe, reliable and sustainable energy supply for EU consumers. These objectives are mutually compatible, so even if less emphasis is placed on climate change in the future, most of the avenues to deal with them remain the same. These objectives are reflected, in a specific form, in the following target values:

by 2020:

- reduce greenhouse gas emissions by 20% compared to 1990 (the year of accession to the EU for the 4R?); reduce the consumption of primary energy sources by 20%
- increase the share of renewable energy in the EU mix to 20%
- increase the share of biofuels for transport to 10%

by 2050:

- reduce greenhouse gas emissions by 50% compared to 1990.

To realize these objectives, on 28 February 2008 the Council of Europe approved the "SET-Plan (European Strategic Energy Technology Plan)",[2] containing a set of measures and goals in research and development for various energy technologies, aimed at contributing to reduced greenhouse gas emissions in the EU and at launching research, development and use of new "clean" technologies.

The priority proposed here is intended to represent the Czech Republic's "national" contribution to the above strategic objectives of EU in the energy sector.

Energy research under this priority covers power plants using fossil fuels, nuclear fission and fusion energy facilities, renewable and distributed resources and energy distribution networks and other infrastructure elements.

Research in the field of ***"fissile" nuclear energy*** should be focused on ensuring the safe, reliable and economic operation of existing nuclear power plants to extend their service life up to 60 years (including addressing the end of the fuel cycle and radioactive waste management), on the development and innovation of new third-generation and generation III+ nuclear power plants, and on the research and development of fourth-generation nuclear systems (mainly in electricity production from secondary raw materials – uranium stocks in

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[1] COM(2007) 1: Communication of the Commission to the European Parliament and the Council: An Energy Policy for Europe,
COM (2007) 2: Limiting Global Climate Change to 2°C: The way ahead for the EU and the World for 2020 and beyond,

[2] COM/2007/0723 final: Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - A European strategic energy technology plan (SET-plan) – "Towards a low carbon future".

spent fuel and depleted uranium in storage and by increasing the use of energy in natural uranium by more than two orders of magnitude – but also in the supply of heat for industrial applications, e.g. for hydrogen production).

A separate area, standing alongside nuclear fission technologies, is the research of ***thermonuclear fusion***. After years of only limited research, there has been a significant boost to this research around the world in the fields of magnetic and inertial confinement of thermonuclear plasma. Key topics of research in nuclear fusion include high-tech materials, plasma stability, and the development of high-repetition, diode-pumped high-power lasers.

In the field of ***classic energy***, the aim is the research and development of new highly efficient technologies allowing for the more efficient use of fossil fuels and a reduction in greenhouse gas emissions; the capture and storage of carbon from combustion processes will contribute to this.

In the field of ***renewable and alternative energy sources***, research and development will focus on the use of biomass, wind energy and geothermal energy, as well as on the use of solar energy through new photovoltaic materials and efficient types of photovoltaic cells. Other subjects of research will be: an increase in the efficient use of secondary energy sources (waste heat), energy storage, and technical equipment and systems related to renewable energy sources. Comprehensive research and development will be devoted to hydrogen management and the use of hydrogen in fuel cells or internal combustion engines for transportation or decentralized energy.

Research into ***local distributed energy efficient units*** and their integration into the infrastructure system deals with the future problem of the dependence of heating on fossil fuels, taking into account the difficulties in transporting heat from large energy sources, and could help tackle problems with quick-start sources.

In the field of energy research, topics include the ***reliability of energy distribution networks***, including the ***integration of distributed energy sources*** and the ***system to ensure energy security*** and backup in case of risk situations (a link to the Security and Defence priority). At the same time, research will focus on new issues and ***elements of the network infrastructure for the supply of hydrogen*** or ***synthesis gas for the production of second-generation biofuels***.

Energy research is closely linked to the priorities Materials Research, Competitive Engineering, Environmental Research, etc.

2. Objectives

In the coming decade, a number of existing blocks of thermal power plants will reach the end of their lives and will have to be replaced by efficient facilities with parameters capable of underpinning the economy and meeting the environmental needs and demands of the 21st century.

One of the primary goals of “fissile” nuclear energy in the timeframe up to at least 2020 is scientific and technological support for the operation of the existing Dukovany and Temelín nuclear power plants, and the creation of conditions for extending their life. The second objective is to master the technology of improved generation III and III+ types of nuclear power plants, which will be put into operation in the Czech Republic in around 2020. There is an opportunity here for the involvement of Czech industry even now, because generation III and III+ NPPs are already being built elsewhere in the world and there is a lack of manufacturing capacity for the components of these NPPs. In parallel with this, it will be necessary to strengthen the involvement of the Czech research base in the international

research programme GEN IV, focused on the development of advanced fourth-generation reactors, especially fast and high-temperature reactors and reactors with supercritical parameters of water or CO_2, so that Czech industry is in a position to supply selected components throughout Europe as soon as the first demonstration units are constructed in the period from 2020 to 2030.

In the field of nuclear fusion, it is crucial to maintain a high level of Czech involvement in integrated fusion research within the scope of EU activities. The research and development of special high-tech technologies and materials opens up significant opportunities for Czech industry to participate in supplies for the construction of some globally unique infrastructures.

In the field of conventional fossil-fuel energy, an important objective is the gradual transition to building "clean" power plants fired by fossil fuels with high efficiency and maximum use of the cogeneration of electricity and heat. The scientific research and industrial base will further improve the technology of gas-fired combined cycles. In tandem with this, it would be appropriate to deal with the issue of carbon capture and storage.

Energy developments globally, and in Europe in particular, will seek to expand the share of renewables in total energy consumption. In accordance with the European Commission's energy package of 10 January 2008, the Czech Republic's energy mix will gradually be expanded to encompass renewables where this is feasible and economically efficient. It will be necessary to identify the optimal proportion of second-generation biofuels in transport under economically acceptable conditions and on a scale that does not endanger the environment or the food industry. A viable objective, having a significant positive environmental impact, will be the gradual introduction of hydrogen technologies in energy and transport.

In addition to large energy plants, it will be necessary to address the effectiveness and proper integration of additional sources of distributed energy, increasing the flexibility of the network, responding to current demand, facilitating the cogeneration of electricity/heat/cold at the supply point, and adapted to the use of alternative energy sources, including local energy accumulation.

Another important objective of this research will be energy savings. In addition to technical and technological solutions for energy savings, possible energy savings will be predicted.

A separate goal is the preparations for the introduction of a new energy carrier – synthetic fuels or hydrogen – and its combustion in engines and fuel cells. In addition to the research of effective and affordable means of transforming chemical energy into mechanical/electrical energy, there will be research into the problems and resources related to the construction of new infrastructure networks for the distribution and accumulation of the chemical energy of gaseous fuels.

3. Reasons and criteria serving as a basis for the proposal of the priority

Energy is the backbone of the economy and its security, as a result of declining reserves of energy resources, is becoming a strategic commodity of maximum priority. The Czech Republic's energy is heavily dependent on imports of raw materials, including from risk areas. Electricity is generated in coal-fired and nuclear power plants and, on a small scale, from renewable sources. After 2010, we will start to see a rapid loss of energy sources as existing capacities reach the end of their service life and, with regard to the territorial mining limits, the availability of steam coal dwindles. This situation applies not only in the Czech Republic, but also in those EU countries that have not implemented an alternative strategy of energy sector development after deciding on the stagnation of nuclear energy. The production

of electricity from renewable sources will always be only a complementary part of the energy mix in the Czech Republic on account of the country's geographical location and climatic conditions. The significant problem of the dependence of heating on fossil fuels, especially in cities, should also be taken into account. Heat for urban agglomerations cannot generally be transported effectively over long distances and large energy complexes cannot be built close to cities. Clearly, then, without significant structural changes in energy and related sectors, we can expect an energy crisis in the Czech Republic.

The current State Energy Policy defines the basic priorities for the long-term development of energy management in the Czech Republic – maximum independence from foreign energy sources, independence from energy sources in risky areas, independence from the reliability of supply from foreign sources, maximum security of energy sources, including nuclear safety, the reliability of supplies of all types of energy, maximum sustainable development and environmental protection.

The implementation of these priorities will require significant improvements in existing technologies and in the development of new technologies, with rapid transfer to industry.

The increased export competitiveness of industry in terms of supply for the energy sector and security of its high technical level will have a significant impact on energy development.

Although energy production in the Czech Republic has a long tradition, the fate of its future development cannot be left to the spontaneous innovation process towards which manufacturers of energy equipment are motivated by the competitive market. A decisive role in the streamlining and upgrading of energy fuel complexes (nuclear power plants with greater security and a resolved fuel cycle, advanced technologies for the use of fossil fuels, carbon capture, economically feasible renewables, the expansion of hydrogen technology) is played in this process by the scientific research base. All the above areas require cutting-edge research with a synergistic effect for the whole of the Czech economy.

Heat supply is wrongly neglected; it is heavily dependent on fossil fuels (especially natural gas or coal) and often contributes significantly to the pollution of the environment. Due to the poor transportability of heat, local less powerful sources are used which offer an opportunity for the systematic implementation of decentralized energy, allowing for flexibility in the network with large sources and using alternative renewable sources.

An important issue is the construction of parallel infrastructure for the distribution of the chemical energy of synthetic fuels, such as hydrogen (where appropriate mixed with natural gas, at least temporarily) and synthesis gas from biomass, usable directly or after conversion into second-generation liquid fuels.

The choice of the future energy technologies that will be the focus of energy research is also based on the following aspects:

- the stimulation of economic development and economic growth
- the quality of the environment and public human
- sustainable energy development as a prerequisite for the sustainable development of society
- the security and reliability of energy supply
- compatibility with the needs and objectives of the EU
- secondary effects (spin-offs) in third markets
- special factors – public acceptance etc.

4. SWOT analysis

4.1 Strengths

Successful participation in the research projects of the EU framework programmes, including the specific EURATOM programme, and in other international programmes creates conditions for the development of energy research in all its breadth and in all contexts. Industrial enterprises in the Czech Republic are well equipped for energy. There is a large energy industry here, including a design base, with potential for further development; in general, enterprises are highly experienced in the construction of power stations, including nuclear plants. The same is true of both large- and small-scale cogeneration (the heat sector).

In the energy sector, the Czech Republic can draw on a quality research and educational base, an experimental background and the related know-how. Research institutes have established close contact with users (especially in the field of nuclear research and the operation of nuclear power plants).

The quality of domestic research on nuclear fission and the Czech Republic's participation in pan-European research in the field of thermonuclear fusion are held in high international regard.

4.2 Weaknesses

Energy-related technical fields are still not studied by sufficient numbers of students, which, together with the increasing average age of R&D workers, means that the Czech Republic is will suffer from an increasing shortage of experts in both energy and energy research, as well as in the industrial sector, the activities of which are related to energy. There is a danger that experience and know-how from the construction of power plants (especially nuclear stations) could be lost.

Investments in the reconstruction and development of the technological and experimental facilities are generally insufficient and therefore they could become obsolete. Instruments of domestic financial support for the involvement of Czech organizations in R&D cooperation with other countries in the field of energy are lacking.

4.3 Opportunities

In the fields of energy and power engineering, great opportunities for further research and development are opening up because of the real possibility that nuclear power plants in operation will have their service life extended to 40–60 years with a concurrent increase in their capacity. Another opportunity is the need to upgrade fossil-fuel power plants, increase the efficiency and reliability of their operation, and reduce emissions. Another major opportunity is the emerging new construction of nuclear power plants in Europe and other parts of the world and the need for research assistance to ensure quality projects guaranteeing a high level of nuclear safety and the economic efficiency of operation. An important opportunity is the newly prepared SET Plan as a key instrument in the coordination of energy research within the EU (with strong pressure to raise funds both at national and Commission level). Other new opportunities include the development of hydrogen technologies and the use of fuel cells in the direct production of electricity and heat. In the near term, the rapid development of hydrogen technology applications in transportation is forecast, including the participation of Czech entities in the production of the power units of hydrogen cars.

Further possibilities exist in research into new renewable and alternative sources, particularly in the context of decentralized heat (CHP) energy. This aspect is closely connected with the greater use of biomass, especially the production of new second-generation synthetic fuels, the use of existing renewable sources (geothermal, wind and solar energy, photovoltaics, etc.), the identification and assessment of the potential benefit of new renewable sources, energy savings and the reliability and adaptive management of distribution networks, and large-scale backup resources to ensure uninterruptible power supply and a flexible response to increased demand at peak times at reasonable prices.

Participation in the development of new types of nuclear fission reactors in the context of international cooperation (EU Framework Programmes, including the specific EURATOM programme, other forms of cooperation in the EU, GIF, INPRO, GNEP, etc., and bilateral cooperation with France, the United Kingdom, Germany, the USA, Japan, Russia and other countries) offers a solid footing for the exploitation of those opportunities in the Czech Republic.

Another opportunity is to bolster the Czech Republic's involvement in nuclear fusion research in the EU.

The projected development of the energy sector and the expected increase in the number of new specialists creates a unique opportunity for universities and academic institutions to become deeply involved in this process.

Within the SNETP, the EU forms its research strategy for the entire energy sector, and the Czech Republic has a unique opportunity to play a major role in this process, including by means of industrial cooperation.

4.4 Risks

Energy is one of the most capital-intensive sectors. The consequences of any outages or accidents are also among the most serious in terms of in scope and significance. Therefore, research aimed at improving energy technology and the development of new technologies is extremely demanding from the perspective of investment and the correct selection of issues to tackle.

In this respect, a major risk is that the financial amounts needed to cover the costs of addressing issues which are essential for the Czech Republic energy sector and related industries will not be secured. Addressing incomplete issues for which funds are obtained will result in the outflow of specialists from areas where funds are missing. If the topics above are not resolved sufficiently comprehensively, there is a risk of loss of infrastructure for the development of safe and effective energy (especially nuclear), increasing the risk of the reduced availability of efficient energy sources and the risk of a shortage of experts. This will ultimately be reflected in the competitiveness of the entire Czech economy.

4.5 Preparedness of the user community

The energy research user community comprises, on the one hand, the energy industry itself, ensuring the production and supply of all forms of energy, especially electricity, heat, and all kinds of fuels, and, on the other hand, the industry producing energy equipment and components.

The need to replace obsolete plants and construct new energy sources is inevitable if the Czech Republic is to maintain long-term self-sufficiency in energy production. Proof of

this lies, inter alia, in the plans of energy companies such as ČEZ a.s. to build new power plants, both nuclear power plants and conventional plants fired by coal and gas, including wind power plants. In the current competitive environment, energy companies essentially have two options – either they commission Czech suppliers to deliver their future capital equipment or have it supplied from abroad. Today, the Czech energy equipment manufacturing industry is in a position to deliver this equipment essentially with its own resources and to a technical standard in line with the requirements of the time. It is therefore prepared to transform R&D results in the relevant field into specific demonstration projects smoothly in accordance with trends around the world. To prevent this favourable and fundamental situation for the Czech economy from destabilizing, it is necessary to continue regarding energy research as a priority area of government science and technology policy.

5. The situation abroad

The rapid economic growth in intensively developing areas of the world (especially China, India and South America) is accompanied by sharp rises in the consumption of raw energy materials and the consumption of electricity. In developed countries, electricity consumption is rising in proportion to GDP growth; the rate of energy consumption is somewhat slower. Energy will be one of the limiting factors for the further development of the world. The basic tasks today are:

- to reduce strategic dependence on supplies of oil and natural gas from areas at risk
- to ensure cuts in CO_2 emissions on a global scale, even as energy consumption continues to grow
- to ensure the availability of electricity at a competitive price and energy carriers for transport.

Alternative ideas that the above-mentioned objectives can be achieved in particular by making savings in consumption and simply by using renewables, which are widely subsidized, are not very viable. Renewable sources can only play a role equivalent to their potential and competitiveness in world prices. Research in Europe and the US is aimed in particular at the research and development of new electricity generating technologies meeting the requirement of reasonable costs and not emitting greenhouse gases (or generating a reduced level of emissions). These technologies include, in particular, nuclear power, clean coal technology with fewer CO_2 emissions discharged into the environment, renewable resources at a rate corresponding to their possible potential, given the fundamental laws of nature (with a very optimistic long-term estimate of coverage standing at 20% of total energy consumption), specific solutions for certain regions and consumers (distributed cogeneration energy associated with heat production and the possibility of rapid responses to changes in demand for electricity, energy storage, no-break sources, etc.). Great expectations and significant resources are being invested in nuclear fusion research in a bid to secure energy in the long term.

Considerable attention in the world is being paid to the research and development of a new uses of energy carrier – hydrogen – particularly for transport.

The following facts demonstrate the seriousness of the situation and efforts to address the energy situation in the EU and the US:

- the US and the EU concluded an agreement on cooperation in the field of hydrogen and fuel cells,

- in 1999, the Office of Nuclear Energy at the US Department of Energy (DOE) proposed the Generation IV initiative for the development of fourth-generation nuclear systems. The initiative was based on the belief that nuclear energy must remain a viable alternative to meet current and future needs of energy supply.
- in 2000, by a decision of the General Conference of the International Atomic Energy Agency (IAEA), the INPRO project (International Project on Nuclear Reactors and Fuel Cycles) was set up. The main mission of INPRO is to demonstrate that nuclear energy is an integral part of sustainable development in the 21st century and can be used both by industrialized countries (the holders and carriers of production technology) and developing countries, whose current knowledge and economic structure are not yet consistent with the simple integration of large technological units.
- in July 2001, the US initiative Generation IV gave rise to the Generation IV International Forum (GIF) to focus the efforts of countries with the most advanced nuclear technology on the development of next-generation nuclear energy systems that would meet future world energy requirements.
- in 2003, the EU (and by extension the Czech Republic), through EURATOM, became a member of the GIF (France and the UK are involved in this programme directly),
- in early 2006, the US announced the Global Nuclear Energy Partnership (GNEP), an initiative designed to strengthen the development of energy, particularly nuclear energy, improve the environment and reduce the risk of proliferation,
- the International Atomic Energy Agency strengthens the INPRO programme as a programme to promote the development of new nuclear reactors with improved economy and safety. INPRO currently comprises 28 entities,
- both the EU and the US are implementing a programme for the use of clean coal,
- in the EU, the increasing proportion of renewable sources, with a comprehensive investigation into their real long-term sustainability, has become one of the priorities of the Sixth Framework Programme in the field of energy and transport (Thematic Priority 6) and led to the funding of research in large integrated projects involving the leading European manufacturers of power equipment and vehicles,
- the EU has developed a range of technology platforms to support, concentrate and coordinate R&D activities in priority areas of interest, such as: the Sustainable Nuclear Energy Technology Platform (SNE-TP – the Czech Republic/NRI has a representative in this platform's executive committee); the Hydrogen and Fuel Cell Technology Platform (HFP); the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ETP ZEP); the Technology Platform for Wind Energy (TPWind); the Smartgrids European Technology Platform (SmartGrids ETP); the European Biofuels Technology Platform (EBFTP); etc.,
- the EU supports other forms of cooperation such as "joint technology undertakings" to prepare for the implementation or demonstration of key energy technologies,
- in November 2006, an international agreement was signed on the construction of the ITER thermonuclear reactor by a consortium of the EU and another six countries (the USA, Russia, Japan, South Korea, India, China); building work was commenced in southern France; in March 2007, a joint European venture was set up for the construction of ITER and the development of energy from thermonuclear fusion ("Fusion for Energy" - F4E), based in Barcelona.

6. Czech conditions

6.1 Preparedness

Research in the field of the sustainable development of energy sources means researchers are well placed to expand research capacity, strengthen cooperation with industry, and, if enough funds are forthcoming, the results will be supported by the wider involvement of Czech industry in the supply of industrial energy plants.

The involvement of the Czech Republic's research in cooperation within the EU is good, but in order to participate directly in targeted projects it will be necessary to increase domestic financial resources, in particular to cover the necessary research and technology base, if the clout of the Czech Republic's international partnerships is to increase in research into new energy sources. Experience shows that the EU Framework Programmes (FP) anticipate that projects will largely be financed by the participating states. Hydrogen energy, i.e. the production, distribution/storage and transformation of hydrogen into electrical/mechanical energy in fuel cells or internal combustion engines, also needs to be boosted. Rationally, the possibility of exploiting renewable energy in the range anticipated by the Czech energy policy needs to be assessed. In the energy sector as a whole, cooperation with the US and Russia also needs to be strengthened.

6.2 Use

Conditions for the use of research results exist in the energy industry itself and in the industry producing energy facilities. In particular, they can ensure the efficient, reliable and sustainable supply of energy resources to the Czech Republic, ensure an optimal and balanced mix of sources in energy management and their optimal deployment and use, ensure the export competitiveness of Czech industry and expanded involvement in European research programmes with the use of capacity for experimental and practical verification.

Departmental policies, especially those of the MIT, the Ministry of the Environment and the Ministry of Education, include long-term measures related to energy policy or related strategies in their concepts. In view of the increasing risk of a shortage of raw energy materials and energy sources, however, medium-term needs must be addressed more vigorously.

Another important element is the domestic industry's focus on the manufacture and export of energy equipment. This industry must keep pace with developments in technology in the world. The global market in this area will grow and is a great opportunity for the Czech industry. Provided that it can cope with the new technology, it will have huge opportunities in Asia and Europe, where, between 2010 and 2050, nearly all the installed capacity of coal and nuclear power plants will be replaced with new resources.

The sheer breadth of the user community – the wide range of manufacturing plants involved in the construction of energy facilities, all the way through to major energy corporations such as ČEZ a.s. and E. ON etc. – prevented it (for practical reasons) from directly participating in the formulation of this priority. However, the factual content of the priority covers all key areas so that, in the future, Czech industry will maintain its current ability to succeed in keen international competition and to produce energy equipment of

specifications and quality required under the sustainable, environmentally friendly energy policy. Ultimately, a criterion of success will be the degree of involvement of Czech industry in handling future energy projects in both the Czech Republic and Europe (and where applicable outside Europe). An important indicator of the correct direction for energy research will be the active involvement of Czech research and development institutions, as well as the user community, in the aforementioned newly formed technological platforms within the EU, because their programmes objectify current and future needs on a European scale.

7. Expected results

Nuclear energy:

Direct results:

- an increase in the safety, reliability, durability and efficiency of the operations of existing nuclear power plants
- the acquisition of evolutionary nuclear energy technology (Generation III and III+) with light-water reactors based on internal know-how
- a solution to the principles of safe and economically acceptable disposal of radioactive waste
- the creation of a knowledge base for advanced fourth-generation nuclear systems, especially fast reactors, and the gradual introduction of the production of selected components for these systems
- the creation of a knowledge base on issues of a closed fuel cycle as a prerequisite for sustainable nuclear energy
- the creation of a knowledge base on the thermonuclear fusion with magnetic and inertial confinement of plasma
- the acquisition and technology of nuclear fusion

Indirect results:

- the provision of energy resources with significantly reduced greenhouse gas emissions and consequently improvements in the environment
- increased use of fuel potential and fuel cost savings
- the Czech Republic's increased energy self-sufficiency under environmentally friendly conditions
- a reduction in energy dependence on fossil fuels
- the development of special products for use in extreme circumstances.

Conventional energy based on fossil fuels:

Direct results:

- the efficient use of fossil fuels
- the development of new progressive technology for power plants fired by fossil fuels
- the development of new environmentally acceptable technologies for processing coal into refined products
- an expansion in the cogeneration of electricity and heat, including trigeneration (electricity, heat, cold)
- the development of equipment for the separation, compression, transport and injection of CO_2 into underground spaces.

Indirect results:

- the use of mineral resources in a socially acceptable manner
- a reduction in the negative environmental impacts of coal mining and combustion
- an increase in the energy efficiency of coal substance use
- rational use of accompanying products (waste) for industrial applications
- improvements in the environment, a reduction in greenhouse gas emissions and other pollutants;
- improvements in public health, improvements in the quality of life.

Alternative and renewable energy sources

Direct results:

- improved technologies for processing biomass, the production of biofuels and their use under conditions consistent with the needs of environmental protection and public nutrition
- the introduction of the broader use of cogeneration units to ensure a local supply of heat, along with coverage of increased demand for electricity
- improved technologies for renewable energy sources
- test introduction of hydrogen distribution, storage and use in transport and local distributed energy

Indirect results:

- fossil fuel savings and improvements in the Czech Republic's energy self-sufficiency
- cheaper energy from renewable sources at an economically acceptable level
- improvements in the environment, minimization of emissions and related health risks
- an increase in the reliability and security of energy supply from RES and a reduction in unwanted effects, including for heat supply
- the decentralization of energy production, an increase in the efficiency of energy production and distribution.

Energy systems and networks:

- the development of alternative visions of trans-European energy networks and future systems and the drafting of a coherent transmission strategy for electricity networks with large and small distributed sources and alternative networks for the distribution of chemical energy, i.e. hydrogen, mixes of hydrogen and natural gas or synthesis gas from the primary processing of biomass.

8. Benefits

The results of research in this area are necessary for the long-term energy needs of the whole of the Czech Republic; this is one of the fundamental requirements of economic growth and economic attractiveness for foreign investors and the general prosperity of the State. In view of the domestic industry's traditional focus on engineering, an important consequence of support for energy research will also be the enhancement of the Czech energy industry and vehicle industry on the world market and an accompanying significant increase in exports.

Enhancing the standard of research in this area will increase the overall level and facilities of Czech research infrastructure, with a significant impact on all other industries.

Energy R&D offers a unique opportunity for the acquisition and effective use of resources from the EU Structural Funds, which will help to ensure the dynamic development of energy sectors in the Czech Republic, to strengthen international ties, and to streamline international cooperation in this field.

9. Financial resources

According to CEP/CEZ, in 2007 around CZK 1.622 billion was drawn from public funding and CZK 0.490 billion from private and own resources for research in the field of energy sources. In view of the significant underestimation of energy research across Europe, the strategic importance of the energy sector, the outdated research infrastructure and the global changes being prepared in energy (known as the third industrial revolution – the energy revolution), a drastic increase in both operational and investment funds is essential. To make the proposed guideline viable, funding from public sources needs to be increased by at least 150% to provide enough incentive to increase private and own resources by 400%, which is the absolute minimum to seize the opportunities emerging in the EU's upcoming global initiative (the SET Plan) . Taking into account all the limitations, this growth is as follows for 2010–2015.

Year	2010	2011	2012	2013	2014	2015
Public funds (CZK billions)	2.325	2.790	3.100	3.410	3.600	3.900
Private and own funds (CZK billions)	1.500	1.800	2.000	2.200	2.400	2.600
Total (CZK billions)	3.825	4.590	5.100	5.610	6.000	6.500

To carry out the necessary replacement of research infrastructure in the energy sector, maximum use should be made of the European Structural Funds with national participation as a complement to the Czech Republic's own initiative. Investment resources channelled into this area should, given the technological complexity of the field, the revolutionary nature of the upcoming technological changes and the direct route to subsequent implementation, constitute 10% to 20% of the total funding for research infrastructure in the Czech Republic (the estimated total need for 2010–2015 is approximately CZK 20 billion).

Materials Research

Summary

The purpose of research and development activities in the field of materials research is to secure sustainable economic growth and the competitiveness of the whole economy for the Czech Republic, as well as conditions for transforming the current structure of the economy into a knowledge economy. The sustainable development of modern engineering, including transport equipment, efficient energy, including fast and reliable information and communication technologies, and advances in the treatment of major diseases and environmental protection would be impossible without support for the research and development of new materials, methods for examining their characteristics and the development of new unique technologies for their production.

Materials research covers a wide range of multi-sectoral and interdisciplinary research activities, resulting in new advanced materials, efficient technology for their production and their use in products with high added value. New multifunctional materials and their production technologies are essential for competitive products with high added value, particularly in mechanical engineering, electrical engineering, photonics, IT, energy, safety engineering, construction, environmental protection and medicine. The existence of a strong development and research base in this area will therefore play a decisive role in the share of Czech exports in the global economy, as well as in the interest shown by foreign investors in the Czech Republic, the standard of living and education of the population, the level of health care and the state of the environment.

Research into advanced (primarily non-metallic) materials is one of the four scientific disciplines in the Czech Republic which, from a global perspective, report an above-average value for the bibliometric quality of publications in the field. Research into nanomaterials and the development of nanotechnology for their preparation will be an important part of basic materials research in the long term. In a timeframe of between two and five years, nanomaterials are also likely to report significant marketable results leading to products with high added value. Research of metal materials has a long tradition in the Czech Republic; in the future, research on special metal materials for applications (e.g. in the generation of electricity) will continue to figure among the priorities supported.

The technological base for the applied research and development of new advanced materials, considering how costly it is and how companies and the government are incapable of pooling resources, is underdeveloped, which severely limits research into the most progressive materials being prepared by unique technologies. As a result, advanced industrial production carried out by Czech firms is dependent on developed countries, and there is a substantial loss of value added in Czech products based on such materials. The lack of skilled workers to transfer research results into practice and the lack of financial support from the national budget for the protection of intellectual property rights significantly limits the scope, speed and efficiency of the commercialization of R&D results. A major problem hampering the integration of Czech science into international cooperation is the insufficient funding levels for the additional financing of Czech ASCR and university researchers' participation in projects funded by EU.

In the US, Japan and most developed EU countries, materials research is a priority scientific field cultivated at universities, government strategic research institutes, and the industrial laboratories of large companies. For some types of materials (nanomaterials, polymers and composites, opto-materials, functional materials, structural ceramics, bio-

materials, etc.) there are large multi-institutional research teams and national research centres focused on the research of advanced materials and their manufacturing technologies, especially in cases where they are pursuing state security interests or the competitiveness of significant or viable new industries and medical applications.

In the Czech Republic, basic and applied materials research takes place at technical universities, in a number of ASCR institutes, at several research institutes, and in some private institutions; this means there are several thousand university-educated workers with relatively advanced experimental techniques. Experimental and human resources are often geographically highly fragmented, leading in some cases to the multiplicity of themes, the loss of potential synergy effects, and a lack of quality. In view of the frequent lack of quality assessments of results, national budget resources are scattered across the board rather than focused on centres reporting the best results and greatest growth potential. Research in the field of production technology for the preparation and manufacture of advanced materials and nanomaterials is underdeveloped, mainly because of its high capital intensity. Allocating resources from EU structural programmes for the Czech Republic in 2009–2013 as efficiently as possible appears to be very important in terms of their use and economic benefit in the coming years.

Materials research support instruments could include vertically structured programmes to encourage the concentration of fragmented capacities, the formation of a hierarchy, including links to technological development, and the intensification of cooperation within the Czech Republic and with European research structures. It is necessary to promote the protection of the results of Czech science with patents and by other means, and to create conditions for the promotion of innovation activities supporting the transfer of R&D results into practice. A SWOT analysis of materials research in the Czech Republic showed that research aid from the national budget should focus only on selected lines in which the Czech Republic achieves at least European, but preferably world-class, standards, which have a more or less direct link to industry in the Czech Republic and its further development, and which could affect the future safety and health of Czech citizens and the environment.

1. Characteristics

Materials research covers a wide range of multi-sectoral and interdisciplinary research activities, resulting in new advanced materials, efficient technology for their production and their use in products with high added value. It encompasses physical, chemical, metallurgical and, recently, biological and biotechnological fields. Long-term candidates for national budget assistance are advanced materials for transport systems (both land and air), for conventional, nuclear, solar and chemical energy, for structures under extreme conditions (high pressures, high and very low temperatures) and for medical applications. Cutting-edge research in these areas focuses on multilevel, multifunctional materials, often with an externally controllable self-adjusting mechanisms on a nano- and micro-scale.

The following priority areas have been identified as priorities nominated for support from the national budget (these are priorities selected on the basis of a multiparametric assessment of existing trends, predictions of future trends and assessments of expected developments in the Czech economy as it moves towards a knowledge economy):

- Multi-functional, heterogeneous polymer materials for structural applications and technologies for their preparation, including nano-bio materials and sensor materials for diagnostic and therapeutic procedures in medicine and in monitoring the environment

- Modified $A^{III}B^{V}$ and $A^{II}B^{VI}$ semiconductors, new forms of carbon and silicon, in particular materials for the preparation of sources of extremely intense coherent radiation, electron beam generation, photovoltaics, photonics, etc.
- Thin-layer gradient ceramic and polymer nanostructures and functional nanolayers for electronics, photonics, spintronics, chemical synthesis, and new sources of ener*gy* and materials for molecular electronics, including the development of diagnostic techniques and methods for the structural analysis of nano-structural materials
- Structural and multifunction materials and their precursors derived from rapidly renewable resources, especially agricultural crops and biotechnological processes
- Metallic materials based on alloys of iron and nonferrous metals with high values of utility properties for high-end equipment in engineering, energy, construction, the defence industry and transport, manufactured by means of technology with high economic efficiency, especially alloys and composites for transport technology and new methods of structural analysis and diagnostic structures, finishes, etc.
- Research into the impact of nanoparticles on the environment and humankind

2. Objectives

The prime objective is to increase the global competitiveness of the Czech economy through products with high added value, the rapid introduction of higher-order innovations, and reductions in the energy and raw material requirements of industrial production, specifically in research areas covering advanced, predominantly non-metallic, materials and composites for transport engineering (the aerospace and automotive industries, the manufacture of rolling stock), construction, electronics and microelectronics, power engineering, IT, health, safety and environmental protection. A significant aim is to increase efficiency in the acquisition and commercialization of intellectual property in industry, services and other sectors, based on the exploitation of the status achieved by Czech materials research. The aims of the proposed priorities of applied R&D are therefore to create a logical framework and set priorities for the preparation of support programmes – funded by the national budget – for the research of advanced materials and the development of technology for their production, with a view to securing the knowledge and technological preconditions needed for the development of industrial production and services with high added value in the Czech Republic. Another goal is to design tools for the development of research infrastructure by concentrating research in individual priority areas in institutions or centres with a comprehensive approach encompassing the acquisition of completely new and unique knowledge, the economic benefits of which are not known with any precision, and the process of transferring that knowledge into industrial or medical practice. This includes the expansion and upgrading of materials research infrastructure in terms of human resources capable of achieving the above objectives and from the perspective of larger unique investment units of European importance.

A sub-objective of the priority is to emphasize the multi- and inter-disciplinarity of themes and the need for a comprehensive approach, including the consortium solutions. Its main contribution should be an increase in the efficiency of research in this area, including the faster transfer of results into industrial and medical practice, which should increase financial input in this research by the private sector.

The priority objective of improving global competitiveness consists mainly of the research of new functional materials, gradient materials, nanostructured materials, biomaterials and materials for extreme conditions. The priorities are to create new functional materials based primarily on polymer nanocomposites, self-adjusting macromolecular

systems, ultra-thin ceramic and semiconductor layers and multi-layer coatings, find technology for the preparation of advanced gradient materials based on nanoceramics and polymer nanocomposites, acquire new, unique knowledge about the relationship between the method of synthesis or preparation, the structure and physicochemical properties, and find ways, through preparation methods, to manage the structure on various dimensional scales.

One of the objectives will be to increase the output of experts educated in engineering and science.

3. Reasons and criteria serving as a basis for the proposal of the LTRG

If the Czech economy is to compete globally, and given that the Czech Republic has limited sources of energy and raw materials, conditions must be created for a gradual transition to a knowledge economy. Therefore it is crucial to address both research and industrial output for high-tech technologies that are impossible without new advanced functional materials, just as it is not possible to improve medical care without new biomaterials. Moreover, within the EU it is necessary to support research transforming rapidly renewable resources into such materials and products with high added value.

Industry is undoubtedly the most important element of the Czech economy. In the Czech economy, industry is crucial for both GDP formation and overall employment. To accelerate the transition of the Czech economy into a knowledge-based economy with globally competitive products and services with high added value, skilled labour and high knowledge levels are essential. Support for the research and development of new advanced materials is crucial in increasing the share of the economy's knowledge base, which induces the global competitiveness of the economy, long-term investment flows, the creation of high-skilled jobs, improvements in the standard of public health care, reductions in energy and raw-material requirements, less dependence on unstable regions, and the sustainable quality of the environment.

The criteria chosen for the selection of priority areas of R&D were proposed based on an evaluation of the use of the results of materials research in industry and services in the Czech Republic, and an evaluation of the state of materials research infrastructure in the Czech Republic and its ability to effectively translate research results into practice. Priority areas are in line with the forecast trends in the development of applications of new materials in modern industries and services, especially medicine, in the Czech Republic, the EU and the US. Research must lead to materials and technologies facilitating the sustainable development of society, the preservation and improvement of the environment, reductions in the energy intensity of production and operation of equipment through the use of new materials, and the use of rapidly renewable sources of raw materials. Another significant criterion is the question of increasing employment in sectors producing high added value.

The proposed priority areas of research are instrumental in maintaining the ability of the Czech economy as a whole to compete in the global market. Research results will be applied in selected areas of products, primarily for land and air transport production, power machinery, machinery and equipment for the manufacturing, textile, chemical, glass, packaging, printing, and food industries, equipment for the mining industry, the production of consumer electronics, electrical machinery and equipment, IT hardware, modern construction, military production and the manufacture of medical devices and technology. In the largest export sectors of transport engineering and electrical engineering, the continuous development of advanced materials is one of the key requirements for the sustainability of global competitiveness.

It is increasingly clear that new materials, thin films, gradient materials and composites and biomaterials should be transferred promptly to industrial and clinical practice only via top-class pilot facilities capable of preparing prototype components from the macro, micro and nanostructure to the atomic level. No manufacturer in the Czech Republic is capable of individually procuring and efficiently operating these facilities. It is therefore essential to ensure high-precision equipment in selected existing successful institutions and their consortium-based interaction, which will ensure further development of currently successful business sectors such as the automotive industry, aviation, electrical engineering, micro and nano-electronics and drug manufacture.

Employment in industry with moderate to high levels of technology is above average in the Czech Republic compared to the EU and newly acceding countries, and is increasing at the expense of low-tech fields. Thanks to the currently sufficient number of highly qualified professionals, foreign investors are showing increasing interest in setting up major branches of research and development centres in the Czech Republic. This increases demand for human resources, the level of which synergistically influences the industrial standards. Moreover, these foreign investments are associated with the transfer of know-how and are very stable, unlike production plants only exploiting the current cost advantages of cheap labour. Therefore, it is desirable to support this situation, which is favourable in terms of GDP growth, with low demands on energy and little environmental pollution, and the increase in skilled employment.

4. SWOT analysis

4.1 Current situation

Materials research enjoys a long-standing, successful tradition in the Czech Republic and is one of the four scientific disciplines in the Czech Republic which, from a global perspective, report an above-average value for the bibliometric quality of publications in the field. In this respect, the best positions are held by centres dealing with chemistry, physics, preparation technology, and the structural characterization of non-metallic materials, particularly polymers and bio-polymers, advanced ceramics, bio-ceramics and nano-ceramics and semiconductors. In the field of special metal materials, there are internationally acclaimed results in the structural analysis and mechanical properties of special alloys, high-tensile steel and inter-metallic compounds. Materials research is partly linked to the material production industry and to industries using new materials.

The quality of the basic research of functional materials and biomaterials in the Czech Republic is much higher than the European average and most of this is concentrated in three or four locations. A positive fact is that institutional funding via “Research Proposals” and the special-purpose financing of projects under the Ministry of Education Programme “Research Centres”, including with the aid of special-purpose funding from NRP II, have made it possible to equip research centres with top-quality experimental technology and concentrate talented young researchers. Despite the considerable investment costs, many of today’s research units are equipped with cutting-edge experimental equipment allowing them to carry materials research to a high professional level in some disciplines. The quality of applied research and the more expensive equipment needed to transfer results to industry still fall short of the level in countries.

4.2 Weaknesses

Weaknesses include the inadequate development of technologies for the preparation of new, mainly non-metallic, materials in the absence of programmes to promote the acquisition of major instrument and technology sets, which are essential for such research. There is also the fragmentation of research capacities in the various priority areas and, consequently, research is often conducted in parallel, is of varying quality, and lacks interdependence and synergy opportunities. As a result of an improperly formulated grant system of targeted support and the prematurely abandoned system of institutional support for national centres, except for rare exceptions there is no coordinated cooperation between public and private research institutes specializing in applied research and industrial development and research teams from ASCR institutes and universities.

Serious drawbacks are the low utilization of research results, little effort, especially among SMEs located away from research institutions, to obtain results with potentially exploitable R&D outcomes, a lack of available information on these results among companies. Universities and public research institutions do not have the financial resources to market their results, and the Higher Education Act offers scant support for results via spin-off companies. Most universities and public research institutions have not drawn up rules on the protection of intellectual property rights or an incentive system to increase the application activities of their researchers and academics. Weak capitalization prevents small businesses in particular from purchasing research services for their long-term development, and so they opt to purchase licences from abroad, with all the consequences that this entails. Although the State funds several programme to help small and medium-sized enterprises gain access to new know-how, the administration and rules on financial management are such that a large part of the funding is used inefficiently.

One of the shortcomings is the current rigid and inappropriate immigration policy, which fails to distinguish between highly skilled workers and ordinary labour. In this sense, immigration laws should be amended soon to ensure the easier supply of talent from outside the EU.

4.3 Opportunities

The research will engender priority effects in the industrial application community by improving economic potential in areas of traditional strength, encouraging the emergence of new industries and services, and enhancing the knowledge level of the Czech economy. Research into new nanomaterials and the development of nanotechnology for their preparation will be an important part of basic materials research in the long term. However, many of these materials are expected to achieve significant commercially applicable results even in the Czech Republic in the next two to five years. In the future, research on special metal materials could contribute significantly to the production of competitive industrial plants for power generation, and in the defence and security industry, transportation, construction, mineral mining, and modern biotechnology. A major opportunity is also opening up in the nuclear energy sector, where special materials are a limiting factor in fusion research. Importance will also be attached to the development of new technology for the preparation, production and processing of newly developed materials. In all cases, the application of developed materials will be a means of ensuring the material self-sufficiency Czech producers, resulting in high production efficiency, industrial expansion and competitiveness.

In the Czech Republic, there are industrial companies and service businesses that are ready to immediately apply new materials in their products and services. These are engineering companies producing complex equipment, vehicles and other transportation equipment, aircraft components, companies producing sensors, electronics and electrical equipment, measurement and diagnostic equipment, technical textiles, manufacturers and distributors of electricity and manufacturers of equipment for the use of non-traditional sources of energy. Not least, there are producers of security and defence systems. The user base of research results is expanding rapidly in services, particularly in human and veterinary medicines, tissue engineering, and pharmacy. Agricultural producers of raw materials from rapidly renewable resources and biotech companies producing the raw material base for modern functional materials also benefit indirectly from the support of materials research.

4.4 Risks

The priorities of State aid for R&D remain unclear, and there is the possibility of fierce competition from the USA, Japan, Russia and other countries outside the EU (South Korea, China, India). Ignoring persistent geographic and thematic fragmentation of experimental and human resources, as well as the multiplicity of the themes being addressed, will result in the loss of potential synergy and the poor cost-effectiveness of national budget resources. Research in the field of production technology for the preparation and manufacture of advanced semi-conductor materials and nanomaterials is underdeveloped, mainly because of its high capital intensity. Neglecting the support of materials research, especially the development of technologies for the preparation of materials, would soon prevent the Czech Republic from competing at all on world markets, particularly in areas of sophisticated products and technologies with high added value.

5. The situation abroad

In the US, Japan and EU countries, materials research is a key field cultivated at universities (both basic and applied research), government strategic research institutes, and the industrial laboratories of large companies (primarily applied research and technology development). The organization and structure of research varies considerably in different parts of the world, such as the USA, Japan, the UK, Germany, Italy, the Netherlands, France, and China. However, a feature common to all successful materials research programmes is their multidisciplinary, problem-oriented platform approach. Research is funded from multiple sources; a substantial proportion (60% – 70%) is funded by the private sector, particularly in the application phase.

For some types of materials (superalloys, ceramics, composites, opto- and biomaterials), there are large research teams, institutes or university national research centres focusing on the preparation, research and development of the technologies for individual materials, especially where State security applications, the competitiveness of major industrial industries and medical applications are involved. Research geared to the needs of nuclear energy has a special status in this respect.

In connection with the development of environmentally friendly transportation technology and new methods for the generation and storage of energy, non-metallic materials are becoming increasingly important, especially polymers and ceramics and their composites, and non-ferrous metals, including alloys and intermetallic materials. In view of the traditions of silicon polymers in the Czech Republic, one possible area of research is advanced nanostructured polymeric materials based on silicon superstructures (silsesquioxanes etc.).

This research is conducted by renowned centres in some EU countries, the USA, Japan and Russia; in many cases Czech centres have established contact with selected institutions in those countries as equal partners. The direct purchase of developed know-how from abroad places an undue burden on licence fees and creates dependency where the buyer is sidelined or becomes a secondary producer incapable of competition. In many cases, this involves classified non-market information enjoying state protection.

In view of the steep increase in oil prices, associated with the geopolitical situation and the gradual depletion of material resources, one rapidly intensifying trend is research into the preparation of polymer materials from rapidly renewable resources. This involves the extraction of technically usable polymers directly synthesized by plants and animals and the genetic modification of plants and animals capable of producing precursors, from which new polymers will be synthesized.

6. Czech conditions

In the Czech Republic, materials research takes place at technical universities, in a number of ASCR institutes, at several privatized State or corporate research institutes, and in some private institutions; this means there are several thousand university-educated workers with relatively advanced experimental techniques. Nanomaterials and nanotechnology are researched by a large numbers of mutually isolated groups in numerous workplaces. A significant part of research focuses on nanomaterials for microelectronics, photonics and information technology, nanoceramic materials for high temperatures and pressures, and polymer nanocomposites. Existing capacities in this area suffer from considerable fragmentation and still have no significant links with industrial implementation, with the exception of certain nanoceramics and polymer nanocomposites.

Research into nanomaterials and the development of nanotechnology will be an important part of basic materials research in the long term. These design materials are expected to achieve significant marketable results even in the Czech Republic in the near future. In the field of nanostructures for electronics, medicine and information technology, this trend will probably take a little longer; the Czech Republic currently lacks sufficiently strong industrial entities capable of applying this technology commercially in order to ensure returns on the investment in the relatively foreseeable future. If the Czech Republic is to become competitive in both the research itself and in its application in this interdisciplinary field, it must first unite the fragmented capacities, strengthen them and establish deeper collaboration with European research structures in this specific field of materials research.

Despite the high capital intensity, numerous research centres are equipped with cutting-edge experimental equipment allowing them to carry out materials research in certain fields to a high professional level, e.g. through the “Research Centres” research and development programme run by the Ministry of Education, Youth and Sports, and thanks to the research projects of these centres. The technological base for the applied research and development of new advanced materials, considering how costly it is and how companies and the government are incapable of pooling resources, is underdeveloped, and research into the application of the most progressive materials prepared with expensive technology is often dependent on samples obtained abroad. As a result, advanced industrial production carried out by Czech firms is dependent on developed countries, and there is a loss of value added in Czech products based on such materials.

Materials research is integrated into projects under framework programmes run by the EU, NATO, INTAS, EUREKA, and COST. Most of the participating teams have produced highly reputable output, as evidenced by the list of publication activity, citation reviews

abroad and in the Czech Republic, the increased cooperation with foreign entities and participation in international projects and networks.

The use of research results depends on the interest of industrial enterprises in innovation and on how well the results are marketed by research and development organizations. The situation could be improved by involving industrial enterprises and companies early on, in the design stage of research projects; this holds true particularly for applied research. Recently, genuine interest among capitally powerful companies in building joint research bases with technical universities has been registered.

It will undoubtedly be necessary to try to increase the number of patents and other means of intellectual property protection and to promote their sales or licensing to industrial enterprises, not only in the Czech Republic. In terms of returns on scientific investments, this can always be a lucrative source of income for research organizations. The preparation of the infrastructure for this activity can be financed from EU operational programmes, with operations funded by the Structural Funds and the programmes of the Czech Science Foundation, the ASCR Grant Agency, ministries and EU FPs. Legislative conditions must be improved to facilitate the transmission of R&D results financed from the national budget to the private sphere (spin-offs), especially in the capital market for IPO issues.

Recently, the Czech Government's strategy to support financial instruments in accordance with Act 130/2002 by distributing materials research activities even outside the centre has proved correct. Substantial success has been achieved mainly in Brno (composites, polymers, ceramics, alloys), Ostrava (metals), Liberec (synthetic fibres), Pardubice (thermosets, inorganic materials), Zlín (plastics processing) and Prague (ceramic coating). The strengthening of the research infrastructure in these regions also resulted in the arrival of major investors from the spheres of services and research and development (IBM, Honeywell, Mayo Clinic, etc.). In view of the lower operating costs of research facilities and the ample numbers of high-quality researchers in the given field, the efficiency of resources invested in research is higher in these regions than in the centre, which is burdened by high overhead costs. This trend is consistent with how research capacities are built in, for example, the US.

The greatest economic benefit can be expected in technical fields focusing on the needs of individual ministries, specifically in the development of information technologies for industry and commerce, government, the safety of surface and air transport, health, territorial data management, education and the entry of firms onto the market in software and corresponding services.

7. Expected results

7.1 Short-term prospects (5 to 10 years)

Generally speaking, the development of both research and the practical application of new materials is a major unexploited opportunity offered by new functional materials, biomaterials and materials for extreme conditions to users and producers of these materials. In the next 5 to 10 years, forecasts indicate the creation of entirely new functional materials, mainly based on polymer nanocomposites, self-adjusting macromolecular systems, ultra-thin polycrystalline ceramic layers and multilayer coatings, some of which will be commercially viable in that timeframe. Technology will be found for the preparation of advanced gradient materials based on nanoceramics and polymer nanocomposites, the acquisition of new, unique knowledge about the relations between the method of synthesis and preparation, structure and

physicochemical properties, and ways to manage their structure on various dimensional scales via preparation methods will be identified.

In the near term, there should be an increase in the number of engineering products with higher added value, which will be based on new materials, new patents and licences, the numbers of which will grow. In particular, the prospects look good for the automotive industrial, the aerospace industry, the textiles and manufacturing machinery industrial, the electrical industry, IT hardware and non-traditional methods of electricity generation, and materials produced by biotechnology. One of the consequences will be an increase in demand for technically and scientifically educated experts. The current pool of skilled workers will soon be exhausted, unless the education system responds accordingly.

7.2 Long-term prospects (10 to 20 years)

In the long term (10-20 years), the trend in new advanced functional materials is headed towards application in molecular electronics, nanoelectronics and photonics, towards nanomaterials for hydrogen energy sources, and towards polymer and composite materials for tissue engineering and materials for high-performance memory and processors in information technologies. There should be research into new non-traditional, low-energy and environmentally friendly designs, complex engineering units, particularly in the fields of transport with minimum fuel consumption, engines for trucks that offer high performance and high efficiency, new ideas for trams and hybrid trolley buses, smaller aircraft with specifications appropriate for intra-European services, mechatronically assisted manufacturing machines, new textile machines, etc.

8. Benefits

Achieving these objectives and transferring them to industry will increase the competitiveness of Czech engineering and electrical companies and firms manufacturing control systems within the scope of complex chemical and biotechnological production, improve infrastructure for instant status monitoring of environmental components, and increase the service life of large structures and implantological devices in orthopaedics and dentistry. An appreciable contribution will also be the development of skilled chemical production producing globally competitive materials and components with high added value. Not least, the application of developed gradient materials can contribute to the management of certain security risks in the field of direct passive protection and by means of the design of the sensors based on them; this form of application can also help enhance the reliability and efficiency of alternative energy sources, including hydrogen. The development of the use of rapidly renewable resources for products with high added value will reduce dependence on oil in the field of bulk commodity polymers.

The domestic research base will be able to support the influx of foreign investment and the growth of difficult-to-relocate highly skilled production with high added value. At the same time, new domestic, highly competitive small and medium-sized enterprises will emerge, and the results will positively influence domestic energy consumption, reduce environmental burdens and make more efficient use of existing sources of raw materials. Research and development of new structural materials based on rapidly renewable agricultural crops and products of biotechnology processes will significantly increase the profitability of agriculture and facilitate the greening of the life cycle of industrial products. There is also significant positive feedback on the development of the research bases of technical universities, without which universities would be unable to produce truly creative engineers.

Overall, this applied R&D priority will encourage the transformation of the Czech economy into a knowledge-based economy capable of forming a significant part of GDP through high added value with reduced energy consumption and environmental stress to a level similar to that in the most developed countries. It will be possible to maintain this in the long term and improve the living standards of the population.

Another benefit is the improved status and prestige of Czech science on a global scale, the creation of materials research centres of excellence capable of coordinating large-scale European projects, and thus an increased influx of young researchers and funding into the Czech Republic. Support for the transfer of results will lead to the creation of small innovative companies with products carrying high added value and supporting employment growth by offering highly skilled jobs.

Indicators evaluating the success of this priority are the level of bibliographic outputs (number, IF, citations), the quantity and use of products protecting intellectual property (patents, industrial designs, licences, etc.), the number of newly created jobs, the amount of funds received for materials research outside the Czech national budget, the amount of increased revenue generated by taxes from new entities formed in conjunction with the transfer of the results of materials research, and an increase in revenues from exports of products and services based on new materials.

9. Financial resources

The volume of existing financial support for materials research as a multidisciplinary field is difficult to estimate, since this category may include a certain degree of research in the fields of chemistry, physics, engineering, construction, electrotechnology, the military, medicine and other sectors. More important than the actual volume of finances is the funding structure and nature of programmes to support materials research from the national budget. Institutional support should focus on national programmes for the support of investments in the human and equipment infrastructure of research in locations with the potential for growth and interaction with industry, and should steer programmes towards the concentration of research capacities in places where the results can be implemented (technology parks near research institutions, more research institutions with programmes relevant to the locality, etc.) and towards support for the protection of intellectual property and its management. Programmes should be initiated that promote new interdisciplinary degree programmes at universities involving ASCR institutes (MSc, PhD).

An important role in the efficient use of national budget funds for the support of materials research could, in the future, be played by regions, particularly as regards targeted support for the transfer of research results to industry in the form of “matching funds” programmes.

10. Links to other priorities

The Materials Research priority is directly linked to Competitive Engineering and Energy Sources, and also has a connection with the Information Society and the related progress in science and medicine.

Competitive Engineering

Summary

Engineering is undoubtedly one of the Czech economy's most important industries. In relation to the national economy, it is of crucial importance for the creation of GDP, the foreign trade balance, and job creation and overall employment. Research, development and educational institutions, as well as many other services, have links to engineering. Competitive Engineering is of interest to domestic and foreign investors, and the promotion of research and development is therefore crucial in order to maintain and increase its standard, which has a long-term stabilizing effect on investment in this sector.

It involves interdisciplinary research, encompassing not just engineering per se, but is also closely related to fields of materials research, energy and information technologies, technical chemistry, heavy-current electrical equipment and microelectronics. The Czech Republic is well qualified (boasting both tradition and its current very dynamic advances) for this type of skilled research. In the field of products, this priority focuses on the design and optimized use of macromechanical, micromechanical and electronic elements to achieve much better energy consumption and greening, which is a key target for the years 2015–2020. The automated control of machinery and equipment operations, including the scanning and evaluation of parameters, the setting of control actions using intelligent algorithms and their transfer to the resulting power effect of the machinery or set of machinery, can also make a contribution to this. In the process-oriented field, there is research on the design of machinery and its optimization through means of simulating future operational activities using virtual reality and advanced experimental research, including the side effects of the activities. This priority also covers research to enhance the standard of technical design, ergonomics and ecology. The process-oriented field must lead to a reduction in the time from the discovery of the principles of an innovation to its introduction to the market.

A SWOT analysis identified the following priority areas:

- Competitive transport engineering (research of innovative products, parts and processes for cars, rail vehicles and aircraft).
- New manufacturing technologies, machinery and equipment (research on innovative products and technological processes for the production machinery industry, the energy sector and manufacturing).
- Integrated engineering (the linking and acceleration of pre-production stages in the process of functional design, structuring, virtual prototyping, manufacturing technology and its further life-cycle, and the search for innovative avenues for future design, including mechatronics, biomechanics and human-machine interaction), developing the chain of manufacturer – supplier – specialized engineering firm – the user.

In the European Research Area, projects have already been launched that are based on technology platforms, i.e. associations of interested parties who themselves create the future research programme and projects that will be seeking State aid. These efforts are motivated by the declining competitiveness of European industry in relation to American and, especially, Far Eastern competition. In view of the parallel phenomenon of dwindling numbers of creative engineers in Western Europe, there is an urgent need in this area for an active technology policy. Therefore, the main motto of the Seventh Framework Programme is the demonstrable applicability of results, not just formal excellence. Although the key word "engineering" does not appear explicitly in the EU's priorities, the weight of all innovations associated with the materialized results of research clearly rests on the shoulders of this industry.

The main fruits are innovative products, technologies and intellectual property. The main benefits of research under R&D priorities will be increased competitiveness in the product area of these disciplines and in the transfer of know-how, including the expansion of foreign investment in research institutions. In the final stage of introducing an innovation, success is measured by the volume of the value added and productivity, assessed from the R&D perspective by a product or process that will be competitive at least on a European scale.

In this way, the domestic research and development base will be able to maintain the inflow of foreign investment and production growth in cases of highly skilled production with high added value that is difficult to relocate (cars – not just the final assembly, but also subcontracting and the manufacture of accessories, manufacturing, energy and processing machinery for new designs, aviation technology, etc.).

1. Characteristics

The support of competitive engineering entails the promotion of research and development in promising fields of engineering which are important in identifying and implementing innovations and in launching them in the form of products and technologies which improve the quality of life and thus contribute to their marketability. This covers both the applied research and development of innovative products and technologies and the research and development of processes and methods of engineering work aimed at accelerating and reducing the cost of all stages of production.

In the product-oriented field, the aim is to design and optimize the use of macromechanical, micromechanical and electronic elements to achieve energy savings and environmental friendliness. In relation to this goal, the automated control of machinery and equipment operations includes the scanning and evaluation of parameters, the setting of control actions using intelligent algorithms, and their transfer to the resulting power effect of the machinery or set of machinery.

The process-oriented field covers the research and development of the design of machinery and the optimization thereof by simulating future operational activities using virtual prototyping and testing and advanced experimental research, including minimization of the side effects of activities, research increasing the standard of technical design and ergonomics in the broader sense of “man-machine interaction” – both active and passive safety in relation to the user and to the surroundings, the ease of operation and the convenience of other users, the development of advanced production and assembly technology, and, not least, the quality control of production. The process-oriented field must lead to a reduction in the time from the discovery of the principles of an innovation to its introduction to the market.

Both fields are closely linked to the research of energy, material sciences and information technology, in all cases in terms of the input and output of their results and the feedback on these fields. In the light of developments in Europe and globally, along with the Czech Republic’s potential, the following priority areas are proposed in response:

Competitive transport engineering[1]

The production of modern and competitive road and rail vehicles for passenger and freight transport and aviation technology is a major opportunity for further economic growth in the Czech Republic. The subject of attention here is the research of structures and components (groups, parts and accessories) of road and rail vehicles, their propulsion and their safety aspects for sustainable mobility (i.e. respecting the limitations of sources of fossil fuels, the generation of harmful emissions and greenhouse gases, and ensuring the proper safety of the persons transported – including people with reduced mobility, costs and other participants in the transport process), and the management of processes taking place in them and during interaction with the infrastructure (transport routes, information technology). Research into concepts of rolling stock and aircraft builds on this work. The rolling stock industry is experiencing a renaissance in conjunction with the growing need to shift traffic flows into more environmentally friendly transport. Aeronautics and astronautics are highly multi-disciplinary fields and contribute to the general development of common technical standards, including technical education.

1.2 New production technologies, machinery and equipment

The Czech Republic is a leading European and global producer of engineering technology for manufacturing. Manufacturing and energy industry machinery also forms an important segment of engineering in terms of GDP formation and its share of the Czech Republic's exports. Research will therefore focus primarily on machinery with high utility properties and the ability to compete with global leaders in the field, i.e. highly efficient, accurate and reliable machinery and equipment fitted with advanced diagnostics, mechatronic systems and artificial intelligence, which will report significantly higher value added and will be consistent with users' needs.

The management of new and advanced technological procedures and processes is an integral part of the manufacturing and energy industries. Research related to technology and technological production processes will be in keeping with ever-increasing demands on quality and productivity, reductions in the energy and material intensity of production and products, the recyclability of products and the separability of components and materials. The aims of the research will be the automation of production technologies, the integration of traditional production technology and new technological solutions, miniaturization and increased precision.

Production machinery and all mechanical equipment must be sufficiently reliable and safe throughout its service life, and must comply with limits related to its effect on humans and the surrounding environment. It is therefore necessary to have means and methods that can be used objectively as early as at the development stage to assess the properties of new products and equipment in future operations, and to monitor and diagnose the status of these products and equipment during their actual operation.

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[1] Under the EU FP7, these are the priorities SUSTAINABLE SURFACE TRANSPORT and AEROSPACE TRANSPORT, from the perspective of a holistic approach to products, infrastructure, user approaches and the legislative framework. More specifically, the following priorities are at issue, all of which are addressed in some way by transport engineering:

- The greening of surface transport
- Encouraging modal shift and transport corridors decongesting (co-modality)
- Ensuring sustainable urban mobility
- Improving safety and security
- Strengthening competitiveness

The FP7 approach is derived from the White Paper on Transport "European Transport Policy for 2010" and "Keep Europe moving" and takes into account the energy and environmental aspects of transport.
It draws on the results of the platforms ERTRAC (road transport) and ERRAC (rail transport).

1.3 Integrated engineering

In addition to the research of advanced products per se, as described above, competitive engineering requires research into tools and methods applicable in the innovation process, i.e. research on engineering tools and procedures ensuring the competitiveness of the products, and research into the execution of the basic structural elements of such advanced designs.

Conventional design methods based on empiricism and the intuition of the designer are now virtually exhausted. Higher-order innovations command more than the optimized parameters of the system of design and configuration, as facilitated by current methods of computer aided engineering based on simulation and optimization methods. Higher-order innovations with a short time-to-market in the innovation cycle also require the integrated (simultaneous) involvement not only of design development capabilities, but also of the developers of materials, technologies and product maintenance/disposal.

In these circumstances, the new quality of design procedures can be achieved by using the concept of virtual prototypes and their gradual materialization. The application of these procedures is made possible, on the one hand, by the progress achieved and expected in the modelling of the function and manufacture of machinery, and on the other hand it is necessary for the design and development of new machinery, structures and components with intelligent behaviour. In accordance with technological design methods, applications facilitating the creation of databases of materials and technologies will also be addressed. Research is therefore also required for model descriptions of existing materials and technologies.

Research into the methods themselves is not possible without feedback from industrial applications. Therefore, the design of advanced machine components, the scanning and control of the movement of their parts, the scanning and control of the flow of fluids and control algorithms for the combination of machinery or its major subsystems with drivers, while respecting the dynamics of the system, are an integral part of research. Mechatronic intelligent structures leading to scales of material particles, consisting of sensors, control algorithms and drivers, the sub-management of which requires systemic coordination, both locally and remotely, can be used as part of the whole.

In its second part, research will focus on the issue of mobile mechatronic systems for handling-service functions (specialized robots), for manufacturing equipment, and for chemical and electrochemical reactors with controlled reactions (the disposal of emissions, waste, fuel cells). It also includes a description of the mechanical behaviour of the human body in interaction with machines, particularly with regard to the risk of damage to health as a result of mechanical effects.

A proper long-term R&D strategy for competitive engineering requires coordination with EU bodies and institutions affecting R&D priorities and related activities in various areas (technology platforms, JTIs, etc.). For example, in aviation there is the comprehensive development of aircraft in the General Aviation category, in road transport there is the ERTRAC platform, in railway transport there is ERRAC, in manufacturing machinery ManuFuture, in energy machinery H2FC, etc.

2. Objectives

To increase the **global competitiveness of engineering in the Czech Republic via products with high added value** by quickly introducing higher-order innovations in fields of innovative product research for

- **transport engineering**, with a view to reducing the consumption of non-renewable and imported (from politically unstable regions) sources of energy and the generation of emissions harmful to health or comprising greenhouse substances, and increasing traffic safety. The following research priorities are involved:

    - Structures and components of transport machinery for sustainable and safe mobility
    - Unconventional and alternative drives for road and rail vehicles
    - Means of ensuring safe road, rail and air transport
    - Rolling stock and components
    - Aeronautics and astronautics, particularly the development of small aircraft, propulsion units, systems and technology, development aimed at increasing safety, reliability and durability.
- **machinery in the manufacturing and energy industries and production technologies**, with a view to increasing the productivity of engineering, textile and electrical manufacturing, and energy, and limiting their impact on the environment and human health. The field of manufacturing machines is mainly covered by the following priorities:
    - New production technology.
    - New production machinery and manufacturing systems, including automatic control of production machines, production systems and technological processes and the automation of production machinery and systems, inter-operational transport and handling.
    - High-performance machine components.
    - Modern drives, advanced control methods and the integration of mechatronic components.
    - Measuring technology and sensors for engineering.
    - Adaptive management of machine properties using intelligent systems
    - Reductions in the energy and material intensity of machinery
    - The testing and operational diagnostics of machinery and equipment; predictions, monitoring and securing of the reliability and safety of technical systems.

To increase the **global competitiveness of engineering research and development** in the Czech Republic in the field of industrial intellectual property rights and the transfer of know-how to the above-mentioned and other industrial sectors, by exploiting the status achieved by Czech engineering through R&D and by introducing:

- Process resources and engineering methods aimed at speeding up and cutting the cost of pre-production stages.
- Resources for the design and optimization of intelligent structures for the management of machinery aimed at performing the intended function with minimal negative side effects, especially by means of mechatronics and active biomechanics, as a basis for further development. The following areas in particular are covered here:
    - Intelligent structures (controlled mechanical and material structures with active behaviour).
    - The ergonomic optimization of machinery and passive biomechanics.
    - Mechatronics, robotics and active biomechanics.
- Integrated operational machinery and equipment diagnosis, predictions, monitoring, and validation of the reliability and safety of technical systems.

A key area of the objectives is the **maintenance and expansion of human resources capable of ensuring the above priorities**.

3. Reasons and criteria serving as a basis for the proposal of the priority

The importance of engineering to the Czech economy is explained in the introductory summary on the first page. The Czech Republic is well qualified (boasting both tradition and its current very dynamic advances) for this type of skilled applied research.

The engineering industry, using output from other sectors (steel and metallurgy, electrical engineering, information technology) in its products, accounts for a substantial part of the Czech Republic's competitive exports with high added value and a significant share of GDP.

Employment in manufacturing with moderate to high levels of technology is above average in the Czech Republic compared to the EU and newly acceding countries, and is increasing at the expense of low-tech fields.

Therefore, the following criteria were applied to the selection of the recommended areas of industry:

The **current performance of the relevant area of industry**, appraised qualitatively (at least at the level of the lower limit of high-tech; turnover; employment; investments – volume, composition, investor; research activities; exports).

An **expert estimate of prospects for the next 20 years**, in particular the possibility of intensifying integration into the mainstream of the global economy via multinational corporations or the use of existing know-how and capacity to fill a market niche (typically emerging as a result of high-tech intensity and relatively small production volumes which are not attractive for large corporations).

In selected areas of industry beneficial to the economy and society, research priorities were selected according to the following criteria:

The extent of penetration of R&D requirements according to an **expert estimate of the global trend** (based on communication with industry representatives in the Czech Republic and globally) and the **assessed development potential of the existing research base** (at both academic and industrial level).

An estimate of **global partners' interest in supporting research** based on trends in research cooperation under European and other international projects.

The recommended areas of research and development are therefore instrumental in maintaining the ability of Czech engineering as a whole to compete in the global market. The selected product areas include, in particular, the surface and air transport industry, the energy machinery industry, the industry encompassing the production of machinery and equipment for manufacturing technologies, such as machining, forming and casting, the textile and chemical industries, the fuel industry, the glass, printing, and food processing industries, the manufacturing of packaging and handling equipment, equipment for the mining industry and medical technology.

Thanks to the industrial base, tradition and the currently sufficient number of highly qualified professionals, foreign investors are showing increasing interest in setting up major branches of research and development centres in the Czech Republic. This increases demand for human resources, the level of which, in return, synergistically influences industrial standards. Moreover, these foreign investments are associated with the transfer of know-how and are stable, unlike production plants. Therefore, it is desirable to encourage this trend, conducive to an increase in GDP and skilled employment and improving energy consumption and environmental friendliness.

In view of the scarcity of other sources of GDP in the Czech Republic, this is a very important item of society and the economy which cannot be secured without active

State aid for R&D. Sustainable development and the most stable possible localization of selected sectors is in the interests of the Czech economy and the whole of society. This is subject to competition, determined by the utility value of products and value for money. These factors cannot be secured without domestic R&D, both with regard to product parameters and with regard to sustainable staffing in the industry (without research and development, it would be impossible to educate new full-time workers). Otherwise, production detached from R&D becomes very vulnerable because it can be transferred anywhere there is an immediate supply of cheap capacities.

4. SWOT analysis

4.1 Strengths

Tradition and high-tech standards make the results of engineering research and development comparable with Europe, particularly in certain regions. This can be documented by growing exports, the relative citation response to engineering research, patenting (especially as regards the number of patents granted) and activities and success under the European Framework Programmes, particularly in comparison to similar (i.e. post-Communist) countries. Similar results are reported by the involvement in European projects under the EU's Sixth Framework Programme, especially in the 6th thematic priority – "Sustainable development, global change and ecosystems". However, the overall participation of Czech workers in the research consortia, not just the success of Czech projects, should be taken into account. These data clearly show that engineering disciplines are at the top area in Czech research and development.

The Czech Republic has managed to strengthen the targeted support of research and development/innovation in engineering, especially under MIT programmes and the LN and 1M Research Centres programme (transport engineering, including aviation, engineering for the manufacturing industry, production machines and textile machinery), and by means of investment aid for the Czech offices of global and local research and development companies (particularly in transport engineering).

The Czech Republic coordinated FP6 IPs in the field of aircraft for regional transport, joined technology platforms for transport (ERTRAC), for hydrogen technology (H2FC) and for engineering production (ManuFuture), participated the most of all new EU Member States in EU FPs linked to engineering, especially vehicles and production machinery, and is successfully entering the competition for projects under the Seventh Framework Programme.

4.2 Weaknesses

For most potentially competitive sectors, industry does not have a broad base of institutional research (with the exception of aviation, textiles, and some areas of energy, especially nuclear). Therefore, State aid for research could be used mainly in the form of targeted support for projects; however, as a matter of principle it cannot create a long-term, coordinated research base, especially considering the effects of historical under-investment in research capacity and uncertain prospects in the event of failure to secure institutional support.

Smaller Czech producers in particular can only stay afloat by selling their products through foreign partners who have sufficient development potential and are connected to research centres. This means that a substantial portion of profits is channelled abroad, thus gradually degrading the level of producers (in terms of capital development) and human resources for industry in general.

Despite significant investments in the production capacity of the engineering industry, there is still a risk that industrial production will be reduced to the level of a developing country with volatile speculative capital, shifting production capacity on the basis of current labour costs.

The link between the education of new research and development workers at universities and their research activities is lost somewhat by the stress on quantity (the number of students, preferably in lower-level budget programmes) necessary for the survival of universities with flat-rate funding. There are not enough universities providing excellent training capacities for outstanding students. The support for demanding (and thus unattractive) secondary and higher education in technical and scientific fields has disappeared along with the close connection between this theory and practice. However, only outstanding experts with practical experience can contribute to the generational renewal. Nevertheless, the problem is not just in higher education, because numerous technical professionals who have completed secondary school or vocational training are required (for the prompt production of models, functional samples and prototypes) if the goals and outputs of R&D are to be successful.

Current legislation impedes the direct formation of profit-making spin-offs at universities. Abroad, these companies hold patents and carry out licensing activities.

4.3 Opportunities

The impetus to research and develop new technologies in engineering is prompted by the need for the global economic competitiveness of products with respect to intensifying demands on the sustainable growth of the economy, i.e. compliance with environmental protection in terms of the product life cycle (production, operation and disposal – recycling).

The combination of investment financing from the European Structural Funds and basic institutional financing from Czech funds will be an opportunity for successful applied research centres and will ensure the rational use of the capacity in individual regions.

This financing will be supplemented by the possibility of the further special-purpose financing of prospective projects on the basis of international cooperation, available inter alia from European sources, such as the FP7.

Special-purpose financing, especially of development and industrial research, can be supplemented by the private sector, which has shown an increasing interest, conditional on indirect instruments of R&D support from the State, improving economic performance, and the need for innovation.

Moreover, there is an opportunity to exploit the existing potential of Czech engineering, famed for the inventiveness and skills of its engineers and the its manufacturing capabilities, for the completion and verification of the prototype production of the innovations developed.

Another significant factor is the combination of the training of new research and development personnel at universities and their research activities, where excellent educational capacities are concentrated for outstanding students and an environment conducive to information and publicity campaigns that will increase the attractiveness of technical disciplines is revived.

Human resources in research and development still exist at secondary and primary vocational level (skilled craftsmen at prototype workshops etc.), but in the absence of change to the system of secondary technical education, this opportunity could turn into a threat.

The application of existing and expanded engineering R&D capacities is also viable on a global scale, particularly in cooperation with the Far East. The important factor here is the

flexibility to respond to demand in an environment with various requirements for sustainable development.

4.4 Threats

The potential stagnation of economic growth in the Czech Republic on account of the global recession (e.g. following another energy shock) and subsequent reduction in the R&D stabilizing subsidies available. In this context, given the country's European ties, delaying the introduction of the European currency would also be a threat.

A decrease in regional disparities through a unilateral preference for the alignment of research potential in Czech regions, leading to a delay in the development of the best performing areas, could also be a disadvantage. The aim should be maximum performance and efficiency, not inefficient middling.

There is still a lack of interest in studying technical fields, due to the dearth of publicity and the focus of teaching at primary and secondary schools, along with parental ignorance of opportunities in the field. Another threat, then, lies in the delayed support of secondary and higher education focusing on technical and strict scientific disciplines.

Generally, there is also a risk that some universities will see their capacity for action deteriorate as a result of pressure from academic senates (with major decision-making and blocking powers) to counter the increasing demands of capable, driven managers and the further differentiation of income between executive and non-executive organizational units, including restrictions on universities' business activities in the field of commercially active spin-off organizations. R&D costs still cannot be included in tax-purpose depreciation for companies purchasing research externally (from research institutes, schools, their own subsidiaries).

There is also the threat that the best performing workers will leave for other countries where the working conditions are better.

4.5 Preparedness of the user community

Selected sectors successfully survived the shock economic transformation because they were competitive thanks to their own R&D or their uninterrupted links with the suppliers of these services. Assessments of this potential always crop up in the criteria used by reputable foreign investors, and are now applied by the leading domestic investors too.

Therefore, the readiness of the selected prospective user community to apply R&D results is high, in respect of both global companies in the Czech Republic and domestic owners. Recently, there has been growing interest and readiness among small and medium-sized enterprises, which is the result of the competitive process and their long-term support by the Czech Republic and the EU. This is evidenced by the massively increasing volume of research ordered from universities and research institutions in the past three years. From this perspective, the readiness of the user community is more of an opportunity than a threat.

5. The situation abroad

Foreign companies draw on research concentrated into national (public, often at universities, and private) and multinational (private) research institutions, usually located in less expensive locations outside major cities, which are steadily forming network consortia, associations, etc. Both types of institutions use national and, in part, European support. Concentrated research exploits the synergy between the disciplines (e.g. energy – transport machinery, aviation – automotive design, use of microelectronics).

Here, too, the coordination and orientation of research activities is better with regard to

- the feasibility of results (i.e. the "turnkey" handling of current problems, not just curiosity driven research), reflected in producers' interest in using the output;
- the interdisciplinarity (the holistic approach), especially among favourable mechatronic attitudes towards engineering products because of their higher-order innovations, the frequent requirement of sustainable development;[2]
- comprehensive assessments of and improvements to the environmental impacts of the operation and production of industrial products, reflected in their assessment by government (or Community) authorities and civil associations through their representatives in technology platforms.[3]

In the European Research Area, projects have already been launched that have been initiated by technology platforms, i.e. associations of interested parties who themselves create the future research programme and projects that will be seeking State aid. These efforts are motivated by the declining competitiveness of European industry compared to the American and Far Eastern competition, due to the rising standards in the research and technological capabilities of competitors and the speed at which they react to the changing demands of various markets, and (especially in the case of East Asia) due to the lower labour cost of research. In view of the current dwindling numbers of creative engineers in Western Europe, there is an urgent need in this area for an active technology policy. Therefore, the main motto of the FP7 is the demonstrable applicability of results, not just formal excellence, as this single line of pursuit result in certain failures in the FP6. The importance of research into all modes of transport (including the wrongly neglected road and small air transport) has been explicitly strengthened in the priorities. Although the key word "engineering" does not appear explicitly in the priorities, the weight of all innovations associated with the materialized results of research clearly rests on the shoulders of this industry. This is fully comprehended in France, Italy and Germany in particular, and is fully reflected in the current recession in the US and the UK.

The importance of industry, with a significant role played by engineering in advanced economies, is undergoing a renaissance: for strategic and security reasons it is impossible to become dependent on production in areas where development and future relations with the Euro-Atlantic civilization are not transparent and guaranteed. Moreover, a shortage of technicians and engineers is already being felt in Western Europe and (to a lesser extent) in the Czech Republic. With production activities being relocated to lower-cost zones in East Asia, a base needs to be built up that can maintain economic growth by drawing on the Czech Republic's potential and that is capable of engaging in trade with this area. This means the research, development and application of advanced technologies addressing issues such as energy (in the production of fuels from local sources there is a close link with machines for the manufacturing industry), mobility (surface and air vehicles, fuel) and the cheap, quality production of machinery, materials and other industrial products. Engineering is becoming

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[2] European policy research under the FP7 focuses on transport engineering within the main objectives
• Development of innovative solutions for surface transport products (vehicles, vessels, infrastructure and their components), processes, operations and services.
• Breakthrough research in support of step changes including the incorporation of breakthrough technologies and results from interdisciplinary research (such as nanotechnologies, biotechnologies, new materials and advanced production) into surface transport applications. Research will support both short to medium term CO2 reduction targets and will contribute to the development of a new vision of transport systems and solutions beyond the 2050th
A holistic approach addressing all possible means to reduce emissions is taken.
For subtopics, see the note on page 2.

[3] The European platforms ERTRAC (road transport, with Czech participation) and ERRAC (rail transport), for manufacturing machines ManuFuture (with Czech participation), for hydrogen technology H2FC, in the Czech Republic the Czech Hydrogen Platform (*Česká vodíková platforma*). For engineering in general in the Czech Republic, the Czech Engineering Technology Platform (*Česká technologická platforma strojírenství*).

increasingly integrated with electrical engineering and informatics in advanced mechatronic complexes, both in final innovative products and at the stage of development and research to accelerate the innovation cycle (virtual products and manufacturing processes, rapid prototyping, etc.). Typically, experience of simulating the functioning of virtual products starts to be applied during the predictive control of these products.

Previously optimistic assumptions about the early application of new energy transformers (fuel cells) in transport machinery are being adjusted and development has taken an evolutionary turn. The same applies to renewable energy sources for vehicles. New technologies and processing machines are currently sought after in the context of this trend. Therefore, traffic and transport engineering were explicitly included among the priorities of the FP7.

6. Czech conditions

6.1 Preparedness

The capacity of industrial research and development has survived thus far thanks to the above-mentioned, but often unsystematic, support. The difficult conditions of economic transformation clearly showed which sectors were potentially competitive. Efforts are coordinated to carry out research on the basis of joint projects.

Experience gained from the Research Centres programme demonstrates the possibility of pooling research capacities when cooperating on specific topics applicable to the practitioners, who already contribute a considerable part of their own funds to research and use the results of research. Centres using the Centre Council to coordinate efforts for viable products within the virtual organization have formed a kind of technology platform on this basis. EU funds have helped stabilize teams at research centres.

There is growing involvement in international research and development programmes and in technology platforms at European level, especially in globalized sectors (aerospace, the automotive industry), as well as in other fields (mechanical production machines). However, this is a sector-specific issue. The R&D priority of Competitive Engineering should also help improve the competitiveness of internal research through the further acquisition of European resources from EU structural funds (particularly for investment) and from the FP7. It should also play a role in strengthening vocational education at all levels which create human resources for engineering.

6.2 Use

The production sphere is advancing in viable industries on the basis of the above-mentioned natural selection. Its requirements, based on technology platforms, and the possibility of additional R&D support from private sources guide industrial research with regard to its targeted applied phase. Previous results in the named areas clearly support this conclusion.

Even if all potential users were unable to participate directly in the formulation of the priority, a number of indicators reveal their interest. The Czech Engineering Technology Platform (CETP) has been formed and is involved in consultations on planned priorities. The Platform includes representatives of industrial and sector unions. There are significant examples of consortia already established between the production and research community; in other cases, the intent to form such consortia has been declared as part of proposals for international and Czech projects. The necessary contributions to consortia (e.g. 50% participation in demonstration projects) mean this is not a matter of platonic interest. This can

be demonstrated in selected specific cases: up to one month (e.g. for the automotive industry, aviation industry, rolling stock industry, textile machinery or mechanical production machinery), or, on the basis of a survey, up to 3–4 months via industrial and sector unions from the CETP. The list of specific users will be dynamic in this case (there is a long timeframe).

The application of findings in key industrial sectors and their acceptance in the form of products by majority users is feasible in the long term, with the benefit of achieving the objective to boost the competitiveness of the domestic engineering industry in high-tech sectors and to ensure its contribution to GDP growth.

The benefit of applying results to the development of industrial production can be gauged by reference to past implementation, successful prototypes, patents and active licences, as well as by contracts awarded to implement programme results in the Czech Republic and the EU (JTIs, IPs – large-scale projects in the EU's FP7), and the supply of research cooperation to other countries. At the same time, the contribution of private capital to R&D (public-private partnership) will be secured in this environment as this is necessary to make the desired increase of the share of R&D spending in GDP, specifically in the field of targeted funding complementing the State "guaranteed" minimum institutional component. Therefore, State aid for the application of these measurable research results is very important.

The cost of transferring research results from State aid consists of the internal cost of covering intellectual property because the cost of implementation is usually borne by the user. The implementation cost runs into several million Czech crowns for all engineering patents. Few producers can afford to cover such engineering costs solely out of their profits. However, they must be covered if the transfer is to work.

The transfer of results cannot take place without functional research institutions, whether in the form of public research institutions or university research centres, which in the future will ultimately be explicitly defined and funded in accordance with a newly introduced model of institutional funding. In this case, the transfer is generally the subject of indirect support as it involves research bases at schools and public research institutions which are partially subsidized with institutional support (otherwise it would be impossible to maintain a stable team of employees). This support normally accounts for 50% - 66% of the research institution's budget. In EU countries, this type of support funding is common and is reflected positively in the number of outputs subsequently applied.

7. Expected results

7.1 Short-term prospects (5 to 10 years)

In the near term, there should be an increase in the number of engineering products with higher added value, which will be based on new knowledge from engineering research, new patents and licences, the numbers of which will grow. In particular, the prospects look good for the automotive industry, the aerospace industry and the industry of textile, manufacturing and energy machinery. At the same time, there will be a further influx of foreign investments to set up branches of research and development institutions; this is increasing to the extent that current reserves of skilled labour could soon be exhausted without an adequate response from the education system and society at large. The main result here is the expansion of the current solid position enjoyed by Czech engineering with regard to qualified products with high added value.

7.2 Long-term prospects (10 to 15 years)

We project research into, and the introduction of, new solutions for the design and management of complex engineering units, particularly in areas insufficiently covered by traditional producers (energy-efficient and safe, low-cost vehicles, based on minimizing the size and consumption of the drive unit, probably a hybrid vehicle, engines for trucks with a high concentration of power and high efficiency; new solutions for trams and hybrid trolley buses; aircraft with parameters suited to intra-European services; efficient, accurate, reliable and ecological machine tools, consisting of high-performance components with modern drives and advanced control with the integration of mechatronic components and adaptive control of machine properties using intelligent systems; new textile machines; new energy machines, etc.). Further to the development outlined in the previous section, conceptually new ways of propelling vehicles, based on alternative synthetic renewable fuels (such as hydrogen), will be discovered.

8. Benefits

In the final stage of introducing an innovation, success is measured by the volume and productivity of production, assessed from the R&D perspective by a product or process.

In this way, the domestic research base will be able to maintain the inflow of foreign investment and production growth in cases of highly skilled production with high added value that is difficult to relocate (cars – not just the final assembly, but also subcontracting and the manufacture of accessories, aviation technology, etc.). New domestic SMEs will also be set up to provide technical assistance and control technology (a synergic link to the IT LTRG), there will be demand for new materials, and the results of transport engineering in particular will have a positive effect on domestic energy consumption and energy sector output on account of demand for alternative fuels. Furthermore, the development of R&D capacities will provide an opportunity for the development of prototype production requiring highly skilled craftsmanship, following in the footsteps of Czech tradition. In addition, this applied R&D priority has positive feedback on the development of the research bases of technical universities, without which universities would be unable to produce truly creative engineers. This will results in the long-term stabilization of experts at universities, who can then bring up a new generation of engineers.

Overall, this priority will support the transformation of the already capitally developed domestic industry into a highly competitive sector able to generate GDP growth with reduced energy consumption and less environmental stress. As in the most developed countries, the application of new engineering principles will create new jobs in diverse production sectors of the engineering industry. This will make it possible to maintain the engineering industry's position and compete with forecast cheap mass production from Asia, or complement it with supplies of pilot products and know-how of the highest level.

Specifically, in relation to transport engineering this priority concerns

- the application of new engineering principles in domestic production sectors (particularly in transport engineering and processing machinery);
- more reliable and safer chassis and box components for road and rail vehicles;
- an increase in the overall efficiency of vehicle engines, with a reduction in emissions, and the use of new energy carriers;
- integrated and intelligent vehicle control systems, particularly with regard to active safety, the reliability of transport, and emission reductions;
- more reliable and safer rolling stock components;
- new principles for the design of aircraft in General Aviation and Security;
- the removal of barriers for people with reduced mobility.

Furthermore, in the field of production machinery and technology the priority focuses on

- high-efficiency intelligent electrical components with adaptively corrected functions;
- the development and introduction of new technological procedures and processes in engineering and textile manufacturing;
- the development and provision of production machinery with higher utility properties and higher competitiveness;
- a reduction in the environmental burden on industrial production, the development of recycling technologies.

In the field of integrated engineering, the priority focuses on

- new principles of structures for motion, stress, the interaction of fluids with the solid phase, etc.;
- new engineering tools in the form of algorithms and programming units for the virtual research and development of machinery;
- ensuring the long service life of equipment components, a more accurate description of the process of material deterioration in various operating conditions taking into account the effect of the surroundings, a more accurate prediction of the life expectancy of the equipment;
- the development of new diagnostic methods, development and innovation in the field of sensors and measuring equipment and drivers.

Important synergistic outcomes include the increased reliability of work systems and production quality, optimization of the performance of manufacturing facilities; a reduction in the incidence of occupational ill health, improvements in the quality of life based on the application of biomechanical knowledge and products; restrictions on ecologically problematic production in the Czech Republic, the safe and reliable recycling of waste as renewable resources; ultimately, improved conditions for the education of engineers.

Competitive engineering is a prerequisite in maintaining and developing a range of other disciplines, including energy, manufacturing, construction, and health care.

Indicators of success are the (increased) number of newly introduced products and technologies, the patents granted, the software applications created and licences granted for their use in selected fields, achieved through the support of priority R&D areas (as compared to areas without support). Licensing revenue should also include the value of research and development contracts for foreign partners (EU research programmes for applied research, other international programmes for applied research involving contracts with private companies), provided that they end with the successful demonstration of a prototype or functional model (a supported exhibition, a presentation on the world stage), or with the application, in the Czech Republic, of a solution developed for the technical problem (a patent, technology, software).

9. Financial resources

According to CEP/CEZ information, roughly CZK 1,900,000,000 is drawn from the public purse for engineering research every year. As a result of the inadequate research infrastructure, an increase in both operating and investment costs should be anticipated. Operational resources for the proposed guideline need to be increased by at least 100%. If the growth in the volume of work includes inflation for the next five years (in connection with the introduction of the euro), this amounts to approximately CZK 3,300,000,000 in 2010 and

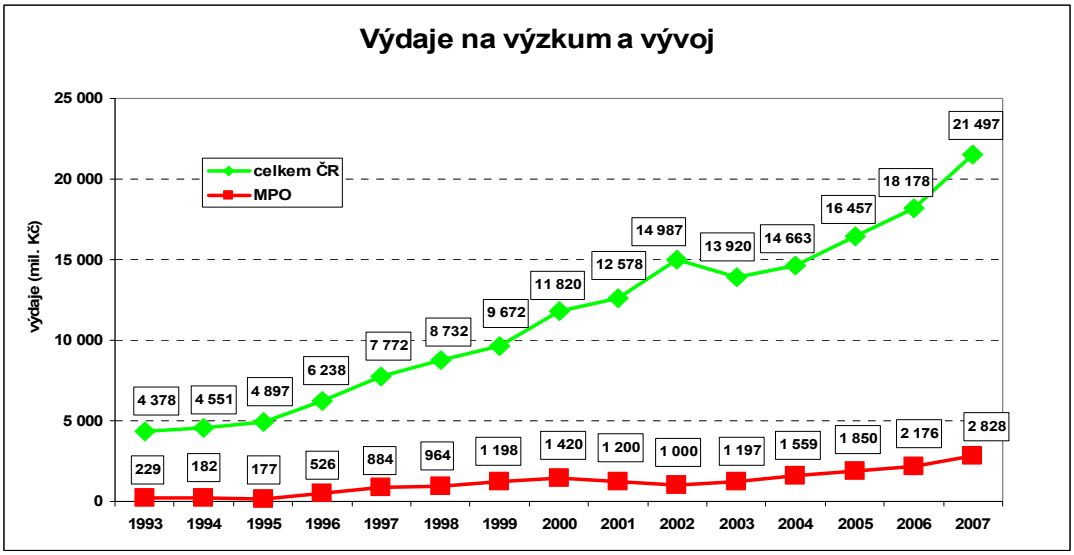
approximately CZK 3,835,000,000 in 2015, with the share of public resources as set out in the table below,[4] including the estimated share in European projects.

Resources received from EU research grants can be estimated by extrapolating the current status of 10% of this amount (mainly in projects led by major players in globalized industry), a tolerable rate of **co-financing from industry**, depending on the nature of the projects, would be 25% for risky research, 40-60% for development, and even more for large firms, below 50% for SMEs. The amounts from the national budget would therefore be approximately CZK 2,500,000,000.
For the transfer itself, a gradual increase to around CZK 250,000,000 per year is needed.

It is expected that the investment readiness of research institutions will be co-secured from the European Structural Funds, with national participation.

LTRG financing – interim projections (CZK bn)	
total (excluding large-scale infrastructure*)	
public sources	
	of which institutional support
	of which special-purpose support
	of which EU sources
private sources	
own sources**	

Financování DZSV - meziprojekce (mld. Kč)		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
celkem (bez velké infrastruktury*)		3.277	3.489	3.700	3.932	3.673	3.835
veřejné zdroje		2.140	2.300	2.460	2.640	2.340	2.440
	z toho institucionální podpora	0.940	0.990	1.040	1.090	1.140	1.190
	z toho účelová podpora	1.000	1.050	1.100	1.150	1.200	1.250
	z toho zdroje EU	0.200	0.260	0.320	0.400		
soukromé zdroje		1.110	1.160	1.210	1.260	1.310	1.360
vlastní zdroje**		0.027	0.029	0.030	0.032	0.033	0.035



R&D Expenditure

- total for the Czech Republic
MIT

[4] A simple calculation shows that at a frequency of one patent per year per creative worker, with efficiency of about 0.5% (in terms of the granting of the patent), this amount does not even cover 20% of the required number of workers. However, this concerns private research institutions.

Developments in government expenditure on R&D up to 2007, including funds allocated to the MIT's management within the national budget. The growth trend in recent years has been positive.

Information Society

Summary

Powerful information and communication technology currently underlies innovations in all fields of science and technology. New concepts of data and voice services enable truly global communications, the Internet has become a source of unprecedented amounts of information, and increasing quantities of data are being obtained directly from the real world through various sensors which scan images and sound. The ability to share, process and use a wealth of information has triggered revolutionary changes in society.

Information and communication technologies are one of the decisive factors in fostering innovation, creativity and change in all sectors of industry and services. They are essential for meeting the increasing demand for health and social care and for modernizing public services such as education, security, transport, energy and the environment. At the same time, they encourage progress in other fields of science and technology as they transform the way researchers conduct their research, collaborate and innovate.

Information and communication technologies are specific in their constitutive nature – not only do they make it possible to do new things, but also shape their form. They change and enrich almost all our activities and become an integral part of them. The nature of the global economy is changing, with knowledge-based products and services increasingly coming to the fore.

The gradual penetration of information and communication technologies among the rapidly growing number of products and services is leading to ambient intelligence, which intersects with all areas of society, immediately surrounds each member of society, and paves the way for further significant improvements in the quality of life. We refer, therefore, to the information society, the further development of which is unthinkable without intensive research and development in information and communication technologies and their practical applications.

The Information Society priority of applied research and development aims to promote research and development in those areas of information and communication technologies which will be critical for the further development of the information society in the application timeframe of 2015–2020, and which provides a valuable opportunity for our research to assert itself in Europe and globally. They include thematic guidelines aimed at developing basic infrastructure, such as new computing and software architecture, network and communication technologies, monitoring and diagnostic systems, software and hardware tools for building ambient intelligence, automatic control systems and advanced technologies for processing and presenting knowledge, including learning knowledge systems. Another area comprises application-oriented themes, directly focused on the research and development of information and communication technologies for the needs of key application sectors – for competitive engineering and industrial production (by means of computer modelling and simulation, industrial robotic technology), for transport and transport infrastructure (transport telematics), for biomedicine and health care (biomedical informatics and e-health), for improvements in the quality of life not only of the elderly or handicapped, but even of healthy people (intelligent machines and robots for humans).

While the major non-European economies are taking the lead in the primary sectors of information and communication technologies (personal computers, commercial electronics, etc.), the Czech Republic, like other European countries, is well placed for success in the secondary and niche sectors in particular. The Czech Republic has a solid grounding in basic and applied research in modelling and the management of complex systems, the security of information and communication networks and knowledge-oriented and information systems. These sectors are at levels comparable to the standard reported by developed countries. With its systematic and well-targeted support of research, the Czech Republic is able to offer ample potential for skilled human resources in the field of information technology.

1. Characteristics

The Information Society priority aims to promote R&D in those areas which will be critical for the further development of the information society and which provide a valuable opportunity for our research to assert itself in Europe and globally. They include the thematic areas:

- ambient intelligence (systems with built-in intelligence, advanced computing technology, intelligent human-machine interfaces, speech technology and intelligent communication with machines, computer vision and computer graphics);
- automatic control (complex and large systems, optimization and reliability, intelligent sensors and actuators, the use of principles for management and communication in living organisms);
- advanced robotics (industrial robotics, intelligent machines and robots for humans, collaborative robotics);
- computer modelling and simulation (optimization of the design process, predictions of service life, efficiency, safety, the quality and reliability of the proposed systems);
- monitoring and diagnostic systems (artificial intelligence for diagnosis, information aspects of monitoring and predictions);
- the processing and presentation of knowledge (knowledge-based learning systems, knowledge-based multimedia on the Internet, e-learning systems, the integration of knowledge);
- biomedical informatics (personalization of health care and telemedicine, data and knowledge to support decision-making in biomedicine and health care, e-health);
- transport telematic systems (intelligent transport systems, navigation systems);
- network and communication infrastructure (interactive digital communication, technologies for fixed and mobile optical networks, communication platforms at high altitudes, technology for communication with objects in space);
- new computing and software architecture (coordination and cooperation in distributed systems, the effective development of reliable software systems using components).

- The above thematic areas are covered by the following groups and disciplines, based on the R&D IS code list:
    - I Informatics (IN Informatics)
    - J Industry (JB Sensors, detecting devices, measurement and control; JC Computer hardware and software; JD Use of computers, robotics and applications thereof)
    - B Physics and mathematics (BA General mathematics; BB Applied statistics, operational research; BC Theory and management systems; BD Theory of information)
    - A - Social sciences and humanities, AE – Management and administration, AI - Linguistics, AM – Pedagogy and education, AN - Psychology

- From the point of view of users of R&D results, the information society offers
- safe means of transport
- service robots
- reliable computers
- reliable Internet
- multilingual translators
- telemedicine and home care for patients
- smart stores
- intelligent communication with the surroundings
- remote services
- integrated system of contact with government authorities

2. Objectives

The prime objectives of the Information Society applied R&D priority include

- the broad integration of intelligent information systems into industrial production and the daily life of society;
- more effective cooperation between man and machine;
- automatic control and optimization of the activities of complex systems;
- automation of routine, tiring or dangerous activities;
- mutual cooperation between robots and humans in an unavailable environment;
- the creation of a base for the high-tech and technology-intensive production of algorithms and components for robotics and complete robots to increase labour productivity and the quality of life;
- the emergence of new market opportunities (diversification) for small and medium-sized enterprises of a research, development, manufacturing and servicing nature – except the production of service robots and subsystems from the high-tech category this includes the provision of services associated with the deployment and servicing of robots;
- the development of new collaborative control methods and technologies for the cooperation of teams of intelligent robots;
- reinforcement of the safety and protection of lives and property;
- develop large-scale distributed systems of automatic control while respecting communication, coordination and cooperation between subsystems;
- develop wireless communication technologies and built-in applications for control systems;
- develop the information aspects of monitoring and prediction, which will be useful particularly in industry, energy, security, health care and environmental protection;
- improve the quality and reliability of products and, economically, optimize the maintenance of machinery and equipment; this will contribute significantly to the growth of industrial competitiveness;
- develop – and incorporate into diagnostic processes – progressive resources based on artificial intelligence, without which self-sufficiency cannot be achieved in the development of pioneering diagnostic, monitoring and predictive methods;
- develop technologies facilitating the automated acquisition of knowledge from large amounts of available data and their further use in decision-making, management and diagnostics in a wide range of areas;
- improve the quality of territorial data management, develop a new generation of geoinformation systems and apply them effectively for the benefit of government and citizens;
- create a set of algorithms and technologies for interactive, knowledge-based communication in a web environment with maximum use of multimedia;
- prepare a universally acceptable modern principles and standards for knowledge sharing and the integration of knowledge and information systems at all levels - national, business, and individual buildings and homes;
- create theoretical and application conditions for the implementation of integrated knowledge-supported Internet services in the Czech environment in order to achieve an entirely new quality in the use of the Internet;
- create an effective fully integrated system of contact with government authorities, including the relevant infrastructure;
- use of information technology to support decision-making in health care, for telemedicine and e-health;
- the creation and strengthening of standards for communication and the sharing of data and knowledge in health care;
- development of systems supporting home care patients and telemedicine to reduce healthcare costs;
- reduction in healthcare costs and improvements in healthcare efficiency, increase in the productivity of the health system in the Czech Republic;
- improvements in the quality and safety of care for individual patients (personalized care supported by scientific evidence), improvements in the quality of life for the sick and the elderly;

- research and development of control algorithms based on processing the maximum quantity of available data on traffic and transport, including non-traditional sources of the type of data from mobile operators, data obtained from search engines, etc.;
- research and development of automotive or user units of navigation systems, including their components (modular hardware solutions, integration of individual functions, integration of telecommunications systems, digital maps and their compression or representation);
- research into methods for the favourable interconnection of components of transport telematics on the principle of cooperative systems;
- optimization of traffic control in order to create economic, ecological and safe transport infrastructure;
- the development of resources for interactive dual or multi-point symmetrical communication for a collaborative environment;
- the development of mobile optical networks and systems with distributed intelligence and mobile multipoint to multipoint optical networks;
- the development of the non-communication applications of fibre optic networks, especially in the form of fibre optic sensors;
- the development of new communication methods providing broadband services throughout the territory;
- participation in the research and development of communication systems for satellites and interplanetary probes;
- develop means for optimal communication and cooperation between autonomous intelligent highly distributed units (agents);
- streamline the planning and scheduling algorithms for mechanical and electrical manufacturing and for supply chains, thereby helping to increase the competitiveness of all branches of industry;
- increase the professional level of the issues addressed (focusing on high technology);
- improve the quality of software development in industry practices;
- improvements in competitiveness in the export of software.

3. Reasons and criteria serving as a basis for the proposal of the priority

Thanks to the enormous progress that has occurred in the field of information technology in recent decades, we can be surrounded by an ever-present intelligent and communicating system – a virtual machine. The introduction of these virtual and highly distributed machines requires the implementation of completely new information and communication technologies and systems that can interlink the physical world and the world of information technology – facilitating real-time human-machine interaction, without the human having to look for the service-providing machine. The ubiquity of such intelligent systems will create ambient intelligence.

The realization of this vision will require intensive research into new methods and the development of new technologies, especially automatic control systems, intelligent computer systems, intelligent human-machine interfaces, speech methods in intelligent communication with machines, computer vision methods and computer graphics. At the same time, it will be necessary to build systems with built-in intelligence that will be able to make independent decisions and cooperate with other systems.

Significant technological advances will allow for the design of new types of robots in the near future that, in addition to benefits in industrial deployment, will also help address a number of serious problems for people with disabilities and improve the quality of life of the ageing population. The wide range of advanced robots being developed includes special health and mobility aids, industrial robots and collaborative robotics. The aim is not to design a humanoid robot, but to create new mobility and rehabilitation equipment or new solutions to commonplace items from everyday life. This is an interdisciplinary subject that has the potential to encourage good joint research teams with a visible, demonstrable output.

At present, it is quite clear that computer modelling is becoming the basis of quality design, replacing the traditional trial-and-error system and accelerating and improving design work. Mathematical modelling tools are based on basic research in mathematics and informatics, but today they are increasingly becoming a separate commercial product with very little material costs and extremely high added value. Active research in this area is therefore essential to maintain the status and competitiveness of the Czech Republic in mechanical engineering, electrical engineering, in the chemical and pharmaceutical industry, in mechatronics, in nanotechnology, and in the materials engineering.

Links between information and communication technologies and the automotive industry are particularly important. Changes in the design and utility value of vehicles clearly take place mainly through the application of intelligent systems.

Diagnostic processes, monitoring and predictions play a key role in improving the quality and reliability of products and production processes. They are also the basis of a variety of techniques and methods for increasing the operational safety of equipment and for other security solutions, including communication security. They are also indispensable in medical care.

Knowledge-based systems, such as system collecting, storing and – especially – using knowledge will play a very important, perhaps decisive, role in economic development this century. While the attention today is on the storage and use of knowledge, in the second decade of the 21st century interest will centre on the ability to obtain knowledge automatically from data, both structured and unstructured (e.g. from the free text of medical records, etc.). Thanks to the Internet, communication and the sharing of knowledge has reached a new level of quality requiring the development of sophisticated tools for work with multimedia information. A specific area in this respect is e-learning technology, the further development of which is a prerequisite for the further development of the lifelong learning of the Czech population.

The use of new information technologies is giving rise, via the current storage of previously separate information from bioinformatics and medical informatics, to the emergence of a structure for the organization and sharing of knowledge in the fields of medicine, health, biology and genetics. The concept of e-health covers the application of information and communication technologies in many areas that may directly affect health care. The deployment of information technology will contribute to improvements in the quality of medical care and lead to the standardization of preventive and therapeutic procedures.

The ambitious development of transport and modern transport infrastructure is an essential part of the sustainable development strategy and an important prerequisite for the continued economic prosperity of society. The basic components of transport-telematic systems include electronic payments (for services, use of infrastructure, vehicles, etc.), the management of security and emergency operations, the management of transport processes, the management of public passenger transport, support in the control of traffic, support for the rational mobility of citizens, support for the supervision of compliance with regulations, the management of freight transport and forwarding, and, not least, the development and administration of traffic and transport databases.

Good communication, which is the de facto kernel of human society, requires an adequate communication infrastructure. The exponentially growing number of devices that need to communicate together is generating demand for ever new forms and technologies within this infrastructure. In the coming years, the completion of the convergence of traditional telephony and newer networking technologies into a single communication infrastructure is forecast; the quality, accessibility and added value of this infrastructure are becoming key factors in the development of society and its economic growth.

Current information technologies are characterized by their swing towards large distributed systems. It follows from the very nature of these systems that their activities must be based on the mutual coordination and cooperation of individual components. Research into coordination and cooperation in distributed systems focuses mainly on the creation of algorithms for optimal

communication between highly distributed autonomous intelligent units (agents) and on the research and development of advanced algorithms of automatic control, and the configuration and optimization of large units generated from them.

Realizing the vision of an information society will require intensive research into new methods and the development of new technologies. However, the needs of the economy and society cannot be secured in this case other than through internal research and development.

The proposed research areas does not fall within the primary sectors of research into information technologies, such as personal computers, mobile communications, or commercial electronics. The Czech Republic cannot compete with major economies in this area and will buy the products. The proposed research areas have been nominated to form secondary and niche sectors important in terms of the widespread use of products and services, in which research will be a guarantee of the prosperity of society.

4. SWOT analysis

4.1 Strengths

Research and development in information technology is carried out by institutes of the Academy of Sciences of the Czech Republic and universities. R&D also involves large corporations and industrial enterprises which focus mainly on promoting products and services without a systematic approach. Small and medium-sized enterprises are also involved in this process, albeit with little potential for human and financial resources.

Generally speaking, with sufficient further support the Czech Republic is capable of securing sufficient potential for skilled human resources in information technologies.

4.2 Weaknesses

Financial support for R&D from public and private funds is low and poorly directed. It does not encourage research centres to find commercial applications for their results.

R&D potential in the Czech Republic is not yet able to integrate into strong, efficient teams and groups, including international cooperation within the European Research Area.

R&D results are often intangible in nature, the market orientation is minimal, and yet hopes for effective solutions to problems requiring high skills are high.

Results of research in information and communication technologies are still mainly applied by foreign companies.

4.3 Opportunities

One opportunity is the development of a technical area which is promising for the Czech Republic and creates potential economic benefits.

Information and communication technologies create high added value, which can be attributed to the high share of services such as high-skilled labour.

Research and development in information and communication technologies makes it possible, on the one hand, to create close links between research institutes and businesses, and, on the other hand, provides space for the emergence of small spin-offs.

4.4 Risks

The Czech Republic does not have the capacity to take on a leading role in the primary sectors of information and communication technologies. If, however, it does not take adequate measures in information research, it will not be able to keep pace even with secondary and niche fields. Research should focus on areas with high potential for innovation, growth and the commercial application of results.

If the Czech Republic does not increase the application of information and communication technologies in the production and products of domestic companies, other sectors will also start lagging behind in the long term.

4.5 Preparedness of the user community

The user community in the Czech Republic is adequately prepared to absorb and use research results. This claim is supported by the tradition of quality technical education. Experience in the field of computers and mobile phones shows that the new generation was able to fully absorb and make sophisticated use of pioneering modern information and communication technologies.

5. The situation abroad

In the field of information technology, there are three main centres: the US, Asia and Europe. Thanks to its powerful and the financial impact, the US plays the dominant role in the development of information technology; the share of Europe and Asia in innovation solutions is growing – in the case of Asia this is often through the transfer of production from the US to Asia. The management of European research is focused on the continuous and sustainable development of society and improving the quality of life. Information technologies play a decisive role in both these areas.

Current research trends abroad can be characterized by the convergence of computer science, cognitive science, communication and management. Large systems and networks with built-in intelligence on the one hand and aspects of interaction between different subsystems on the other are being examined. The research is motivated by the increased demands on security (data security, traffic safety), quality (health care, production) and the all-around reliability of systems, products and services.

6. Czech conditions

6.1 Preparedness

While the major non-European economies are taking the lead in the primary ICT sectors (personal computers, commercial electronics, etc.), the Czech Republic, like other European countries, is well placed for success in the secondary and niche sectors in particular. The Czech Republic has a solid grounding in basic and applied research in modelling and the management of complex systems, the security of information and communication networks and knowledge-oriented and information systems. These sectors are at levels comparable to the standard reported by developed countries.

Generally speaking, with systematic and well-targeted support of research in this field, the Czech Republic is capable of securing sufficient potential for skilled human resources. However, R&D support needs to be increased from public sources and, especially, from private sources.

Financial support for R&D from the public purse is not only low, but also poorly channelled. It does not encourage research centres to find commercial applications for their results. However, in information and communication technologies, support from public sources carries a strong multiplier effect because these technologies affect a large number of products and services.

R&D potential in the Czech Republic is not yet able to integrate into strong, efficient teams and groups, including international cooperation within the European Research Area. R&D results are often

intangible in nature, the market orientation is minimal, and yet hopes for effective solutions to problems requiring high skills are high.

In order to participate in Europe's major projects, it is necessary to improve the coordination of domestic centres. The work of existing centres should be coordinated within larger units, which are long-term holders of knowledge covering highly interdisciplinary issues. The industrial sphere will be able to turn more easily to these coordinated centres to seek mutual cooperation. At the same time, space will be created for the investment and pooling of public and private funding for research.

From the perspective of the commercial sector, universities and academic institutions act as producers of intellectual property which is available for further commercial application. Therefore it is necessary to create an environment for the emergence of small spin-offs and their support, e.g. funds and rules for the subsidized rental of office space. Another important aspect of research and development funding from the private sector is the innovation of legislation in the field of intellectual property.

6.2 Use

The greatest economic benefit can be expected in technical fields focusing on the needs of individual ministries, specifically in the development of information technologies for industry and commerce, government, the safety of surface and air transport, health care, territorial data management, education and the entry of firms onto the market in software and corresponding services.

Current trends indicate that the manufacturing sector and other users have the opportunity to use all the thematic areas that characterize the intentions of an information society. The cost of transferring and applying the results will be covered by private and foreign sources and can reach twice the funds invested in research.

7. Expected results

Significantly greater use of information and communication technologies offers

- increased comfort in the management of complex technical systems;
- increased security;
- improved quality of life;
- strengthening of the competitiveness of industry (computer-aided technology, product lifecycle management);
- economic benefits in many areas (e-business, e-government, e-safety, e-health, e-learning, GIS);

Examples of the use of information and communication technologies include the following products and services.

Safe means of transport: Increase in the safety of traffic and a substantial reduction in fatalities. Unmanned air transport over small distances, which will be appropriate for the transportation of products, during rescue operations, during the surveillance of inhospitable terrain or in the protection of national borders.

Multilingual translator: The enlarged European Union speaks many languages. Information technology will help to develop multilingual translators to overcome communication barriers between Member States.

Service robots: The European population is ageing and healthcare costs burden the economy. The development of service robots is projected in order to broaden the ability of seniors to perform common tasks and improve their living standard.

Reliable computer: Malfunctions are a common phenomenon in complex information systems. Computer systems with much greater reliability will be developed, which will be equipped with the ability to recognize malfunctions and, where possible, fix them.

Internet police: The development of the Internet is hampered by cybercrime and the socially inappropriate behaviour of certain users (viruses, spam). The security of Internet services will be restored by a system for the automatic verification of addresses and users.

Disease simulator: A computer platform which simulates the course of a specific disease, allowing doctors to test drugs and reduce the risk undertaken by the patient. This will help accelerate research into dangerous diseases, such as cancer and heart attacks.

Expanded personal memory: Information technology will make it possible to store every picture seen, every conversation had, and every book read. Digital diaries of personal experiences will automatically organize information and answer questions.

Communication suit: Most objects at home, at work and in public spaces will be equipped with wireless communication capabilities. A special jacket equipped with sensors will enable individuals to use these information sources.

Smart retail: Information technology can be used to build smart department stores where customers will look for individual products (equipped with a chip) via a mobile terminal.

8. Benefits

The effective application of information technology and the availability of electronic services is a prerequisite for the involvement of the Czech Republic in the process of creating a global information society which will ensure an adequate level and quality of services for citizens in everyday life. The level and quality of services will be an indicator of the success of support for R&D in information technology.

Support for R&D in information technology will be reflected especially in

- improved quality of life;
- direct economic benefits in many areas (e-business, e-government, e-safety, e-health, e-learning);
- the strengthening of the competitiveness of industry, productivity growth, improvements in the quality of products and services;
- the emergence of new market opportunities for small and medium-sized enterprises of a research and development, manufacturing and service nature;
- the streamlining of communication and cooperation through new broadband communication services;
- help and support for elderly and disabled persons;
- a reduction in healthcare costs and improvements in healthcare quality, increase in the productivity of the health system in the Czech Republic;
- the creation of economic, ecological and safe transport infrastructure;
- increased security;
- improvements in environmental protection (the effective detection of pollution and other negative changes);
- an increase in the efficiency of rescue and humanitarian operations.

9. Financial resources

In 2007, research into information technology was supported by public funds in excess of GCZK 1.25, of which MCZK 697 in the form of research projects, MCZK 316 in the form of national applied research projects, and MCZK 232 in the form of EU projects. Support for basic research through the CSF and individual ministries should be added to this. Therefore, targeted financing accounts for about 85% of institutional funding. Private entities invest an estimated GCZK 1 in R&D.

The main beneficiaries of public funds for the research of information technology are public universities (70%), public research institutions (13%), consortia (11%), private institutions (5%) and

government authorities (1%). By sector, support is distributed among the groups Industry (57%), Informatics (28%) and Physics and Mathematics (15%).

This distribution is healthy and indicative of the existence of a diversified research base in the Czech Republic. To achieve the stated objectives, it is therefore not necessary to establish new centres on a broad scale; rather, existing R&D centres should be interlinked into larger units which will be long-term holders of knowledge in a sector or group of sectors, and these, through the appropriate routing of financial support from the public purse, will encourage the search for the commercial application of results. The industrial sphere will then turn to them for advice and research assistance, thus creating room for investment and the pooling of public and private funding for research. The quality assistance of domestic centres is also required for participation in major European projects.

The share of the ICT sector in public expenditure on R&D in the Czech Republic is only about 5%, which is low in comparison with the European Union, where support for this sector of research and development via the FP7 – albeit somewhat more broadly conceived – amounts to 25%; in the US it exceeds 30%.

To cover all these thematic areas and achieve the objectives of the Information Society, it is necessary to gradually increase support for applied research from public resources so that in 2015 it comes to twice the current situation. It is recommended to use 80% of funds to support projects larger than MCZK 10, of which at least three more than MCZK 30. The pace of growth should also continue beyond this year. Building on support from public sources, it would be useful to increase the share of private funding in applied research so that, in line with the Lisbon strategy, it gradually outweighs the expenditure of both institutional and special-purpose public funds.

The area of information and communication technologies is a priority for the EU and it is desirable for it to become one of the priorities of the Czech Republic. At the same time, it is clear that neither the Czech Republic nor the EU will survive without transatlantic cooperation.

Security and Defence

Summary

One of the fundamental roles of the State is to guarantee the safety of citizens and create conditions significantly reducing security threats. The importance of the economic development of the State, its social stability, arrangements for the development of democracy and the protection of human rights is also rising.

The level of security of the Czech Republic and its citizens depends on the State's ability achieve a knowledge-based technical and technological level enabling it to acquire and develop the necessary specific skills. It will also depend on the Czech Republic's ability to develop its priorities within the scope of the security structures of democratic states and adequately respond to the increasing competitive pressures in a globalizing world. The security challenges we face are increasingly complex and our ability to deal with them will be significantly influenced by the sophistication of our approaches to the exploitation of possibilities and opportunities offered by security and defence research and development in the Czech Republic.

R&D security and defence R&D in the Czech Republic must therefore deliver new knowledge, products, technologies and services that will increase the State's readiness to prevent and respond to threats and to clear up the consequences. It must be viewed as a system integrated solution of specific research support and an integral part of the State's security system and security policy. The priority focus of R&D will comprise the minimization of security threats and their consequences, in particular those resulting from possible environmental changes, demographic development, economic development, raw material and energy resources, science and technological development, cyber security, terrorism and organized crime.

The Czech Republic has highly skilled teams with practical experience gained from participation in foreign missions and in extensive international cooperation within NATO, EU, Interpol and other structures. There is therefore a sound foundation to achieve the stated objectives. At the Academy of Sciences, the Ministry of the Interior, the Ministry of Defence, the Ministry of Justice, the State Office for Nuclear Safety, the Czech Mining Office, civilian universities, research institutions and interested business entities, there is a strong research background with a focus on the security aspects of virtually all areas of society.

The results of R&D in security and defence will be applied in practice through new knowledge, technologies, technical and technological processes, prototypes of new products, proprietary software, new methods and methodologies, expert analysis and conceptual work, draft legislation, studies and analyses, and publishing activities either at home or abroad.

The users of R&D results in the field of security and defence will be institutions of central and regional government, components of the Czech Security System, security forces and businesses involved in providing security and defence, the professional public and, from the perspective of self-protection, the population of the Czech Republic.

The financial resources spent on security and defence R&D should be regarded as a fundamental contribution to increasing the level of the Czech Republic's preparedness to handle crisis situations of a military and non-military nature. "***Security in the field of public health and the biological protection of the population is the responsibility of the Ministry of Health, along with the security provided by the emergency medical system***."

Responsibility for security research rests with the Ministry of the Interior, which carries out the research in close coordination with the Ministry of Defence. Security in the

field of public health and the biological protection of the population is the responsibility of the Ministry of Health, along with the security provided by the emergency medical system.

Programmes implementing this priority were approved by Government Resolution No 49 of 12 January 2009 on the cross-sectional programme of Security Research for the Needs of the State from 2010 to 2015, and Government Resolution No 50 of 12 January 2009 on the Security Research Programme in the Czech Republic between 2010 and 2015.

1. Characteristics

Security and defence is viewed as a desirable situation minimizing the risks arising from threats to the population, sovereignty and territorial integrity, the democratic order and the principles of the rule of law, internal order, property, the environment, compliance with international security obligations and other defined interests.

The importance of the economic development of the State, its social stability, arrangements for the development of democracy and the protection of human rights is also rising. Security research is defined in the EU as a set of research activities aimed at the identification, prevention, preparation and protection against illegal acts or conduct intentionally detrimental to the European Community, citizens of EU Member States, organizations or structures, tangible and intangible assets and infrastructure, including the mitigation of consequences and operational continuity after such conduct. In the Czech Republic, security and defence R&D is seen as a process aimed at achieving a knowledge, technical and technological level allowing the Czech Republic to obtain, acquire, maintain and develop the specific skills needed to ensure the security and defence of the State and its people.

Security and defence R&D has a strong interdisciplinary nature and necessarily affects a wide range of technical, natural, medical and social sciences related to the enduring security and protection of the State and its people. They require the creation of a pro-innovation environment facilitating the efficient, effective and rapid acquisition, transfer and practical use of knowledge and modern technology.

2. Objectives

The long-term basic and strategic objective is to achieve a knowledge, technical and technological level allowing the Czech Republic to obtain, acquire, maintain and develop the specific skills needed to ensure the security and defence of the State and its people as a necessary condition for the sustainable development of society. Specifically, this objective encompasses:

- the development and updating of the Czech Republic’s response strategy for the security situation in Europe, characterized by dynamic changes, in particular by a reduction in the threat of military aggression and the increased importance of asymmetric threats, the negative impact of which on society continues to grow. The priority will focus particularly on changes to the environment, demographic development, economic development, sources of raw materials and energy, society and culture, including the creation of a framework for the relevant interdisciplinary science;
- the development of methods for prediction and subsequent preparation of scenarios with a preference for possible alternatives regarding the future development of security in the Czech Republic and the corresponding responses;
- the development of key skills and technologies for military expeditionary operations;

- the development and updating of an operating strategy to ensure the country's internal security, respecting the interaction between a wide spectrum of political, economic and security tools;
- a specification of the Czech Republic's priorities to create a system of internal EU security;
- an increase in security, the strengthening of principles for the protection of society and critical infrastructures; a reduction in the risk of attacks on critical infrastructure facilities and improvements in their security, focusing mainly on the fields of energy, water and waste management, agriculture and food, health care, transport, communication and information systems, the banking and financial sector, emergency services and public administration;
- develop distributed systems of automatic control to ensure the security of communications, coordination and cooperation between subsystems;
- develop crisis management, with a preference for preparedness, prevention, response and recovery; early warning systems; civil-military cooperation and civil emergency planning; communications with the public and modern methods of intervention training; information aspects of monitoring and prediction; analysis of the components of risk (predictions of a disastrous natural phenomenon, its probability and its consequences), the development of their observations, including estimates of uncertainties;
- develop and apply technologies facilitating the automated acquisition of knowledge from large amounts of available data and their further use in decision-making, management and diagnostics in the wide range of State defence and security;
- improve the quality of territorial data with the use of a new generation of geoinformation systems and apply them effectively for the benefit of the security and defence of the State and its people;
- improvements in the Czech police's capacity to fight terrorism and organized crime;
- an increased level of security for cities and municipalities in the event of natural disasters or operating accidents, and in case of adverse sociopathological phenomena;
- the striking of a balance between taking measures to protect citizens and respecting the Charter of Human Rights and Freedoms;
- the development of technologies, methods and practices to raise the level of situational preparedness with a preference for knowledge and technology to support information pooling, international cooperation in the field of data sources, intelligence surveillance and safe and reliable communication between law enforcement agencies and security forces;
- the development of technologies, methods and procedures to increase the level of identification of people and resources with a preference for modern methods of education and training; modern methods of information classification and biometric identification;
- the development of methods, procedures and the application of new technologies to increase the level of cyber security in systems related to the security and defence of the State and its people;
- the development and optimization of specific methods, laboratory techniques, diagnostic tests and methods for increasing the level of resources and services ensuring the protection of people, property and the environment in crisis situations, with particular focus on the evaluation of the radiological, chemical and biological situation in the use of chemical, biological or radioactive substances, nuclear materials and explosives; detection, characterization and identification;

- an increase in the effectiveness of planning, organizational, supervisory, technical, technological and other processes related to the stability of the State's economic and financial system;
- an increase in the effectiveness of measures and procedures to optimize the state of civil resources ensuring the security of the Czech Republic, especially in relation to new needs and the possibilities of their saturation;
- an increase in the effectiveness, standardization and optimization of the basic structures of security planning;
- an increase in the effectiveness of measures and procedures related to legislative preparedness to ensure the security and defence of the Czech Republic.

3. Reasons and criteria serving as a basis for the proposal of the applied R&D priority

Since the beginning of the 21st century, the Czech Republic has faced new security threats, the scope of which will further intensify. These are mainly environmental threats (drinking water, food sources, etc.), natural disasters and technological disasters, socio-economic threats (extreme poverty, the growth of nationalism, fundamentalism), terrorism, organized crime, the potential proliferation of weapons of mass destruction (especially in developing countries), regional conflicts, threats to information security and the vulnerability of financial markets. These threats and their possible elimination, but mainly their prevention, raise the need for specific, carefully coordinated research support as an integral part of the Security System of the Czech Republic.

The Security System of the Czech Republic is viewed as an integrated interface of four basic security subsystems (internal State security, civil emergency planning, the stability of the State's economic and financial system, the defence and external security of the State). The following can be regarded as priorities:

- in the subsystem of internal State security, a focus on the issue of the uncontrollable migration of people, immigration waves, a sharp rise in crime, the growth of organized crime, terrorism (including cyber terrorism), the escalation of the political, economic and social situation in the State, the proliferation of attacks on the constitutional establishment, racial, religious or civil unrest;
- in the subsystem of civil emergency planning, a focus on the planning and management of crises entailing threats to the life and health of the population, the degradation of the environment, property and cultural values in relation to threats to the external or internal security of the State, natural disasters and anthropogenic emergencies, crisis management and long-term solutions to the negative impacts of economic and social globalization;
- in the subsystem of the protection of the stability of State's economic and financial system, a focus on the threat of large-scale shortfalls in the functioning of the State's economy or its production capacity, currency destabilization, large-scale disregard for customs and exchange regulations, the threat of an embargo on imports of essential raw materials;
- in the subsystem of the defence and external security of the State, a focus on issues related to aggression or the threat of aggression by foreign powers, problems related to drawing, or the threat of drawing, the Czech Republic into local or regional military conflict and the consequences of participating in the peacekeeping operations of international organizations, or problems arising from the performance of contractual obligations in favour of allies which are associated with the deployment of security and rescue forces, civilian humanitarian and development missions.

Criteria for the focus of research and development in security and defence include:

- possible measures to increase the level of security and defence for the Czech Republic and its people, including benefits for the economy, its competitiveness and the sustainable development of society,
- compliance with the draft of the revised Security Strategy of the Czech Republic,
- improvements in the legislative process and the formulation of ideas to speed up the adaptation of the Czech Republic's security and defence to European integration processes,
- effective reinforcement of citizens' sense of safety and security, their confidence in the security and rescue services, the guarantee of their civil rights, the positive formation of a socio-political climate,
- increases in the level of preparedness of security and rescue forces,
- analysis of the actual effectiveness of security and defence policy,
- the formulation of recommendations for the creation of control, repressive and preventive measures in case of naturogenic and anthropogenic events,
- the use of the systemic cooperation and collaboration of various institutions (research centres in the competence of central government agencies, universities, the research establishments of businesses, etc.) participating in the security and defence of citizens,
- the creation and acquisition of knowledge, documentation and tools for conceptual, methodological and decision-making activities in the exercise of state administration, with a focus on improving State security, especially in the fields of crisis management, civil emergency planning, public protection, the integrated rescue system, fire protection and the performance of police services in exposed areas,
- the requirements for the active involvement of Czech research capacity in the European Research Area focused on security and defence, the safeguarding of continuity with security research conducted within the EU and NATO, with full respect for the Czech Republic's specific situation,
- the possibility of eliminating the gravest threats to the basic functions of the State, critical infrastructure, the protection of lives, health and property of the Czech population, in the event of military or non-military crisis situations,
- the status and expected near-term development of the Czech base for security research (respect for the real possibilities and conditions of this base).

Analysis of security threats and the resulting risks shows the need for the comprehensive provision and management of the security of the State and the protection of its people. It is therefore desirable to develop long-term security and defence R&D in the Czech Republic in order to be able to produce ideas and technologies to maintain and improve the security of the Czech Republic; to produce an analysis of needs and opportunities by creating tools to facilitate the use of opportunities which arise; to produce concepts and demonstrate their viability; to propose and define new specific skills needed to ensure the security of the State and its people; to ensure the transfer of knowledge into practice; to influence the acquisition process; to create a basis for the subsequent development of technologies affecting State security; to affect consulting; to support systems and technologies implemented within the security system of the Czech Republic; to support decision-making processes; to be an essential factor in maintaining the knowledge, technical and technological base within the security system of the Czech Republic; to eliminate possible technical and technological surprises and to ensure technological innovations.

Security and defence R&D can be developed separately, but both areas should be coordinated in mutually consistent way in order to avoid unnecessary duplication. Close

cooperation in the coordination of the content of research is also necessary in terms of sharing the results at both national and international level.

4. SWOT analysis

4.1 Strengths

Framework compliance has been identified in the focus of the main security priorities of the Czech Republic's national strategy and the strategies of the EU and NATO.

At universities in the competence of the Ministry of Defence and the Ministry of the Interior, there are highly skilled teams with practical experience gained from participation in foreign missions and in extensive international cooperation within the NATO, Interpol and other structures. Particularly good results have been achieved in the areas of CBRNE detection and protection against them, active and passive sensors, the analysis and identification of hazardous substances, electronic warfare, forensic science and criminology, disaster medicine and military medicine.

At the Academy of Sciences, the Ministry of the Interior, the Ministry of Defence, the State Office for Nuclear Safety, civilian universities, research institutions and interested business entities, there is a research background with a focus on the security aspects of virtually all areas of society.

Security and defence R&D may be advantageously used to interact with a number of scientific disciplines and, in this sense, stimulate research activities in general and thus the economic situation in the public sector and the economic prosperity of the country.

Cooperation with agencies involved in the Czech Republic's security and defence research is gradually developing.

In view of the stated objectives, in the Czech Republic there are good conditions for the implementation of new knowledge in this area; in particular, there is a relatively well-prepared user community able to absorb and use this knowledge, including both the public and private sector, encompassing producers, services and end users.

4.2 Weaknesses

A comprehensive approach to security and defence R&D is being successfully promoted only in certain areas, particularly in crisis management, civil emergency planning and the application of modern technologies for the detection, monitoring and evaluation of chemical, biological and radioactive substances.

Security and defence R&D is not paid sufficient attention by the authorities responsible for defence and security and for the defence of the State and its citizens.

Mutual cooperation, support and communication between relevant departments and institutions involved in the security and defence of the State and its people is still limited by departmental interests in many cases. However, the coordination of basic and applied R&D, academic, school, ministerial and business entities is essential.

In the Czech Republic, the structure for the management and coordination of security and defence R&D (in particular its information and communication support) is not sufficiently developed.

Within the EU and NATO, security and defence R&D is developed to a high level and is a high priority; the Czech Republic is not yet an equal partner to the developed Member States of the EU and NATO. This is reflected in a reluctance to participate and in the poor success rate of Czech entities in obtaining support from international R&D programmes.

The research and development base is not convinced of the profitability of private investment, leading to low involvement in the co-financing of R&D.

4.3 Opportunities

Support for security and defence R&D creates good opportunities for the application of a number of disciplines in the field of technical, natural and social sciences and for close cooperation between the public and private sectors.

Stimulation of the emergence of a market in security and defence technology with a supply and a demand side. Consolidation of a research and development base capable of responding to user requirements.

Security and defence R&D can become part of the economic, technical and organizational stimulation of the public sector in the field of R&D, with the involvement and collaboration of research and development institutions, universities and interested businesses.

The incorporation of elements of security management into the decision-making processes of public administration and businesses creates space for the elimination of the simplified understanding of the security and defence of modern society.

For universities, research institutions and interested businesses, security and defence R&D is clearly a challenge, as well as a potential practical output and appreciation of their research activities.

Deepening the prestige of the armed forces, security and rescue forces in society; security and defence R&D emphasizes the importance of all processes related to the security and defence of the State and its people.

4.4 Risks

Inadequate specification of possible threats to security and defence, lack of flexibility in responding to as yet unexpected threats.

Security research is still viewed as “defence” (“military”) research focusing on the technical aspects of the management and handling of emergency situations.

Underestimation of the socio-psychological aspects of security research.

Failure to appreciate the needs of effective management in view of the dynamics, complexity and broad nature of issues related to security and defence R&D.

The achievement of stated objectives depends on the equilibrium of human, material, economic and other resources.

5. The situation abroad

Abroad, the issue of security research has received significant attention for many years in connection with terrorist acts on the territory of Member States of the EU and NATO (the

USA in 2001, Spain in 2004, the United Kingdom in 2005) and in relation to other security threats around the world. This is directly reflected in the EU Security Strategy.

The research base is seen as a decisive factor in the level of attainment of society and a determining factor for further development; one of the fundamental functions of the State is considered to be the safeguarding of State security and the defence and protection of the population in crisis situations. The European Security Strategy and targeted studies show that the greatest fears of EU citizens are terrorism, organized crime and natural disasters. Current security threats reflect the conflict between the increasingly globalized world and the deteriorating environmental situation.

A characteristic feature of the new security threats lies in the dynamism of their creation and interconnectivity. Most of the current major threats do not require a traditional military response, but the implementation of integrated crisis management systems and their related systems of rescue, medical, social, psychological and other services. In the long term, research activities in the field of security have focused more on the technical aspects of security and problems of a military nature. Economic globalization, environmental changes and changes in the political environment in the world have generally created a situation which highlights the need for effective, efficient, coordinated and comprehensive security research. The European Security Research Programme 2004–2006, implemented with a view to strengthening the EU's security, reviving Europe's competitiveness and creating a bridge between civil and defence research, was a response to this situation. The EU's Seventh Framework Research Programme 2007–2013 also responds to these challenges.

This framework programme is based on the assumption that the security issue is highly topical and EU Member States should be better prepared to deal with new security threats. The current EU Security Strategy identifies the following as security research guidelines:

- protection against terrorism and crime – the provision of technology solutions for the detection, prevention, identification, protection, neutralization and containment of the effects of terrorist attacks (the abuse of CBRN resources is highlighted) and crime;
- the security of infrastructure and critical public services;
- border security – a focus on technologies and the ability to increase the efficiency and effectiveness of all systems, equipment, tools, processes required to improve the security of Europe's land, air and coastal borders, including the appropriate level of control and surveillance of borders;
- the restoration of security in a crisis – a focus on technologies and processes to support the activities necessary to deal with crisis situations and to clear up their consequences, issues of coordination and communication among the responsible institutions and issues of the impact of the human factor and architecture of the crisis management system.

6. Czech conditions

6.1 Preparedness

An adequate level of security for the Czech Republic and its citizens can only be achieved if this area is systematically and comprehensively coordinated long term nationally and internationally, if it is handled at the necessary technical and technological level, and if it is capable of acquiring, absorbing and developing the necessary knowledge and skills.

The Czech Republic is involved in EU and NATO structures related to security and defence at all levels.

Support earmarked for security and defence R&D creates an acceptable starting point for the progressive development of that area.

The security threats that need to be tackled are increasingly complex and our ability to deal with them will be significantly influenced by the sophistication of our approaches to the exploitation of possibilities and opportunities that must be provided by security and defence R&D. Investment in security and defence R&D should be seen as an essential contribution not only in increasing the Czech Republic's level of preparedness to deal with crisis situations of a military and non-military nature, but also as a strategic contribution to the long-term improvement of industrial competitiveness and the strengthening of the research and technological base of the Czech Republic. Several research teams and research organizations are well placed to succeed in the international competitive environment.

In order to achieve a high degree of preparedness in the Czech Republic to address the security of the State and its people, security and defence R&D will be built and developed as:

- part of the international Euro-Atlantic security environment and national environment with the research, development and information support of ministries crucial for the security and defence of the State and its people;
- a system with a comprehensive approach to the development of security and defence R&D;
- a system coordinating and guiding basic and applied R&D institutions towards identified priorities and research issues regarding the security and defence of the State and its people not covered elsewhere, tapping the broad research potential of governmental and nongovernmental organizations in the Czech Republic;
- a system consistently drawing on already created and globally available knowledge, especially knowledge gained through international cooperation and the exchange of scientific and technical information at EU and NATO level and at the bilateral level of Member States.

The Czech Republic's research capacity has the potential to address projects in the fields of the prediction, analysis and identification of security threats and risks, crisis management, civil emergency planning, critical infrastructure, the protection of the population, the integrated rescue system, radiation and nuclear safety, forensic science, criminology, the security of the mining of strategic materials, and fire science, in particular:

- in the protection of individuals – methods and means of protection in case of the use of weapons of mass destruction; legislative, organizational and technical measures for effective protection against and resistance to weapons of mass destruction, new principles and methods for the development of resources, materials and technology in case of the use of WMD, CBRNE resources;
- in the field of terrorism and organized crime – ensuring an adequate level of security of the State and its people, focusing in particular on the possible misuse of chemical, biological and radiological substances and nuclear materials; streamlining the framework of information exchange and pooling among those entities involved in the fight against terrorism and organized crime; permanent improvements in the relevant technological and methodological practices in this field;
- in the fight against cyber crime – an effective method of cooperation, information exchange and sharing in the fight against information crime at national and transnational levels; computer network resistance to cyber attacks;

- in the fight against corruption – improvements in communication between public authorities, the public and nongovernmental organizations, the limiting of opportunities for corruption, methods for identifying the negative impact of corruption on society, the economy and the environment;
- in issues of social and humanitarian threats – health care under field conditions and on foreign missions, the behavioural risk of people and society in emergency situations (crime, aggression, loss of moral values, lack of ideals, etc.); social and psychological aspects of measures to protect people and society when clearing up after a crisis; optimization of these measures, taking into account the psychological and social factors (the price of human life).

Based on the above facts, there are good preconditions for a comprehensive, centrally coordinated system, and the formulation of comprehensive security and defence R&D programmes allowing the Czech Republic to obtain, acquire, maintain and develop the specific skills needed to ensure the security and defence of the State and its people under changing conditions with efficient use of available resources.

6.2 Use

One of the fundamental roles of the State is to guarantee the security and defence of citizens and create conditions significantly reducing security threats. The basic philosophy of the new R&D policy in security and defence is to create a comprehensive system that can integrate national interests with international approaches.

The benefits of raising the level of security and defence of a State and its citizens are not generally measurable, but the results will be compared with the R&D Council's Methodology for the Assessment of R&D Results.

Security and defence R&D will also support the development of other fields of research, the findings of which will be increasingly applied in practice. Priorities will be not only the development and application of knowledge of technical and natural sciences, but also (and increasingly) the development and application of knowledge of social sciences prioritizing an interest in the behaviour of people in crisis situations and the ways this can be influenced. In this sense, it can become a stimulus for research in general and thus spur on the country's economic prosperity.

The users of R&D results in the field of security and defence will be institutions of central and regional government, components of the Czech security system, security forces and businesses involved in providing security and defence, increases in the protection of values, the professional public and, from the perspective of self-protection, the population of the Czech Republic. From the perspective of future use, support for security and defence R&D in the field of dual use should be prioritized. An emphasis will be placed on ensuring that security and defence R&D projects meet the required capabilities of the security, rescue and defence units. The results of applied security and defence R&D projects must be understandable and usable by the customers who requested them, or must create conditions for subsequent development or innovation. Subsequent acquisition by the contracting authority must be the follow-up to projects to award public development and innovation contracts.

The business community in general, and the business community engaged in production in particular, is relatively well prepared and capable of absorbing and using new security research findings.

7. Expected results

Security and defence R&D will help expand and firm up the future Security Strategies of the Czech Republic. It will be based on an analysis of the current situation and the effectiveness of processes under the security system of the Czech Republic and democratic countries in an environment of rapidly changing needs; it will form technical, technological, organizational, legislative and other prerequisites for successful their implementation. Security and Defence R&D will also contribute to a better understanding of risks and the complex phenomena associated with them; it will create tools, technologies and methods of crisis management, enhance the effectiveness of the system to prepare the population for crisis situations, and will create an optimized profile of the required competencies and capabilities.

The results of R&D in security and defence will be applied in practice through methods and methodologies, expert analysis and conceptual work, draft legislation, prototypes, new technical and technological processes, proprietary software, publishing activities in the Czech Republic and abroad, textbooks, teaching texts and syllabi, instructional and educational films.

In the longer term it will contribute to:

- the introduction of new technologies and solutions related to the provision of the system's operational capacity to carry out rescue and relief work and other measures to deal with crisis situations, the ability to react to threats,
- support for the developing market in advanced security and defence technologies.
  R&D results in security and defence will also be reflected in the outcomes of implementation and the further development of collaborative technical and other scientific disciplines.

8. Benefits

The benefits of R&D in this area are that it ensures and improves the quality of the required level of security and defence of the State and its citizens. Effective security and defence R&D creates space for the Czech Republic's involvement in the process of forming a safe society in the EU. The results of security and defence R&D are used to prepare alternative scenarios in response to real and potential threats.

The results also raise the quality of life and the environment, the level, quality and efficiency of rescue and humanitarian operations, create new opportunities for small and medium-sized businesses and generate new employment opportunities.

Another significant benefit is the fact that to achieve the stated goals it is not necessary to establish set up new centres on a large scale; rather, the existing R&D centres involved should be integrated into larger units and problem-solving teams and consortia, which will be long-term carriers of knowledge and progress in the field, and with the appropriate routing of financial support from the public purse these entities should be encouraged to make further commercial use of the results.

Measures of the success of programmes and projects related to security and defence R&D must include the application of results on the market in products, technologies, services and knowledge. Setting indicators in the field of security and defence is a serious problem that has also been encountered abroad. The necessary studies will be carried out under conceptual

security and defence research documents (research into the situation abroad, indicators proposed for the Czech Republic). Indicators of qualitative and quantified effects of R&D include, in particular:

- the transfer of knowledge and R&D results into practice,
- the continuity of research activities in the field of security and defence with the tasks arising from the Czech Republic's status as a member of the EU and other international organizations,
- improvements in the Czech legal system, improvements in the legislative process, the achievement of the greater efficiency of legal institutions and their harmonization with EU norms,
- the achievement of the greater preparedness and responsiveness of the Czech security system,
- the results of an annual evaluation of security and defence research based o the R&D Council's Methodology for the Assessment of R&D Results,
- evaluations of the benefits of security research for the implementation of the measures listed in the Czech Interdepartmental Concept of Security Research,
- quantification of approved participation by Czech R&D entities in international security research projects, and the foreign funds acquired.

9. Financial resources

The specific nature, significance and importance of security and defence R&D for the security of the State and its citizens requires a gradual increase in the support of the relevant R&D from public sources. This is financial support from the national budget, amounting to at least 5.07% of total government expenditure on R&D per year (of which security, in the competence of the Ministry of the Interior, 2.99%, and defence, in the competence of the Ministry of Defence, 2.08%), commencing in 2010.

A complementary source of funding for security research in the Czech Republic will be increased EU resources under the budget item "Security Research".

The transfer and use of the results of security and defence R&D in practice will also be supported by the public budgets of provinces and municipalities. To this end, the EU Structural Funds will be used, in particular through the Operational Programme "Research and Development for Innovation", as an integral part of the National Development Plan of the Czech Republic.

10. Links to other applied R&D priorities

The Security and Defence priority draws on the full range of other priority areas and extends to other areas of research and development.

Priorities for the Development of Czech Society

Summary

Characteristics

In the field of social sciences and humanities, five priority areas are proposed for applied research and development (AR&D):[1] (i) Governance, (ii) The human potential of the Czech Republic, its reproduction and development, (iii) The competitiveness of Czech society, (iv) Czech identity and the outside world, (v) Technology and methods. The priority areas incorporate synergies and overlap. Area (iv) primarily concerns the humanities and is closely linked with a concept of the MoC.[2] Area (v) mainly affects social sciences and has large-scale synergy with areas (i), (ii), and (iii).

Each of the five areas is characterized in detail in the structural specifications and describes the circumstances which are specific to the area and their relationship with other areas. Circumstances common to all the areas are set out in the structure of the initial summary and are not revisited in the descriptions of the areas. The scope of the text goes beyond the confines set by the Presidium of the R&D Council because, given the significant synergies, it interconnects areas of social sciences and humanities.

A peculiarity of AR&D in SS&H is that, unlike other fields of science, it also includes themes focused on the actual mechanisms behind the functioning of basic research (BR) and AR&D, and on the exploration of the quality of regulation in all areas where the State intervenes in spontaneous economic and social processes.

Czech conditions

The first prerequisite for the successful implementation of AR&D is that it is based on global knowledge of basic research and current needs and demand. The academic community's ability to accept knowledge and implement AR&D methods is a prerequisite for the successful implementation of AR&D. In the Czech Republic, however, AR&D quality (not only in SS&H fields) is not sufficiently credible, and has not been mapped in detail according to international standards and methodologies. Only partial analyses and simplified international comparisons are available. Very fragmentary data suggest that AR&D results in various SS&H fields generally lag behind economically more advanced countries, both in terms of quality and the scale of quality outputs.[3,4] A major hindrance here is the egalitarian distribution of resources for RDI, which does not sufficiently reflect the quality of results. The result is a lack of motivation to engage in ambitious, but high quality BR and AR&D. Priority areas (i)

[1] The planned amendment to Act No 130/2002 for the LTRG introduces the more appropriate term "Priorities of applied research, development and innovation of the Czech Republic."
[2] The interdepartmental concept of applied research and development of national and cultural identity.
[3] See Annex 3.
[4] A large number of BR outputs are reported in the Czech Republic, but quality only exists in articles published in impact journals. Extended citation analysis, which would affect the quality of professional books and articles in non-impact peer-reviewed journals, is not yet carried out.

and (v) therefore also include AR&D in assessments of the quality of RDI results on the basis of proven foreign approaches.[5]

The second prerequisite for successful AR&D implementation is the readiness of users to apply AR&D results in practice. As is explained below, the dominant users of the AR&D results in the field of SS&H are public sector institutions, including central and local government,[6] the national, regional and municipal political sphere, labour, social affairs, culture and cultural institutions, educational institutions and education, the media sphere, the public and civil institutions.[7] At present, most ministries are insufficiently aware of which types of AR&D are commonly applied in countries practising modern forms in the preparation of regulations and governance in general. Most ministries do not know how to articulate their AR&D requirements well enough. Therefore, all the priority areas, but particularly area (v), include AR&D outputs that contribute to a better understanding of the use and role of AR&D results in relation to the evidence-based[8] preparation of regulation. No ministries mediate a significant level of demand for AR&D. They are potential institutionalized users in the non-profit sector who deal with social issues which, for various reasons, are not addressed by the State. Users also include various non-institutionalized demographic groups of the population. Therefore, it is not possible to explicitly document, to any adequate degree, demand for AR&D in SS&H.

Expected results and benefits

On principle, AR&D results in SS&H mostly take the form of know-how supporting quality control and governance[9] in general, and therefore only rarely can results be measured as direct financial benefits.[10] Benefits mainly comprise public goods, fiscal savings, and, in particular, a better economic and social quality of life.[11] However, identifying causal links between the funding of AR&D, its results and ultimate benefits is methodologically very difficult. A major change in this regard is the government regulation on the need for RIA (regulation impact assessments) as a mandatory element of any new regulatory legislation. Accordingly, priority area (v) includes the development of applicable methodologies and the data base necessary for regulation impact assessments at all ministries.

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[5] Proposals for mechanisms and methodologies, including empirical scientometric analyses, which will form the basis for RDI policy.

[6] Including government institutions such as the Czech National Bank and the Office of the Government.

[7] Education (from primary school to university, or further education), labour market and social security institutions, cultural institutions (museums, galleries, libraries, theatres, philharmonic orchestra), the public sphere and media communication (development of the civil sector, regulation and self-regulation of the media, alternative media education), the public and civil institutions (non-profit and charitable societies and associations), ASCR research institutes, universities and colleges, commercial organizations, the legislative and judicial sphere, the sphere of religious and spiritual life (churches and religious societies).

[8] The preparation of legal norms, regulations and other interventions by the State and its constituents in the functioning of the economy and society, based on detailed knowledge of the functioning of processes and effectiveness of regulation applied so far.

[9] Governance

[10] E.g. sales of goods and services.

[11] Public goods are defined by different attributes: goods do not diminish in line with the number of users, private operators do not have a profit motive to offer the goods, user access to use of the goods cannot be restricted.

A number of real AR&D achievements in SS&H have not been sufficiently covered by the definitions of the Methodology for Evaluations of R&D Results, so these results are not adequately mapped.[12] Some of the empirical research in the field of SS&H in the Czech Republic is classified under BR, even though, in many countries, it is regarded as AR&D.

The annexes (5) contain observations on LTRG by several selected representatives of potential users of AR&D results. The opinion of the CNB and, to some extent, the observations of the Ministry of Education and MIT can be regarded as arguments of relatively good quality which are well supported and sufficiently specific. The observations submitted by People in Need (*Člověk v tísni*) sum up the results of discussions with its leadership.

Financial resources

When financing AR&D in SS&H, it is necessary to take into account a number of important facts:

a) Demand for AR&D was representatively mapped in the Czech Republic in the preparation of the National and Cultural Identity Programme, but the demand among numerous ministries for research in line with the needs of state administration needs to be identified and analysed; there may be a need to raise awareness. Even if ministerial demand were completely mapped, funding cannot be based solely on articulated demand, but must take into account the vital needs of the civic, political and government communities at various levels.
b) Major financing from private sources cannot be expected. This is because potential users of AR&D are predominantly public institutions and the non-profit sector, and most benefits are public goods, social benefits and positive externalities.[13] The role of public funding is therefore essential for SS&H.
c) Evidence of the low quality of Czech BR in SS&H is not sufficiently conclusive to draw sceptical or optimistic conclusions on the Czech Republic's professional capacity to engage in quality AR&D in SS&H. It should be borne in mind that the incentives to strive for excellence are planned as part of the RDI reform.
d) The need for AR&D in the upcoming period will significantly increase the Government's requirement to carry out RIA as a compulsory part of any new regulation. This agenda concerns all ministries. Research on the impact of new regulations (ex-ante, pilot and ex-post) falls under SS&H in terms of the themes covered.[14]

The data for 2007, provided by the Secretariat of the R&D Council, shows that spending on AR&D in SS&H (excluding security research) amounted to CZK 980 million, broken down as CZK 622 million (63.5%) in the form of institutional funding and CZK 357 million (36.5%) in the form of special-purpose financing. The number of results reported for AR&D in SS&H in 2006 was generally low. The Expert

[12] Results in the form of technical assistance and consultation activities, underlying studies used in the creation of a new regulation, exhibitions, etc., have not yet been fully reported.
[13] Economic theory indicates that, for the generation of goods and services of this nature, there is insufficient economic incentive among private, profit-oriented entities.
[14] Economics, operational research, law.

Commission does not have data available about the current share of funding from private sources and from the EU.

Public funding for non-commercially applied research, which applies especially in the field of SS&H, should be given greater priority than the funding of commercially (profitable) applicable AR&D. Whereas, in the latter case, public financing often entails the subsidizing of privately profitable operations, in the former case AR&D cannot take place without public financial support.

On the basis of the above facts, the SS&H EC proposes financing AR&D in priority areas (i), (ii), (iii) and (v), described below. The real purchasing power of the currency is expected to decline; this takes into account the likely learning and attenuation curve of TA programme implementation, the low share of private co-financing and a certain, hard to estimate share of funding from the EU. The projection follows the trend of a steady rise in the share of special-purpose funding, but leaves room for research organizations to adapt to higher institutional funds. It is also expected that projects will be planned to last more than one or two years, especially in the early years of the period. At the end of the period, projects receiving special-purpose funding are likely to be on the wane, and therefore they will be less resource-intensive. The budget structure comprises CZK 425 million per year, which is destined for funding under area (iv) closely interrelated with the interdepartmental concept of AR&D into national and cultural identity. The financial proposal represents an increase in funding for AR&D in the field of SS&H.

1. Governance

1.1. Characteristics

The identification, proposals and testing of new methods of governance,[15] the formation and application of the law and the adaptation of the political system and public administration to the current and future needs of Czech society in the context of globalization and European integration, based on an analysis of these processes. Unlike the old hierarchical model of public administration, based on the assumption of the absolute sovereignty of nation states, in practice a model of governance is being promoted that has multiple tiers,[16] expands participation in governance to include the private (profit and non-profit) sector, and increasingly promotes the horizontal networking of players. New governance tools are being applied (strategic governance, regulatory reform, management by objectives, decisions based on richer facts from experience, the evaluation of programmes and policy impacts, [17] cross-sectoral collaboration, new forms of communication), and the more traditional tools are suffering a crisis of adaptation. The structures and functions of the public sector and the contents of public policies are changing. The participation of citizens and experts in the political life of society is forming, the role of the media and communication in public space in general is strengthening. The identification, validation and proposals

[15] In the context of LTRG, we use the term governance, which has a more general and broader meaning than the term regulation, as used by RIA and relating to specific legislation and other government instruments.
[16] Management also takes place at European, national and regional level.
[17] Link to priority area (v).

of methods for the adaptation of governance must cope with the task of increasing the legitimacy of governance.[18]

1.2. Objectives

Based on research into the specific processes of government, the shaping of laws, the political system, public administration and mechanisms for the creation and application of public policies in the Czech Republic, formulate specific guidelines and procedures for optimizing these processes, including procedures for the optimal application of the Czech Republic's interests in the creation and implementation of European law and specific management tools, and the formation and implementation of common EU policies.

1.3. Reasons and criteria serving as a basis for the proposal of the applied R&D priority

International comparisons show that the capacity and quality of governance in the Czech Republic is not satisfactory.[19] Government deficits cause extensive, often irreplaceable, social and economic losses.[20]

1.4. SWOT analysis

1.4.a. Strengths: after 1989, many new or revived SS&H disciplines and departments with this area of specialization emerged, which forged collaborative links with top foreign institutions.

1.4.b. Weaknesses:

- low capacity, fragmentation and lack of coordination of AR&D,
- lack of readiness to offer optimization suggestions to potential users.

1.4.c. Opportunities:

- the achievement of results in governance and public administration at the same level of output as leading centres in the EU, permanent cooperation with users,
- increased effectiveness of governance in the Czech Republic,
- improved perception of the Czech Republic and better application of its interests in the EU.

1.4.d. Risks:

- lack of support for this priority area in the initial phase of capacity building (institutions, teams),
- low conceptual and methodological skills among the contracting organizations.

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[18] See the results of a poll of Czech citizens on their trust in various professional groups and their usefulness.

[19] See the Czech Republic's status compared with the EU-15 and EU-27 according to governance indicators.

[20] Delays in decision-making, bad decisions, disregard for emerging new problems, the ignoring of potential threats or the failure to exploit development opportunities significantly reduce the overall efficiency of the management of social processes. This area of applied social-science research has really only received marginal attention from contracting entities and research institutions.

1.4.e Preparedness of the user community: Workers from the user community will be systematically educated so that they are ready to implement the results of AR&D. In addition to specific training programmes,[21] users will be directly involved in the handling of applied tasks. Conversely, researchers will be involved in the practical implementation of the relevant proposals.

1.5. The situation abroad

Although developed countries differ in the level of development of their research into these issues, it is noted that the Czech Republic is lagging behind them by at least two decades.[22]

1.6. Czech conditions

1.6.a Preparedness: The existing structure of the centres, their professional standards and participation in international research networks indicate that the quality of output will be high, provided that, in the initial phase of support, adequate capacities are built.

1.6.b Use: Examples of countries such as Holland, the UK and Finland show that close cooperation between public institutions and SS&H AR&D leads to the extraordinary streamlining of governance. In the Czech Republic, it would be expedient to train user community representatives in the possibilities and ways of using the results of AR&D.

1.7. Expected results

AR&D offers social and economic users specific, effective instructions on how to improve the quality of regulation and on the more efficient involvement of the Czech Republic in European integration processes.[23]

This means:

- the creation of the knowledge base necessary to realize the Governance objectives,
- the concentration of users' knowledge and skills, facilitating better regulation,
- improvements in regulation as a prerequisite for improving the quality of processes in economic, political and cultural life in the Czech Republic and the strengthening of the country's international position.
- The basic types of outputs will be:

[21] Programmes offered by universities in particular.

[22] The US is at the forefront of exploring the processes behind the formation and implementation of governance, public policy and administration; besides the analyses of the political system, law and public administration, developed West European countries have developed the study of the processes of European integration and European governance, in both cases with significant positive effects that have improved governance.

[23] If practical guidelines formulated for this priority area are implemented properly and on time, this will be reflected in a rapid improvement in governance, with other long-term positive effects in the order of decades. This will, in turn, translate into a positive shift in the results of public opinion polls and in the improving position of the Czech Republic in international comparisons. For the current unfavourable situation, see Annexes 1 and 2.

- the formulation of specific instructions, methodologies, tools and innovations in governance and the more effective involvement of the Czech Republic in the processes of European integration,[24]
- expertise and methodologies for the public and political sphere (e.g. methodology for evaluating RDI results), methodical publications in the vein of "Best Practice Guide" and "Policy Brief",
- educational and teaching programmes for politicians, officials and representatives of civil society, based on the results of application-oriented research, including manuals and other teaching aids,
- presentations, exhibitions and educational shows based on results obtained by applied research,
- electronic databases and accessible sources delivering new knowledge applicable in the improvement of governance.

1.8. Benefits

The support of AR&D in this area can have a significant and long-term positive multiplicative effect if systematically supported by the transfer of scientific knowledge into management practices. The benefits should include potentially large budgetary savings, the opening of development opportunities and improvements in the quality of life of citizens.

1.9. Financial resources

Besides national budget resources, a significant contribution from EU research support programmes, particularly in areas related to European integration processes, can be expected.

2. Human potential and its reproduction and development

2.1. Characteristics

The reproduction and development of human potential (HP) are key factors of successful development in any society. HP is reproduced through demographic processes and is developed mainly through various forms of education. Reproduction is influenced by past and current trends in fertility, mortality and migration. These shape the structure[25] of the Czech population, which in turn affects the various dimensions of the functioning of society and determines the future possibilities for the existence of that society. The quantity, quality and structure of HP subsequently determine the structure of investments in the Czech Republic and affect the functioning of the labour market, dynamics in the development of the economy, the state of public finances, the system of public health, opportunities for the development of public social services, and, not least, voter behaviour. HP issues should be a key theme of Czech SS&H, along with medical and biological sciences.

[24] Targeted on effective solutions to the defined problems in all phases of the decision-making cycle (e.g. draft innovations of the regulatory framework for the efficient implementation of the country's specific development objectives)

[25] The age, ethnicity, or education structure, for example, is very important.

2.2. Objectives

The basic aim is to create conditions in the Czech Republic to stop its HP from demographically reproducing and to help find an effective place in the conditions of globalizing, ageing and multi-ethnic knowledge societies. In this respect, it will be necessary to examine how human potential is created in today's society, what the factors of reproduction are, what the consequences of such reproduction are, what conditions and mechanisms exist for the development of its quality. The knowledge gained will serve as a basis for the creation of better regulation, particularly in the areas of social, family, pension, health, migration, security and education policy.

2.3. Reasons and criteria serving as a basis for the proposal of the applied R&D priority

In this priority area, BR and AR&D have been addressed by scientific sub-studies of CSF projects, research projects, the NRP and ministerial research. These were usually individualized activities and the findings yielded only partial knowledge. The theme needs to be continuously and systematically examined because it is complex, the situation changes over time and the issues are becoming more urgent. Therefore, these topics are included in the FP7. [26] The issue of identifying determinants in the reproduction of HP is crucial, because long-term low reproduction is a source of other problems. Another fundamental issue is longevity, which is linked to AR&D on the role of older people in modern society and health-related issues. Since the current non-reproducing advanced societies are characterized by relatively large immigration (as a compensating element), the integration of immigrants into majority society is a major theme for AR&D. This issue is also important for national security. For the development of high-quality HP and its effective application, extremely important issues include the role of education in rapidly evolving information societies – especially lifelong learning and the achievement of high functional literacy rates. Since, in every country, there are specific conditions determined by cultural history, tradition and path dependency (dependence on previous developments) that do not facilitate the direct acceptance of the results of foreign studies and their application in the Czech Republic, HP-related issues should be the subject of AR&D, with regard to the specific characteristics of the Czech environment.

2.4. SWOT analysis

2.4.a. Strengths:

- in many respects, Czech research in this field has already taken sub-problem areas as a theme and started to examine them,
- the involvement of the Czech research community in international structures,
- the results achieved so far form the basis for further examination.

2.4.b. Weaknesses:

- the small number of centres devoted to this issue,
- the impossibility of examining the themes through longitudinal data and methodologies, although in many cases this is the only appropriate approach,

[26] The Research Programme of the EU's Seventh Framework Programme.

- the lack of study programmes educating experts capable of conducting AR&D in this area.

2.4.c. Opportunities:

- the building of a stronger research and educational base for this area will enhance the possibility of effectively investigating and addressing these social problems,
- ministries responsible for policymaking in this area will have access to analytical information and databases for the preparation and implementation of quality ("evidence-based") regulation.

2.4.d. Risks: Due to the current undersized research base in the relevant SS&H fields, inertia is to be anticipated before well focused AR&D brings the expected findings. By definition, longitudinally based research will not start yielding fruit for some years – sometimes decades.

2.4.e. Preparedness of the user community: The user sphere needs AR&D results for the creation, implementation and re-verification of regulation nationally and regionally. The preparedness of the application community to apply the results in practice is relatively low (see Area No 1) and AR&D outputs must include instructions and overviews of good practice in the use of AR&D for quality regulation.

2.5. The situation abroad

This thematic area falls within multidisciplinary population studies, which are not widespread in the Czech Republic. This is due to a lack of research infrastructure.[27]

2.6. Czech conditions

2.6.a. Preparedness: Despite the undersized research infrastructure in this field, experts exist in the Czech Republic who are able to form teams capable of addressing these issues. They are armed with theoretical and methodological approaches, and are involved in international teams.

2.6.b. Use: Users of AR&D outputs in this area will be public administration and public policy institutions, especially the MoLSA, the MoEYS, the MoI and provincial authorities. The results will be used for the preparation, implementation and verification of quality regulation at national and regional level.

2.7. Expected results

- knowledge of current social issues which have appeared in the Czech Republic or which – thus far latently maturing – will be manifested with full force in the near future,
- the necessary data base, allowing for a comparison with other countries and providing alternative scenarios for solutions in areas of HP development,

[27] In the Czech Republic, for example, there are none of the research institutes common abroad where demographic research is linked to historical, geographical, sociological, anthropological, economic, security, biological, medical and epidemiological research. These institutions deliver an essential basis for public policymaking. Also, the departments of universities where studies of this type are cultivated are at a premium in the Czech Republic compared with other countries.

- the identification of factors influencing the reproductive strategies of the young Czech population, which is useful in preparing government family policy,
- knowledge of factors affecting the integration of immigrants into Czech society,
- the identification of risks associated with the openness of Czech society towards immigration waves,
- the identification of risks of social exclusion,
- the identification of the possible consequences of population ageing,
- the identification of barriers preventing the development of lifelong learning.

2.8. Benefits

The basic benefit will be the erection of a knowledge base for quality regulation. The following can be regarded as indicators of success: "age-friendly", "socially cohesive", "ethnically integrated", "lifelong learning", "safe" and "health savvy" society where human potential is not wasted. These benefits are usually long term in nature and extend beyond the limits of these applied R&D priorities.

2.9. Financial resources

In this area, besides resources from the national budget, a contribution from EU funds can be expected because the theme of this LTRG is, in a way, part of the FP7, specifically the Cooperation Programme. The participation of private resources, while it cannot be guaranteed, is not out of the question.[28]

3. The competitiveness of Czech society

3.1. Characteristics

The successful development of Czech society depends on the capacity for objective self-reflection and priorities set on that basis. In the modern world, a society can only succeed if it ensures balanced development in all areas of life – economic, cultural, social, political and environmental, i.e. only a society with an effective sectoral and regional economic structure, skilled and flexible workforce, flexible institutional environment, permeable and non-discriminatory education system and socially cohesive environment limiting social exclusion can succeed.

3.2. Objectives

The basic aim is to transform Czech society into a society that is competitive on the international stage. A prerequisite for such a transformation is research into its current social and economic status in the context of the EU, and, on this basis, the determining of the basic parameters for the further development of the economy, securing an increase in its competitiveness, the preparation of a Czech economic model, the formulation of employment policy and social policy guidelines, education system reform principles, and conditions and procedures necessary to ensure greater geographical and occupational mobility of the workforce.

[28] E.g. the participation of pension funds for research in areas of population ageing and longevity aspects, insurance companies in issues regarding determinants of public health, employers in the field of predicting the educational needs of the labour market, etc.

3.3. Reasons and criteria serving as a basis for the proposal of the applied R&D priority

Czech society is part of the process of globalization and European integration. These phenomena are delivering a fundamental change in circumstances – Czech economy and culture, and the political, social and demographic environment are becoming interconnected with the same environment in other countries. The need to compete and succeed in this dynamic multicultural environment is coming to the fore, i.e. there is a need focus the development of Czech society so that it becomes competitive in all respects. This can be achieved by guiding it towards a highly educated, innovation and socially cohesive society. A prerequisite for this is a science-based concept of economic, educational and social policy based on the results of the social-science interdisciplinary research. Without interconnecting social science research in this area, it is impossible to set and achieve a balanced prognosis for the development of Czech society.

3.4. SWOT analysis

3.4.a. Strengths:

- an increasing proportion of young scientists,
- the existence of centres of excellence,
- awareness of the need to promote interdisciplinary social-science research.

3.4.b. Weaknesses:

- lack of effort by researchers to apply themselves abroad,
- lack of information on the quality of social-science research,
- the small role played by the results of social-science research in formulating the strategic directions to be taken in the development of society.

3.4.c. Opportunities:

- increasing international cooperation in social-science research,
- research priorities under the FP7,
- ways of harnessing experience of the development of social-science research in small knowledge-based economies.

3.4.d. Risks:

- reticence by the political representation to reflect the results of social-science research,
- the low capacity of ministries to use AR&D to improve regulation,
- lack of perception of the importance of education in society and inflexible responses to changes in skill requirements,
- the weakening of the integration of society in terms of uneven willingness and access to modern modes of communication.

3.4.e. Preparedness of the user community:

- Public administration has very limited capacity in this regard. The involvement of public administration staff in AR&D research projects and researchers in the preparation of regulation could significantly improve the situation.

3.5. The situation abroad

The kernel of programmes supporting social-science research in developed countries is interdisciplinarity. This mainly involves research into economic, demographic, social and cultural factors of development as determinants of a sustainable and socially cohesive model of society – this is the focus of research programmes in countries such as Germany, the UK and the Netherlands.

3.6. Czech conditions

3.6.a. Preparedness: In the Czech Republic there are numerous centres[29] which have devoted themselves long term to issues related to the competitiveness of Czech society. The scale of international cooperation on selected topics is expanding, the centres are earning international recognition, and some have managed to retain their young researchers.

3.6.b. Use: The users of output will be public administration authorities (particularly the MoLSA, MoEYS, MRD, and the regions). The research results will be used in formulating and implementing economic policy, employment policy, in the preparations for education reform, in determining the overall concept for the development of a Czech knowledge-based society. The development of Czech society towards competitiveness is unrealistic without a coherent concept based on the results of both BR and AR&D.

3.7. Expected results

The results are derived from the objectives which should ultimately be achieved. Research will deliver knowledge concentrated:

- into the design of an economic model facilitating evaluations of competitiveness and the creation of an adequate, quality database,
- into the establishment of a scientifically based concept of regional development, including an adequate database,
- into proposals for reforms of the education system, aiming to improve general education, ensure alignment between the labour market and the development of key skills, cultivate increased workforce flexibility, and an effective system of lifelong learning,
- into the design of labour market models for an advanced education society, with a view to ensuring social cohesion.

3.8. Benefits

An indicator of the success of research results in this area will be an improvement in the Czech Republic's position in many aspects of international comparison carried out regularly by international institutions (the OECD, Eurostat, the UN) in the economic, social, and educational fields.

[29] These are mainly centres at public universities and at the Academy of Sciences.

3.9. Financial resources

With regard to the objectives of this priority, significant financial contributions from private sources cannot be expected. Besides resources from the Czech national budget, EU funds will evidently also be available.

4. Czech identity and the outside world

4.1. Characteristics

In this proposed area of applied research, research work will focus on the comprehensive, application-oriented examination of the importance of Czech identity for Czech society (nationally, regionally and municipally) and the Czech State, as well as in wider international context. Research will be focused mainly on application in projects aimed at tapping the potential offered by specific cultural and historical values connected with the Czech identity, both in government (at central and at local level) and in education, and in media projects shaping the philosophical and value-based orientation of the Czech population and affecting the international image of the Czech Republic. The research will rely on an examination of the historical roots from which Czech identity has grown, as well as an investigation into a wide range of factors that have helped shape the current situation in this area, and will become an essential part of development strategies. Research will be developed mainly in the following scientific fields (including their interdisciplinary relations):

- archaeological and historical research,
- philosophy and the history of thought,
- linguistics and literary science,
- the history of art and material culture, conservation,
- social sciences (particularly sociology, global and regional studies),
- religion,
- pedagogy and education,
- ethics and the strengthening of civil society,
- media and communication studies.

In all these areas, applied research will focus on factors that have significantly influenced the formation of Czech identity. Conditions that did, do and will define national and state identity in relation to the outside world will be themes.

From this angle, the application of the results of individual disciplines, following their interaction, will contribute to the formation of a balanced relationship between citizens and the Czech State and Czech culture, especially on the basis of specific projects, and to the necessary guidance of citizens in processes of intensifying political, economic and cultural globalization.

4.2. Objectives

The main aim of this research will be to acquire new scientific knowledge that will make it possible to:

- explain the processes shaping Czech identity in the past,
- describe current factors affecting the way this identity is shaped,

- effectively influence the formation of Czech identity in the future and strengthen its role in the international context,
- understand intracultural and intercultural communication taking place in the Czech environment and on its internal and external borders, and its variations over time,
- influence changes in the concept of cultural heritage and education, the structure and flow of public communication in the shaping and transformation of identity,
- stimulate the formation of effective cultural, educational and media policymaking by the State as a factor influencing the cultural and economic standards of Czech society,
- cultivate the balanced economic, social and cultural relations of Czech society at a transnational level and in relation to national minorities living in the Czech Republic,
- formulate new and fundamental knowledge usable not only in political practice, but also at all levels of management in public life in the Czech Republic, including cultural institutions.

AR&D projects for the broadly defined public sphere cannot be formulated without examining transformations of cultural heritage and education, and the structure and flow of public communication, as major conditions for the shaping and influencing of processes in this sphere.

4.3. Reasons and criteria serving as a basis for the proposal of the applied R&D priority

National identity is crucial for any state formation which is linked to national tradition and has ambitions of playing an autonomous and self-confident role on the international scene. Discussions on Czech identity and its relationship to the outside world took place in the 19th century. The disputes were often very heated and ended without finding a universally satisfactory solution that would contribute to the development of the national and state unit. The concept of a Czech identity was supported by the establishment of the Czechoslovak Republic in 1918. This was fundamentally challenged during the occupation and war. After the onset of the totalitarian regime, the Czech identity was relativized by communist ideology. In the 1990s, this issue again became the subject of numerous debates (e.g. due to the collapse of the federal state of Czechs and Slovaks). Currently, Czech society is faced with challenges arising mainly from the gradual integration of the Czech Republic into transnational communities, particularly the EU, and into global processes.

All these processes, past and present, have problematized and relativized Czech identity and the position of the Czech State on the European and global stage. The results of specific applied research projects associated with Czech identity can significantly reduce the negative forces that shape the economic, political and cultural life of the Czech Republic. Therefore, it is becoming increasingly apparent that there is a need to provide innovation “guides to action” for the operation of state institutions, regional authorities and local authorities in order to positively affect the behaviour and decisions of individual structures, in particular to ensure a reasonable quality of life for citizens of the Czech Republic (including the stability of society and its institutions) in today’s world, shaped by complex processes carrying a number of risks and potential negative impacts.

A significant reason to apply knowledge from social sciences and humanities in this context is the fact that today's world is itself becoming increasingly complex in terms of the way it is perceived, which contributes to culture clashes and the expanding role of virtual reality created by the media.

4.4. SWOT analysis

4.4.a. Strengths

- the required number of erudite experts for applied research in this area,
- the existence of research centres at universities and at the ASCR which can carry out and coordinate the proposed research,
- the good access to most materials and possibilities for further processing,
- the increasing awareness of the need for interdisciplinary research in SS&H linked to the practical application and the public sphere,
- the productive tradition of interest in problems associated with the relationship between the Czech environment and the outside world, continuously influencing processes in the formation of national life,
- the incumbent network of cultural and educational institutions involved in the national, regional and municipal framework.

4.4.b. Weaknesses

- lack of interest among the state and public administration, the political sphere at national and local levels, the media and educational institutions in projects and results of applied research in the field of SS&H,
- lack of interest among part of the scientific community in the needs of SS&H AR&D and in the possibilities of applying such research,
- lack of consideration for the need to apply SS&H knowledge in educational processes at universities,
- the declining interest among young professionals in research into issues relevant primarily for the Czech environment (a focus on Czech issues often reduces the options of finding a placement abroad),
- the small degree of actual application of the results of the social-science and humanities-oriented research in political decision-making processes,
- the lack of public awareness of the need to apply the results of social-science and humanities research in public policy.

4.4.c. Opportunities

- the creation of a platform linking research, education (further education) and the cultural sphere, which will dramatically increase the possibility of exposure to the public, the media and politics and can thus contribute significantly to reducing the risks of extreme variations in the development of social processes,
- the benefits of projects under this priority that could be reflected in the innovation of a number of specific economic, social, political and cultural processes in the life of individuals and society in the Czech Republic,
- the application of SS&H AR&D results can significantly enhance the status and prestige of the Czech Republic, not only within the structures of the EU, but worldwide,
- in some cases, projects may deliver model solutions also applicable to the conditions in surrounding countries.

4.4.d. Risks

- many potential users are not accustomed to working with the results of AR&D and there is a risk of the inefficient use of the results,
- issues related to national identity are sensitive and often politically controversial matters which could lead to the limited application of results,
- sparse and generally negative experience of attempts to apply SS&H AR&D results, especially before 1989.

4.5. The situation abroad

In developed countries, problems associated with national identity, particularly in the context of globalization and internationalization, are the subject of special attention. The absorption capacity of sub-structures of society to take advantage of and practically enhance the results of applied SS&H research is remarkable. For example, the US and France, as well as States comparable to the Czech Republic, such as Austria and the Scandinavian countries, have formed specific programmes designed to apply the systematic examination of the historical and cultural heritage from the position of the relationship between national identity and the outside world within the scope of SS&H, including the subsequent application of the results of this examination in public policies aimed at strengthening the international position of countries.

4.6. Czech conditions

4.6.a. Preparedness:

- at ASCR centres and at universities there are numerous erudite experts who deal long term with issues covered in the proposed area of AR&D; individual research projects can draw on many results achieved by Czech science since the early 19th century.
- a broad base of educational and cultural institutions with the necessary infrastructure and professional potential,

4.6.b. Use: users of outputs can be found in all spheres of public life set out in the introduction, especially the Ministry of Culture, the Ministry of Education, the Ministry of Foreign Affairs, the Ministry of the Interior, the provincial departments of culture and heritage conservation, education, tourism and promotion, cultural institutions, the media sphere, the religious sphere and spiritual life.

4.7. Expected results

The result of research work in the proposed priority area will be:

- specific instructions, suggestions and recommendations of innovation processes in the negotiations and decisions regarding the above listed spheres in the life of society and individuals,
- the influencing of processes supporting the formation of Czech identity as important components of the cultural and economic potential of Czech society,
- the concentration of knowledge and expertise to granting users with better orientation in the contemporary world and in solving its problems,

- improvements in the quality of government decisions and the effectiveness thereof, particularly in the field of education, culture and heritage conservation and tourism,
- the influencing of and improvements in the quality of all processes in economic, political and cultural life in the Czech Republic and the strengthening of the country's international position,
- the promotion of the Czech Republic's status as a cultural and tourist hotspot with its own national and historical traditions.
- The basic types of outputs will be:
- publications (conventional and electronic), delivering new knowledge applicable in the portrayal of Czech identity and its relationship to the outside world,
- expertise and methodologies for the public and political sphere, methodical publications in the vein of "Best Practice Guide",
- educational and teaching programmes based on the results of application-oriented research (educational programmes, including interactive computer applications),
- AR&D results summarized in popular educational texts for the public and media,
- presentations, exhibitions and educational shows of results obtained by research,
- electronic databases, electronically accessed sources, or other IT applications,
- interpreted monuments of civilization,
- catalogues, inventories of cultural heritage artefacts,
- ethical and professional codes.

4.8. Benefits

Projects developed within the proposed area will have benefits in the quality of life of citizens in the Czech Republic and will lead to a deeper understanding of the ideological sources of Czech identity and thus to improvements in the quality of economic, political and cultural life in the Czech Republic. They will also provide input for decision-making in the political, administrative, economic and cultural fields. The projected outcomes can be used in many spheres of social life (see 4.6.b), and, inter alia, for the long-term fostering of positive relations between the public and national and democratic values and Czech statehood.

4.9. Financial resources

With regard to the focus and objectives of this priority, significant financial contributions from private sources cannot be expected. Besides resources from the Czech national budget, EU funds will be available to a certain extent (especially in education).

5. Technologies and methods

5.1. Characteristics

Informed public policymaking and regulations require credible empirical research identifying relationships in society (evidence-based policies). This research cannot be conducted without a quality base of data and statistics, which in the Czech Republic, unlike many developed countries, is not available.

The methodological priority in the field of applied social sciences[30] comprises empirical analyses using data on individuals[31] to describe the processes and development in areas related to public policies and estimates of the impact of these policies and regulations.[32] An expansion in the application of evaluation methods in different ministries must be based on new BR knowledge.

5.2. Objectives

- provide access to and expand data sources for AR&D purposes,
- popularize, disseminate and apply modern statistical methods in public administration, i.e. start by developing overviews, for individual ministries, of methodologies and applications which are used in international practices in the agenda of each ministry,
- adapt the pilot testing of upcoming and potential legislative adjustments in order to be able to effectively assess their impact,
- make systematic use of impact assessment methodologies to create effective regulatory and other instruments of public policy,
- extend the teaching of modern methods of impact assessments in tertiary education and in the training of civil servants.
- a follow-up objective is the application of these methods in the preparation of new legislation in the form of ex-ante and ex-post evaluations of measures and regulations, and the provision of access to results at all levels of decision-making processes, including political representation.

5.3. Reasons and criteria serving as a basis for the proposal of the applied R&D priority

Lawmaking and the implementation of public policies in the Czech Republic is now largely detached from analyses quantifying their impact. In the use of modern techniques to measure the effects of actions and regulations, the Czech Republic lags far behind the developed world. This also explains the low efficiency of the measures introduced and the low legitimacy of government.

[30] In particular, demographics, economics, sociology and (in part) psychology.
[31] Data on employees, families, companies, public and state institutions, etc.
[32] In particular, the impact of social, educational, health, environmental and economic policy.

5.4. SWOT analysis

5.4.a. Strengths:

- many data sources already exist,
- there is a developed IT infrastructure for collecting, storing and processing data files.

5.4.b. Weaknesses:

- limited access to existing data resources for RDI purposes,
- lack of longitudinal investigations,
- little awareness of the possibilities of empirical evaluation,
- minimal use of ex-ante and ex-post evaluations of policies and regulations.

5.4.c. Opportunities: streamlining of the creation of regulations and public policy by strengthening the quality of RIA.

5.4.d. Risks:

- the access of the Office for the Protection of Personal Data to the use of anonymized data about individuals for the purposes of basic empirical and related applied research,
- ideological approaches to the creation of economic and social policy,
- lack of expert background in the field of methodologies.

5.4.e. Preparedness of the user community:

- low awareness among the ministries of the opportunities and requirements of AR&D tools,
- low capacity of ministries to commission and accept AR&D results,
- new regulatory measures must now be accompanied by an RIA, which substantially increases the need for AR&D in the field of SS&H.

5.5. The situation abroad

The European agenda to improve the quality of regulation is related to the global expansion of the use of empirically measured impacts of all kinds of government actions and policies (evidence-based policies and RIA). Controlled access to data on individuals for the purposes of evaluating policies has been enacted in many EU countries in the last decade. The European Commission has invited Member States to develop national strategies and institutional conditions for the system of evaluating economic, social and environmental impacts of regulation created at national level. For example, in the field of social policy there is a need for regular evaluations with an emphasis on cost-effectiveness and on the net impacts of the measures.[33]

5.6. Czech conditions

5.6.a. Preparedness: Policy impact assessments in the Czech Republic falls within the binding RIA framework adopted by the Government. However, the impact of policies and regulation is not systematically assessed in the Czech Republic. General awareness about the nature and importance of impact

[33] Unlike inconclusive evaluations regarding the volume of sources used or the number of people involved.

assessments of policy and other policies in the Czech Republic is very weak among the professional public and in state administration. There is not enough professional expertise for impact assessments in the Czech Republic. There is a solid foundation in terms of the database (but this is still unavailable for BR and AR&D).

5.6.b. **Use:** The public sphere and policymaking can and must (see RIA) be based on such impact analyses. The transfer of knowledge is direct and without significant additional cost. The result of applying these procedures is estimates of the net benefits of the policies, which can then be compared with their costs.

5.7. Expected results

The result will be systems (commonly used in the developed world) of analytical methods for the systematic assessment of negative and positive impacts of proposed or existing legislation in the economic, social and environmental spheres, including assessments of the impact on various social groups. Measurements do not apply only to purely economic variables, but also to psychological, health, social and other effects. It is therefore advisable to focus AR&D in this priority area on the implementation of the following outputs:

- the interconnection of, and provision of access to, existing databases for the purposes of basic and applied research,
- a multisectoral structural macroeconomic model of the Czech economy,
- the implementation of longitudinal surveys of the population,
- sample surveys of the young population, aimed at verifying the results of education,
- a simulation model of the impact of the tax and welfare system,
- a model predicting the educational needs of the labour market,
- the development of an energy model for the Czech Republic,
- the development of methodologies for the assessment of active employment policy programmes,
- a simulation model for the implementation of pension reform,
- the development of methodologies for evaluations of RDI results at the level of the fields and beneficiaries of public financial support,
- a model predicting the educational needs of the labour market,
- methodologies for the evaluation of programmes to include disadvantaged groups.

An indicator of AR&D success could be the percentage of newly introduced legislation which is based on quantified analyses of its impact.

5.8. Benefits

The benefits should be seen in improvements in the regulation and quality of governance in general and in the more efficient use of public funds. The ultimate benefit is the improved quality of life, in its economic and social dimensions, and the stronger legitimacy of governance.

5.9. Financial resources

No major interest in co-financing from the private sector can be expected in this priority area. Partial financing from EU funds should be available.

Abbreviations

AR&D	Applied Research and Development
ASCR	Academy of Sciences of the Czech Republic
CR	Czech Republic
LLL	Lifelong learning
LTRG	Long-term Research Guidelines
CSF	Czech Science Foundation
IT	Information technology
HP	Human potential
MoC	Ministry of Culture
MoLSA	Ministry of Labour and Social Affairs
MoEYS	Ministry of Education, Youth and Sports
MIT	Ministry of Industry and Trade
SS&H EC	Expert Commission on Social Sciences and Humanities
RIA	Regulation Impact Assessment
sR&DC	Secretariat of the Council for Research, Development and Innovation
pR&DC	Presidium of the R&D Council
SS&H	Social Sciences and Humanities
RDI	Research, development and innovation
FP7	Seventh EU Framework Programme
BR	Basic research