Attachment to Resolution of the Council of Ministers No. …
of ……. 2011

National Research Programme

Assumptions for the Science & Technology and Innovation Policy of the State

The National Research Programme drafted pursuant to Article 1 Section 1 of the Act on the Principles of Financing Science

INTRODUCTION

This document formulates the strategic directions for research & development (R&D), setting the goals and guidelines for the science & technology and innovation policy of the state. The directions are used by the National Centre for Research and Development to prepare strategic R&D programmes.

The strategic goal for Polish science development is to use research to improve Poland's level of civilisation, among others, by taking a fuller advantage of its outcomes in such areas as education, economy and culture. An important task facing Polish science consists in bridging the civilisation gap between Poland and economically developed countries, improving the living conditions of Polish society and realising the development-related aspirations of present and future generations, in line with sustainable development principles.

The delivery of this goal will depend to equal degrees on: increasing R&D development funding in Poland and establishing new rules for using such funding in a way reflecting the current situation. The new situation in terms of funding requires new research organisation rules to be defined and priority research areas to be indicated. This will improve the quality and efficiency of Polish science in terms of supplying research results and products characterised by a high cognitive value and high social, economic and technological usefulness. The activities in all the above areas will result cumulatively in improved science efficiency in Poland, increased innovativeness of the economy and enhanced international importance and competitiveness of Polish science.

Enhancing the competitiveness and innovation of the Polish economy requires initiating mechanisms which will broaden the demand for economically viable outcomes of research. This effect may be attained by creating a system of effective incentives for enterprises to invest, which will contribute to increasing private R&D funding and will support cross-sector cooperation in the area of R&D and implementation, securing at the same time the strategic development needs of the state.

Orchestrated actions will respond to the challenges defined in the Europe 2020 strategy for smart, sustainable and inclusive growth. What is of particular importance is promoting innovation capacity to support investment, diversification of the economy and orientation towards higher value-added production and services by strengthening the links between tertiary education, research and innovation system.[1] These actions were indicated by the European Commission as key areas requiring intervention in the framework of the Europe 2020 strategy implementation at national level.

One of the measures to deliver the above goals is the **National Research Programme** (Krajowy Program Badań), which defines the R&D directions and allows the R&D stream of funding to be channelled into those research areas and disciplines which are crucial for the country's social and economic development. The National Research Programme is an instrument facilitating the delivery of the research, science & technology and innovation policy of the state in line with the European and global standards. The creation, systematic delivery and regular evaluation of the National Research Programme will allow state-budget

[1] Macro structural bottlenecks to growth in EU Member States, Occasional Papers 65, July 2010.

funds to be used in an effective way and channelled to those units which are involved in priority and top-quality research.

Ensuring closer cooperation between science and economy requires on-going dialogue, but primarily creating a system of effective incentives for businesses to invest in science. Therefore the relevant decisions must be taken jointly by the government, as the research, scientific & technical and innovation policy-maker, researchers, enterprises and investors. The process must also take into account the international context, especially the European Research Area and cooperation with non-EU developed countries.

Taking into account the local specificities in choosing the topics of strategic research projects, especially those of an interdisciplinary and multi-sectoral nature, will bring together the dispersed community of researchers in Poland and contribute to achieving new-quality R&D activities.

1. LEGAL AND PROGRAMME BASES

On 1 October 2010, a package of 6 acts reforming the Polish research system entered into force, including the Act of 30 April 2010 on the Principles of Financing Science (Journal of Laws [Dz. U.] No. 96, Item 615 and of 2011 No. 84, Item 455) and Act of 30 April 2010 on the National Centre for Research and Development (Journal of Laws [Dz. U.] No. 96, Item 616, No. 257, Item 1726 and of 2011 No. 84, Item 455).

Pursuant to Article 4 Section 1 of the Act on the Principles of Financing Science, the Council of Ministers adopts, by resolution, the National Research Programme, which defines the R&D directions and replaces the National Research and Development Programme of 30 October 2008[2]. The draft National Research Programme is prepared by the minister responsible for science after consulting the Polish Academy of Sciences, the Conference of Rectors of Academic Schools in Poland, the General Council for Higher Education, the General Council of Research Institutes and self-regulatory business organisations.

The reform of the research system implemented in 2010 allowed the Ministry of Science and Higher Education to assume the role of the leading research policy-making body and coordinator of the activities in this area in Poland. The National Centre of Science and the National Centre for Research and Development, acting as executive agencies, assumed the tasks of programme drafting and financing projects related to basic research (the National Centre for Science) and application research (the National Centre for Research and Development).

[2] The National Framework Programme, which set out the priority R&D directions, was drafted and published in 2005 pursuant to the Act of 8 October 2004 on the Principles of Financing Science (Journal of Laws [Dz. U.] No. 238, Item 2390). It was established by the Minister of Science and Higher Education on the basis of proposals submitted by ministers, province governors, province government bodies, the President of the Polish Academy of Sciences, higher education institutions, research units and national business self-regulatory organisations. As a result of the entry into force of the new legislation: the Act of 15 June 2007 on the National Centre for Research and Development (Journal of Laws [Dz. U.] No. 115, Item 789) and the Act of 15 June 2007amending the Act on the Principles of Financing Science (Journal of Laws [Dz. U.] No. 115, Item 795), the National Framework Programme was replaced in 2008 by the National Research and Development Programme, approved by the Minister of Science and Higher Education. The draft National Research and Development Programme was prepared by the Research and Science & Technology Committee of the Council of Science, the Interdisciplinary Team for Strategic Research & Development Programmes and experts and employees of the Ministry of Science and Higher Education. The authors of the National Research and Development Programme consulted scientists, businesses and representatives of the state and self-government administration.

Since 2008, the amount of science funds from the state budget has grown considerably. The radical growth is attributable to an efficient use of the Structural Funds. However, this source of funding is limited and after the end of the 2007-2013 financial perspective, the share of this source is bound to decrease. Bearing this in mind and considering the need for even higher increases in research spending, the Multiannual State Finance Plan (WPFP) 2011-2014 provides for an increase in the budgetary expenditure on research, which is to offset the drop in structural funding (Tables 1 and 2).

Table 1. State-budget funding under *Heading 28 - Science* in the years 2006-2014 (in PLN million)

2006	2007	2008	2009	2010	2011	2012	2013	2014
3 380	3 750	3 918	4 568	5 890	6 617	6 373	6 526	6 006

Source: Budget Implementation Report for *Heading 28 - Science* for the years 2006-2010, Financial Plan for *Heading 28 - Science* as at 30 June 2011 for current year, Draft State Budget for *Heading 28 - Science* for 2012, Multiannual State Finance Plan covering *Heading 28 - Science* for the years 2013-2014. Data for 2011-2013 comprise funds of the Polish Science and Technology Fund. The amounts of projected expenditure in 2014 may change.

Table 2. State-budget funding under *Heading 28 - Science* in the years 2006-2014 excluding the Structural Funds and co-funding (in PLN million)

2006	2007	2008	2009	2010	2011	2012	2013	2014
3 380	3 750	3 821	4 178	4 672	4 650	5 058	5 186	5 498

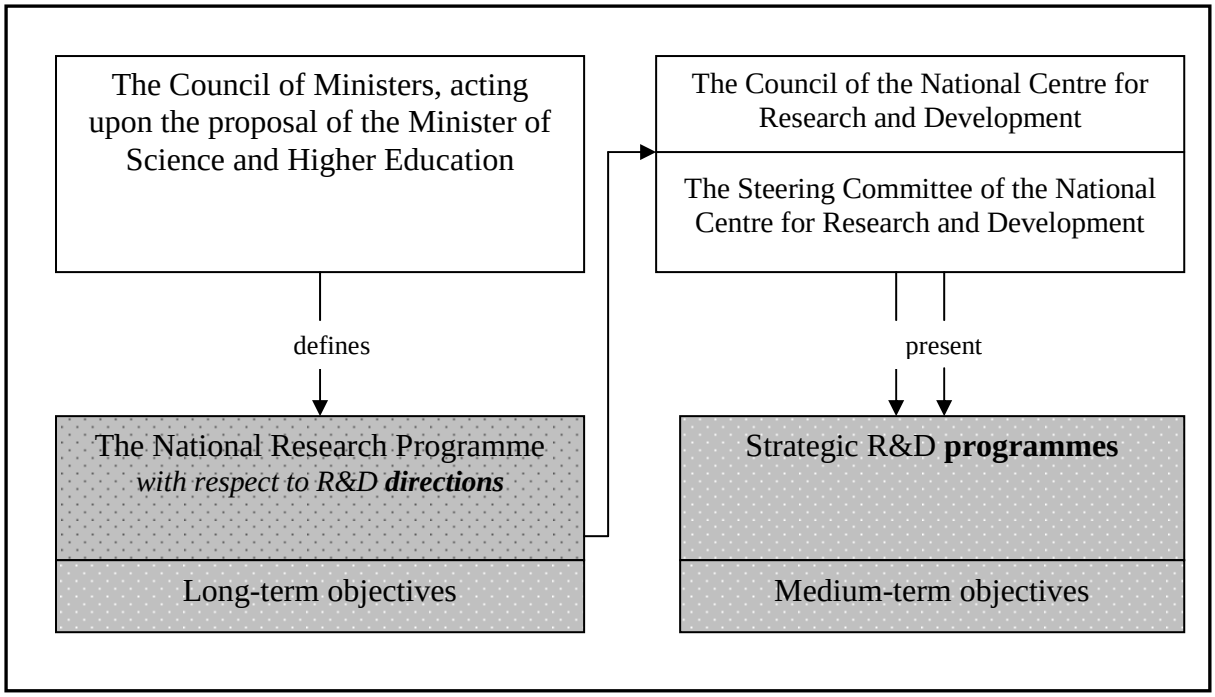
Source: Budget Implementation Report for *Heading 28 - Science* for the years 2006-2010, Financial Plan for *Heading 28 - Science* as at 30 June 2011 for current year, Draft State Budget for *Heading 28 - Science* for 2012, Multiannual State Finance Plan covering *Heading 28 - Science* for the years 2013-2014. Data for 2011-2013 comprise funds of the Polish Science and Technology Fund. The amounts of projected expenditure in 2014 may change.

What also seems important is further efforts towards increasing funds allocated for research by the business sector. Currently, this represents only around 30%, with the 70% of institutional funding. The Europe 2020 strategy provides that by the year 2020 the share of research funding allocated by businesses should reach 50%.

The changes in the research system which reform the National Centre for Research and Development and establish the National Research Centre will stimulate the financing of projects benefiting from grants, both with respect to basic and application research.

The National Research Programme lays down the directions of R&D which are of strategic importance for the state. A strategic R&D direction is defined as a broad undertaking setting forth the goals and assumptions of the long-term research, science & technology and innovation policy of the state. The strategic R&D directions are a basis for the National Centre for Research and Development to formulate strategic R&D programmes. Figure 1 illustrates the strategic programming process.

Figure 1. Strategic R&D directions and programmes



Source: own graphics.

Pursuant to Article 15 Section 1 of the Act on the National Centre for Research and Development, draft strategic R&D programmes are prepared by the Council of the National Centre for Research and Development, and then presented for approval to the minister responsible for science. As regards R&D serving state defence and security, draft strategic R&D programmes are prepared and submitted for approval to the minister responsible for science by the Steering Committee of the National Centre for Research and Development (Article 17 Item 1 of the Act on the National Centre for Research and Development), based on the definition of such research specified in Article 2 Item 5 of the Act of 30 April 2010 on the Principles of Financing Science.

The timeframes for strategic R&D directions and strategic research programmes are set in such a way as to ensure research stability. However, they should be modifiable depending on the changing conditions, tasks and economic and social needs. The strategic R&D directions should be implemented over a period of 10-15 years, while strategic research programmes over a 3-7-year period, considering the realistic levels of funding. The bodies participating in the construction of the National Research Programme, collaborating with one another, regularly evaluate and update draft strategic R&D programmes. The above actions are coordinated by the minister in charge of science.

2. CHOOSING PRIORITY R&D DIRECTIONS

The delivery of the National Research Programme should contribute to improving the results of research into new technology solutions, increasing the number of new patents and

developing innovative economy. Achieving this objective requires focusing the efforts of researchers and state-budget funding on a limited number of pre-defined priority areas.

In the medium and long term Poland faces the challenge of increasing the productivity of Polish businesses, while, at the same time, reducing the unemployment rate. In order to come up to this challenge, Poland will have to enhance the internal capacity to absorb technology with an adequate potential for increasing the productivity of capital and labour. The key to success should be sought in such actions as: increasing the participation in the global market, focusing on modernisation and change, building legal and institutional environment and responsible macroeconomic policy making[3]. Transforming the structure of Polish exports is a prerequisite for Poland to benefit from globalisation. In Poland, changes in the production structure consist in an ever growing importance of services, which account for an increasingly higher proportion of GDP. In this context, the key to Poland's long-term success lies in making an effective use of production factors and technology. Because the global technological progress is the fastest in those sectors of the economy which require high capital investments into production, countries willing to achieve high growth dynamics must make substantial investment outlays to attain the economic success requiring fast diffusion of top-productivity technologies by the entire economy.

The National Research Programme comprises seven strategic, interdisciplinary R&D directions:

1. **New energy-related technologies,**
2. **Diseases of affluence, new medicines and regenerative medicine,**
3. **Advanced information, telecommunications and mechatronic technologies,**
4. **New materials technologies,**
5. **Natural environment, agriculture and forestry,**
6. **Poland's social and economic development in the context of globalising markets,**
7. **State security and defence.**

With respect to directions 1-6 the Council of the National Centre for Research and Development will draft strategic R&D programmes.

Direction No. 7, which addresses state security and defence, will be used by the Steering Committee of the National Centre for Research and Development as a basis for preparing strategic R&D programmes in the area of state security and defence.

The above directions take into account:

- the global challenges facing a modern society, as specified in the following documents: Europe 2020 strategy[4], the Innovation Union flagship initiative[5], the OECD Innovation Strategy[6];
- the global development trends as reflected in the following documents: The World in 2025: Rising Asia and Socio-Ecological Transition[7], Preparing Europe for a New Renaissance:

[3] Report *Poland 2030. Development Challenges*, Team of Strategic Advisors to the Prime Minister, ed. M. Boni.
[4] http://ec.europa.eu/europe2020/index_pl.htm
[5] http://ec.europa.eu/research/innovation-union/index_en.cfm
[6] http://www.oecd.org/pages/0,3417,en_41462537_41454856_1_1_1_1_1,00.html
[7] http://ec.europa.eu/research/social-sciences/pdf/the-world-in-2025-report_en.pdf

A Strategic View of the European Research Area[8], Global Trends 2025: A Transformed World[9];

- The results of the National Program Foresight *Polska 2020* implemented in the years 2006-2008 with the participation of experts in the following three fields of research: Poland's Sustainable Development, ICT and Security. The project was delivered with the participation of various groups of stakeholders, in particular representatives of the science and business communities (approx. 85% of all the experts). Moreover, the project received expert and analytic support from the following partner institutions: higher education institutions (Warsaw School of Economics, Warsaw University of Technology, Białystok University of Technology, Wrocław University of Technology, University of Warsaw, Adam Mickiewicz University in Poznań), organisations representing the scientific and engineering communities (e.g. the Polish Federation of Engineering Associations (NOT)), employers' organisations (the Polish Confederation of Private Employers Lewiatan, the Polish Chamber of Chemical Industry), and businesses (CBR KGHM Cuprum Sp. z o.o.), as well as Polish Technology Platforms (Production Processes, Textile Industry, Mobile Technology and Wireless Communications, Advanced Materials, Internal Security, Aerospace, Opto- and Nanoelectronics, Sustainable Chemistry, Forestry and Wood Sector, Environment)[10];
- an analysis of the needs for scientific support carried out by the National Centre for Research and Development in 2009 among the leading industry sectors in Poland;
- results of the evaluation of the National Research and Development Programme established in 2008.

The choice of the strategic R&D directions was made with the participation of distinguished representatives of various communities, especially researchers, in the context of activities benefiting the economy which have the superior objective of creating favourable conditions for improving the competitiveness of the Polish economy by exploiting the added value generated by close interaction between Polish science and industry. The following criteria were applied in selecting the strategic R&D directions:

- long-term needs of the economy - especially in terms of using modern technologies and making an effective use of human resources,
- high-quality scientific research in domestic centres - global competitiveness, achievements winning international prizes and distinctions,
- developing innovative business sectors at the level of micro-, small and medium-sized enterprises, based on new Polish technologies - exploring the opportunity of using advanced technologies by businesses, manufacturing modern products and providing new or highly-improved services on the Polish market,
- priority research development areas as indicated in European research programmes - especially as set out in the 7th Framework Programme, programmes of the European Research Council and Euratom.

In selecting the research directions and R&D directions priority is given to:

- multidisciplinary and cross-disciplinary research programmes, focusing on objectives of

[8] http://ec.europa.eu/research/erab/pdf/erab-first-annual-report-06102009_en.pdf
[9] http://www.dni.gov/nic/PDF_2025/2025_Global_Trends_Final_Report.pdf
[10] Available on the following website: http://www.nauka.gov.pl/fileadmin/user_upload/Nauka/Polityka_naukowapanstwa/Prognozy_rozwoju/20100104_Wyniki_NPF-Polska_2020.pdf;

strategic importance for Poland's sustainable development,

- programmes enhancing the innovation, entrepreneurship and competitiveness of the Polish economy,
- actions supporting the fields of science in which Poland has a strong international position,
- programmes reflecting the research priorities of the European Union,
- the fields of knowledge which are crucial determinants of the world's civilisation and economy development,
- research enabling the implementing of their scientific and technological effects,
- activities reinforcing the educational aspects of research.

Delivering the above strategic research directions and at the same time rising up to the challenges facing Poland requires a complete and in-depth identification of all the (intellectual, human, natural, infrastructure, social and regulatory) resources at hand, especially those unique for Poland, and indicating the degree, scale and form of their engagement to minimise and remove existing barriers to growth, take advantage of the possibilities and opportunities provided by modern development lines and trends, and as a consequence, make sustainable growth a reality.

The draft National Research Programme was prepared by the Scientific Policy Committee and submitted for interministerial and public consultations. The following institutions submitted their comments to the draft programme: The Ministry of National Defence, the Ministry of the Interior and Administration, the Ministry of Infrastructure, the Ministry of the Economy, the Ministry of National Education, the Ministry of Regional Development, the Ministry of Agriculture and Rural Development, the Ministry of Finance, the Internal Security Agency, the Government Centre for Security, the Prosecutor General's Office, the Polish Academy of Sciences, the Conference of Rectors of Academic Schools in Poland, the Central Council for Higher Education, the Main Council of the Research Institutes, Employers of Poland, Polish Confederation of Private Employers Lewiatan, Business Centre Club. The comments were taken into consideration.

STRATEGIC RESEARCH AND DEVELOPMENT DIRECTIONS

1. NEW ENERGY TECHNOLOGIES

The Polish energy sector should be transformed over the long term into a sustainable,

low-emission, environmentally friendly system based on diversified energy sources and benefiting from increased energy efficiency. Such factors as the obsolete and inefficient infrastructure of the Polish energy sector, dependence on external supply of fuels and energy, strong negative environmental impact of the sector and Poland's commitments arising from the adoption by the EU of the climate and energy package clearly indicate that Poland needs to introduce a number of radical technological and technical changes to the structure of energy generation, transmission, energy-efficient distribution and storage. It must be stressed that developing modern energy technologies is crucially important for Poland's transition to a green economy, in support of the objectives set out by the Europe 2020 strategy, especially by its *Resource-efficient Europe* flagship initiative,

The research in this area must work towards the implementation of the *Energy Policy of Poland until 2030*, adopted by the Council of Ministers on 10 November 2009, and the delivery of the UE's energy and climate policy. Both documents assume that by 2020 Poland will achieve full energy supply security, without breaching the applicable environmental requirements, and will develop low-emission technologies to meet the *3x20 objective*, which consists in improving energy efficiency by 20%, increasing the share of renewable energy to 20% and reducing greenhouse gas emissions by 20%. The future research into modern energy technologies will support the delivery of the currently prepared National Low Emission Economy Programme, whose main objective is Poland's transition into a low-emission economy. This may be achieved only on condition that Poland will carry out research on its major energy sources, the traditional energy sector based on hard coal and gas, including shale gas, and renewable energy sources. For the assumed goals to be achieved, Poland will also have to work towards developing safe nuclear energy, which will have the additional benefit of allowing the country to keep up with the most technologically advanced countries of the world.

The development and implementation of new efficient and environmentally safe energy technologies must proceed in an atmosphere of multidisciplinary collaboration of researchers and engineers representing a range of scientific fields and disciplines, with ongoing support for the education of scholars and engineers.

As regards energy efficiency improvement, the goal of R&D is to reduce the demand for fuel and energy. Indirectly, by reducing the dependence on imports, such research improves the country's energy security and minimises the environmental impact of energy by reducing gas, dust and process waste emissions. Scientific & research progress as well as technology development, taking due account of the need to minimise their negative impacts on the environment and living standard, will mainly contribute to reducing the consumption of energy by the Polish economy and increasing the efficiency of electricity and heat generation, processing, transmission and storage.

The existing solutions in terms of materials and construction design applied in the national power system seriously constrain the transmission capacity, which, considering the rising demand for electricity, leads to emergencies and power cuts, which have a severe impact on the economy. The need to put a stop on these phenomena requires Poland to develop such new-generation power transmission and distribution materials and structural solutions as to allow the domestic power system to be modernised.

Delivering the assumptions of the Polish energy policy and meeting the applicable environmental standards and international commitments requires making an effective use of

all energy sources, including alternative ones, and developing technologies which are safer for users and the environment. Renewable energy research and technology development in this area should focus on all types of energy: geothermal, biomass, wind energy, hydropower, solar energy and others.

Research supporting the above agenda requires interdisciplinary ecological and economic studies, supporting, among others, the monitoring of the risks inherent in the energy solutions applied.

Implementing the nuclear power agenda will generate demand, e.g. for research in such fields as: materials technologies, electrical engineering, automation e.g. of the fuel cycle, 4th-generation reactors or developing probabilistic models and software. Research in the field of nuclear energy will allow Poland to meet the deadline set for the start-up of the first nuclear power unit in 2020, as declared by the Polish Government in its resolution of 13 January 2009. Moreover nuclear technologies are applied in other areas: medical prevention, diagnostics and treatment, manufacturing of new materials, the petrochemical sector, agriculture, environmental protection and water management. The existing supply of electrical energy, based on large concentrated power generation sources, will require gradual transition to the so-called “dispersed generation” model, which creates better potential for increasing the share of renewable energy sources, in particular by ensuring better possibilities for generating such energy by households.

Hydrogen energy, considered to be “an emerging technology”, is currently at an early stage of development. Apart from future commercialisation opportunities, research in this area, including on fuel cell technologies, will provide Polish researchers and engineers with the possibility of getting acquainted with the most demanding technologies of modern times. Owing to its specificities, effective research and development in this area must be of a multi-disciplinary nature, breaking the typical barriers between such sciences as physics, chemistry and materials engineering.

The domestic energy sector utilises one of the biggest hard and brown coal resources in the world. Therefore Poland should become a country promoting and developing clean coal technologies. Using coal to generate clean electrical energy, synthetic fuels and chemical substances requires developing clean coal technologies that are safe for humans and the environment and support underground coal gasification, fossil fuel gasification and mass production of hydrogen. Integrating nuclear energy with coal conversion may optimise the use of coal resources.

What is also important is developing technologies using non-conventional energy sources, such as shale gas and methane obtained from coal deposits. This involves the need to develop new technologies for the exploration and safe mining of the domestic resources, including critical elements and raw materials, which are indispensible for a modern economy (rare earth elements, strategic metals, raw materials for advanced technologies).

By participating in European framework programmes and domestic R&D programmes, Polish higher-education institutions, research institutes and the Polish Academy of Sciences institutes, have attained a high level of expertise, and are developing a network of unique benchmarking installations. For the first time, industrial organisations participate financially in the programmes, engaging their own funds. Therefore it can be concluded that the public-private partnership and the potential created allow those involved to carry out R&D

at a European level.

2. DISEASES OF AFFLUENCE, NEW MEDICINES AND REGENERATIVE MEDICINE

Diseases of affluence will be the greatest health threat for Poland's population in the nearest future. They include: cardiovascular diseases (including: hypertension, myocardial infarction and cerebrovascular accident), malignant neoplasms, kidney diseases, diabetes and obesity, mental diseases (notably depression), dementive diseases and addiction to alcohol, medicines and drugs. For a number of years, rising allergy incidence rates have been observed, especially among the elderly. Apart from population aging, the main causes of most of these diseases include environmental exposure and negative lifestyle changes, resulting, among others, in changes in the musculoskeletal system, as well as the rising mental strain related to decision-making processes and psychosocial stress.

The fast progress of knowledge allows for the causes of the diseases of affluence to be explored, high-risk groups identified, population-targeted intervention accurately focused and the diseases to be detected at an earlier stage, which improves the success of treatment. The huge dynamics of the work on new medicines, including those which interact in a specific way with defined molecular structures, as well as nanopharmacology, create new therapeutic possibilities. Research on stem cells open new perspectives as regards the regeneration and reconstruction of organs.

What is extremely important is the development of analytic epidemiology, which is the most effective tool, e.g. in detecting new environmental threats, identifying environmental exposure markers and absorbed dose markers, as well as early markers of organ damage. Population-based epidemiological studies facilitate successful identification of the risk factors responsible for diseases of affluence and factors which affect treatment success (e.g. compliance, adherence, therapeutic inertia) and increase the risk of dangerous complications of the diseases. Similarly, developing molecular studies on the genetic predisposition increasing the risk of incidence and research on the epigenetics of diseases of affluence, which is the element linking specific environmental exposures with the incidence of multigenetic diseases, fits into the strategic research agenda of many centres worldwide.

The likelihood of progress in the field of mental and neurodegenerative disorders and substance abuse is associated with fast progress in the research on neurotransmission, the function of cell surface receptors and channels, and on the various stages of signal transduction in the cells of the nervous system. It also depends on the development of modern neuropsychopharmacology.

Modern diagnostics focuses, among others, on searching for molecular biomarkers which are associated with genomics, transcriptomics and proteomics, useful in early detection of diseases, planning the course of therapy and monitoring the effectiveness of treatment, and which are potential targets for new therapies. The development of research in the field of pharmacogenetics and pharmacogenomics for identifying individual drug susceptibility and resistance will enable the treatment to be chosen in an optimal way and its complications to be minimised.

At present, modern pharmacology is a multidisciplinary field. The dominant trends in this rapidly developing research area, which is also of great economic importance, include the use of computer modelling and advanced analytical and toxicological analysis methods, developing nanopharmacology and searching for targeted medicines with selective effect. Developing nanotechnologies, among others, by seeking new polymer and lipid carriers of medicines in targeted therapy is also of crucial importance. Research in this field is aimed at creating original and patentable methods of generic drug synthesis and manufacturing technologies. Substantial progress in this area depends on creating preferences for interdisciplinary projects and projects delivered jointly by several institutions, involving molecular biologists, IT specialists, biochemists, doctors and pharmacologists.

What has a huge potential is research in the field of regenerative medicine, particularly on the use of the therapeutic potential associated with the properties of somatic stem cells and umbilical cord blood, especially in organ regeneration. An important area of activity is also research on the phenomena of histocompatibility between the recipient and donor and developing methods of breeding organs for transplantation.

Research into health problems, in particular diseases of affluence, new drugs and regenerative medicine, is a dominant study area of many faculties of medical universities, some centres of the Polish Academy of Sciences and numerous research institutes.

3. ADVANCED INFORMATION, TELECOMMUNICATIONS AND MECHATRONIC TECHNOLOGIES

The huge progress in the area of data access and transmission and the development of the telecommunications sector observed over the last several years have transformed many economies worldwide. Economic growth is driven by information resources and the possibilities of their processing rather than by natural resources. Wide access to high-quality ICT has become a key priority for political and economic decision makers. As a result, sectors offering ICT (information and communication technologies) have seen an unprecedented growth in terms of their value, at least in some economies, and have contributed to an accelerated overall increase in the productivity of these economies.

The influence of technical progress in the field of ICT on economic activity goes beyond its direct impact on the ICT producing industry branches. The adaptation and application of new solutions in most sectors of an innovative economy increase the effectiveness and competitiveness of the economy.

The current ICT development is stimulated by science and business applications requiring above-standard functionality of the new systems and general availability of technologies, which is ensured by new virtual computing environments and widely available computer networks. The revolutionary “cloud” computing solutions do not require physical installation of system components and ensure a wide access to the functionalities they offer. Such solutions highly improve the competitiveness of many businesses, especially SMEs. Despite the huge growth, stimulated mainly by innovative solutions developed in response to

specific needs, currently the race is for getting better, more flexible, cheaper, easier to use and functionally innovative IT products.

The IT component has become an essential aspect of many complex and advanced innovative projects, both in science and industry. It is computer science that often brings together researchers representing various fields through joint work on tools or through setting the limits for modern technology solutions. These in turn stimulate approximate solutions and contribute to progress in general. Subsequently, questions remaining without a solution stimulate basic research, the results of which often foster development in the field which posed the very question. Often, the range of solutions is so important and comprehensive, while the challenges so significant, that they become the nucleus of a new discipline in the field of computer science, such as bioinformatics, image processing, multimedia processing on mobile devices, network security, computer graphics, or in the past - artificial intelligence. Many of these areas are now successfully developed by networks of small and medium-sized enterprises and various types of clusters, in which the business sector works together with research institutions in several regions of the country.

The expectations for ICT solutions are enormous, both in Europe and worldwide. They include equipment that computes and communicates, software that provides data, knowledge and information and at the same time controls complex technology and business processes and communicates through interfaces between computers, tools or production line machinery. Customised production processes are a huge competitive advantage and are often cited as essential for further development of specialized technologies.

Smart sensor networks set up to monitor data variability in difficult access environments, self-configuring embedded systems and adaptable service robot systems represent a research & business area with a high rate of growth. What merits particular attention is modern management of energy consumption within smart power grids connected to receiving devices which self-optimise the consumption.

The current, widely used computational model offered in various types of computers has obvious limitations. Developing quantum technologies, which carry a huge potential for significant acceleration and multiplication of concurrent computational processes based on a number of diversified data and for reducing equipment weight, as well as new, better and more difficult to decode cryptographic systems, using quantum distribution of the cryptographic keys and quantum cryptography, are the focus of a number of centres throughout the world.

Subsequent challenges are also overcome by modern mechatronics - an interdisciplinary field of engineering which is a combination of mechanical, electrical and computer engineering, automation and robotics, used for designing and manufacturing modern state-of-the-art equipment. The increasing versatility of mechatronic products offers multifunctionality, configurability and adaptability, depending on the needs of the application area.

The world is on the eve of a technology breakthrough of increasing the autonomy of many devices and technologies in all areas of public life and industry, from military applications to simple household appliances. This requires looking at products from a different perspective, both during the design, manufacture and operation stage - this approach reflects the notion of mechatronics. What is characteristic of mechatronic solutions is multi- and cross-disciplinary approach. It overcomes the previously established divisions between disciplines and analyzes the created product as a whole in the market environment at any

stage of its development. This requires developing methods for interdisciplinary designing and interfaces between such distant areas as mechanics, electronics, software, economics, medicine and management. Furthering the mechatronic approach is necessary to improve industry competitiveness. It will be also a basis for the creation of structures imitating biological objects.

Similarly, fast-growing photonics focused on practical applications integrates R&D in many areas. National innovative implementations in this field will increase the potential of scientific cooperation with leading European and global centres, supporting development and innovative activities of Polish photonic / optoelectronic companies.

In many countries the use of ICT in managing and monitoring the transportation infrastructure becomes a priority in the development of communication and transportation networks. The modernization of the national transport infrastructure requires a modern transportation infrastructure management system, ensuring, at the same time, reliability and sustainability of air, rail, road, water and pipeline transport, as well as structures and systems protecting users and rescuing them in case of failures. Developing "smart modes of transport" and "smart infrastructure" which provides and processes data about the condition of the vehicle or infrastructure, the traffic, the threats, the behaviour of vehicle users and of the infrastructure, requires a specialist and integrated approach. In addition, the use materials and systems allowing emissions to be reduced thanks to “clean” means of public transport driven by renewable energy concurs with the direction of research towards new energy technologies. These effects can be achieved by: integrated implementation of information and communications technologies to reduce the number of means of transportation used and increase the efficiency of urban and suburban transport, introducing integrated transport and designating "green areas" in urban centres, improving transportation systems by interlinking different modes of transport and integrating the related services and by using small airports and light aircraft in the transport systems.

An important aspect is the development and implementation of environmentally clean means of transport (vehicles), including electric cars. In the future, these vehicles should be integrated with the public power system, acting not only as electric energy receivers, but also being a dispersed energy buffer stabilising the operation of the public power system.

Despite the very significant benefits associated with technology and information society development, one should be also mindful of the risks arising from the use and democratization of the Internet, including cyber-terrorism and the access by cyber criminals to sensitive, confidential or secret data.

Poland has a huge intellectual potential in terms of ICT development. The excellent academic teachers, many talented graduates of IT and telecommunications faculties, should create possibilities for achieving a satisfactory rate of return on investment in the ICT sector. Often, research in this area carried out by Polish scientists represents world quality, while its results are published in the best journals and widely quoted. The strategic direction in this area identified as a catalyst of solutions in a number of areas requiring progress, based on active cooperation of scientists from many fields of applied sciences, has a huge potential for development and rapid implementation in the economy.

Poland must make every effort to make the best possible use of the potential in the field of satellite and space technologies. Actions towards developing advanced technologies in this

area and strengthening cooperation between the R&D sector and the economy will play a significant part in increasing the competitiveness of Polish enterprises.
At the same time, the efficiency and effectiveness of public administration must be improved through developing and implementing solutions based on satellite technologies to enable better use of existing resources and infrastructure. This will satisfy the needs of the state in national security terms thanks to the use of the tools available and developing autonomous capacities in selected areas.
In the years to come, Poland will face the challenge of meeting the prevailing international technical, technological and organisational standards, while the economy and state administration will be able to take the opportunity of creating a national space technology agenda and participating in multinational programmes.

4. MODERN MATERIALS TECHNOLOGIES

Multidisciplinary research in chemistry, physics, biology, pharmacy, engineering sciences and information technology are currently the most effective source of products and materials with new and improved properties, as well as new applications improving security and living standards. Implementing the technologies and techniques created as a result of such research will highly improve the competitiveness of Polish industry. Among these technologies, a key role is played by the nanotechnologies generating new materials with a structure programmed at the molecular level and having completely new properties and applications. Polish economic development is also largely dependent on the availability of a wide range of mineral resources.

The research should result in developing new effective technologies of manufacturing metals, their alloys and chemical compounds, functional composite materials, nanocrystalline, layered and graded-index materials, functional ceramics, glass, refractory materials, polymeric materials, new semiconductors, modified wood and composite lignocellulosic materials. It must be accompanied by the search of materials having unique properties and specific applications in a range of areas of human life and economy and supporting sustainable development.

New generation materials, developed, implemented in the manufacturing sector and applied in the economy have already become a “Polish specialty” and are bound to enhance this reputation. Achieving this goal requires using technology to produce functional materials for applications in computing, electronics, photonics and energy, the chemical industry, the engineering industry, the food industry, the textile industry, construction-based industries, biomedical engineering, transportation, agriculture and the defence industry. Developing advanced material engineering technologies will facilitate controlled development of the properties of materials and designing energy-efficient and environmentally friendly solutions.

An opportunity for innovative and upgraded technologies improving the security of society, the economy and the state should be sought in materials and technologies linked to energy storage and transmission, as well as photonic technologies used in reliable and efficient long-distance data transmission systems. This requires developing nanoelectronics,

optoelectronics and spintronics by using new semiconductor materials (e.g. graphene), single crystals, active glass and laser ceramics. What must become an essential component of these developments are energy conversion technologies based on power electronics using traditional and new semiconductor compounds (silicon, carbon and its new varieties, wide bandgap semiconductors, organic semiconductors), composite materials with strong magnetic, piezoelectric, thermoelectric and luminescent properties, electrode materials for new types of batteries and hydrogen-absorbing materials. As a result of such research, new medical nanosensors and photonic and spintronic structures may be developed for new devices using these properties.

The need to modernise the national transport infrastructure is a strong challenge for materials science in terms of developing new materials and technologies for the powering, management and diagnostics systems of the transport infrastructure. What will be of crucial importance for “green” and energy-efficient transport is using light metals and new wire and construction materials.

A key role in industry development will be played by materials with designed parameters. Their use will require upgrading the existing and implementing new large-scale metallurgical and chemical industry processes in compliance with BAT (Best Available Techniques).

The advisable actions in this respect will include stimulating R&D related to the manufacturing of materials for environmental applications, with a focus on gas, biogas and flue gas treatment, and materials used for fuel cell production. The planned development of nuclear energy and radiation methods, including the manufacturing of radiopharmaceuticals, requires developing technologies for raw materials treatment and managing the specific waste that is produced during nuclear energy generation.

Ensuring safety, sustainability, usability and reliability of building structures requires designing new types of constructions and materials which are safe for the health and environment, and, at the same time, characterised by high durability. Therefore it is necessary to develop new-generation construction materials with high strength and thermal properties by using nanotechnology, microtechnology and biotechnology, so as to allow for materials to be designed and modified depending the expected properties. As a rule, increasing the production of construction materials based on mining, industrial and demolition waste recycling technologies, allows the amount of mined raw mineral materials to be reduced.

The ever increasing traffic, with a growing share of heavy vehicles, growing expectations of road users and the expectations of road managers in terms of the longevity of infrastructure solutions, require such research as to enable the much used road infrastructure in Poland to be remodelled and strengthened. Applying the method of analysing the actual impacts of heavy vehicles on road infrastructure will improve the quality of road infrastructure diagnostics. Research on new materials and technologies used for redesigning and reinforcing bridge structures (including historic ones) may provide a basis for modern applications.

Innovative use of processes and products manufactured by biotechnology methods should add new biodegradable products and new pharmacological therapy products and processes to the domestic pool of resources. Such products are also used in the food and cosmetic industry and in household chemistry. They may be used as the so-called "specialities" by various

industry sectors. Targeted research should focus on obtaining unique and improved biocatalysts and metabolites to be used in the pharmaceutical and food industries and in environmental protection, as well as environmentally and health friendly biodegradable and biocompatible biopolymers. Their use in technologies for ecosystem purification, obtaining valuable components from minerals, treatment of gases and mineral waste will also be desirable.

Economic growth and the resulting new threats for society require developing new technical and organisational safety systems and innovative, health and environmentally friendly materials, products and technologies. Innovative biodegradable lignocellulosic materials should play a vital role in this process.

Research into new materials and their manufacturing technologies is the main focus of some units of the Academy of Sciences, faculties of technical higher-education institutions and universities as well as research institutes. The scientific achievements of these institutions in the field of basic research represent high international standards. Well-equipped institutes deliver projects in full research cycles - up to the implementation phase - from laboratory tests and pilot studies to product marketing and international licence selling.

5. NATURAL ENVIRONMENT, AGRICULTURE AND FORESTRY

In the 21st century, the quality of human life on Earth will depend to a large extent on the condition of the natural environment, as well as the availability and quality of food and clean water. The growing human population on the planet means, among others, problems related to the state of the natural environment and rivalry for natural resources. Over the last 100 years, the Earth has seen changes resulting, among others, in forest cover shrinking and climate change.

According to FAO, in 2050 the global agriculture will have to produce 50% food more than currently, with nearly the same area of crops. This is a huge challenge for science - for new, but at the same time safe food production technologies, seeking new varieties of plants and safer methods of their protection for consumers. The crisis which affected the world in 2008-2009 made all European countries, including Poland, aware of the importance of food security. Europe and Poland must be self-sufficient in terms of food production. It is also expected that new implementations of research will allow logging to be increased and wood conservation to be improved.

Research in this area is intended to support activities related to environmental management and rational use of natural resources, addresses the strategic and on-going problems of environmental protection and management, reflecting the principle of sustainable development, and serves the delivery of commitments arising from international conventions, Poland’s membership in the EU and other international organisations. Strategic decision making should be based on research comprising evaluation of the current status and threats, the use of the country’s natural resources and biodiversity and the possibilities of their more effective use for the benefit of the national economy and society, while maintaining the environment in a condition allowing for its natural regeneration and functioning of natural processes. As regards non-renewable resources, especially mineral resources, it is reasonable to focus on research allowing them to be used in the best possible way (among others, by using non-waste and low-waste technologies) and on the most efficient methods of their use

and processing. In parallel, the use of natural resources may be substantially improved by streamlining the recycling processes through enhancing their organisation, logistics and efficiency. What is an important planning factor is wider industrial use of mineral waste allowing for rational management of raw materials deposits, and limiting, at the same time, the need to adopt new land for mining.

Reducing greenhouse gas emissions is one of the most important goals of EU-wide actions. It is expected that over the next 50 years climate change will seriously affect the functioning of the main sectors, such as water supply and management, agriculture, forestry, fisheries, infrastructure and transport, tourism, protection of (human, animal and plant) health, energy, ecosystems (including sea ecosystems) and biodiversity. Ecosystem degradation is bound to take speed and likewise the impoverishment of biodiversity will proceed at a faster pace. Climate change will affect both households and businesses, as well as the more vulnerable social groups - especially the elderly, the handicapped and low-income families. Its impact will differ from region to region.

Research on the broadly defined natural space, nature conservation, new food management technologies, climate change and the role of forests and wood-based industries, rational water and mineral resources management is crucially important for the functioning of the economy. The declared sustainable development must not only be declared but also actual. What is also necessary is research aimed at ensuring a balanced approach to the climate policy, which will prevent a decline in the competitiveness of Polish industry and a growth of unemployment rates.

The natural environment, nature and forest conservation, agriculture, ensuring food security and food safety, taking advantage of the health-related aspects of food - all these fields constitute a great interdisciplinary research area requiring continuous education of scientific and engineering staff. These issues are of utmost importance. The development of new technologies is based on the assumption that Poland will use any energy sources available, inclusive of the rich natural resources. These include non-renewable resources, such as coal and gas, renewable energy and nuclear energy.

The above actions will require in-depth analyses and research as well as developing new technologies aimed at minimising negative environmental impacts, especially as regards the burdensome industrial waste. Another important type of research is that aimed at developing methods of increasing renewable and available resources, by developing sustainable forms of retention and protection of underground and ground water against contamination. Science must develop new technologies of rational water management and reducing its unproductive losses in agriculture, forestry and municipal water and sewage management.

Research supporting agriculture and forestry development in Poland should take into account issues related to industrial, sustainable and ecological agriculture, the importance of agricultural infrastructure development and the development of non-public forestry and production for energy-related purposes in the context of reasonable use of the agricultural production area. What is also crucial is carrying out research on environmental impacts of animal production and on the protection of the genetic resources of endangered Polish farm animals and crop varieties.

What is of key importance in the context of climate change is research related to water management in rural areas and in agriculture, biological progress and new production technologies in the context of changing climate, forest management and production of wood products, as well as the impact of these factors on agriculture and the natural environment. In the context of the sector concerned, it is important that the decline of the content of organic carbon in agricultural soil and the resultant negative impacts should be stopped. Energy and water consumption of agricultural production and limiting the use of synthetic pesticides are also of crucial importance.

As regards the production of healthy food, emphasis must be put on technologies supporting evaluation of raw materials quality, developing the criteria of safety guarantees, the level of animal welfare and its impact on production effectiveness, evaluation of genetically modified organisms and studying their impact on the quality of food and environment. The research should contribute to establishing norms and standards, e.g. with reference to GMOs.

Present-day progress in biotechnology development effectively supports developing new technologies in agriculture and processing. A key objective here is to protect natural biodiversity, also in the agricultural and forestry environment.

Making use of the knowledge and information on the environment as an effective tool of land management, natural resources management, agricultural activity, water management, minimisation of air, water and soil pollution and mitigating the impact of natural disasters, is crucial to strategic planning of the country's development. As such it must be based on the latest achievements in this respect.

The agricultural research disciplines, both in Europe and in Poland, should take into account practical implementations of research outcomes and contribute to effective building of a new food and agricultural sector. Thus complementary actions responding to the needs of lifelong learning and fast turning of ideas into the production practice are of utmost importance in this sector. The on-going research projects in such areas as obtaining new varieties of crop plants and animal breeds immune to adverse environmental factors, methods of protecting agricultural production against pests and functional food production technologies benefit from the excellent research potential of the scholars employed at agricultural higher-education institutions, universities, technical universities, the Polish Academy of Sciences institutes and research institutes.

Research in this area should address the issues indicated in the OCED Green Growth Strategy, which include identifying the thematic areas and instruments which have the greatest potential of supporting green growth, including the appropriate valuation of ecosystem functions, supporting environmental technology development and innovative financing mechanisms which promote replacing the existing consumption and production models with more sustainable ones. It is also vital to identify the policies likely to ensure seamless transition to a greener economy, with emphasis on the labour market, notably the system for improving and/or changing qualifications to allow more freedom of movement of staff to the green economy sectors.

The technologies of obtaining information about the global climate change processes from satellites surrounding the Earth and factors linked to sustainable use of resources are a key element of today's satellite-based monitoring of the service sector based on satellite imaging. Owing to their strategic nature, for decades, the data obtained in this way was only available to the administration of some states, which had built their own infrastructure of

satellite observation. The change came with the gradual removal of the legal and administrative barriers to the access to satellite imagery, reduction in its prices and the popularisation of the Internet. Poland must ensure the widest possible involvement of small and medium-sized enterprises in these types of services.

6. POLAND'S SOCIAL AND ECONOMIC DEVELOPMENT IN THE CONTEXT OF GLOBALISING MARKETS

Building a modern economy, based on knowledge, facing difficult global challenges and exposed to high instability and risk requires extensive research and analyses of a holistic nature, addressing both the analytic and synthetic dimension. It also requires a deeper reflection on society and national heritage.

Building strong human capital requires providing solid education to youths, tailored to the needs of modern world. Introducing changes to the educational system to reflect these requirements and their monitoring, as well as improving the quality of education, are among the key challenges in the years to come. Due attention must also be paid to the growing need for life-long learning, which is an area relevant for all society. This will pose new challenges for state authority institutions, requiring systematic educational research to create modern development strategies aimed at building a competitive knowledge-based economy.

In a world dominated by technologies, which are both a driver of progress and a potential threat, society needs permanent points of reference, including: collective memory, feeling of identity, systems of values and standards, social knowledge and the feeling of bond with the national heritage. Therefore it is crucial that research should contribute to the preservation of the tangible and spiritual heritage of Polish society.

At the same time, to ensure and maintain sustainable development, it is crucial that all, especially unique, assets should be preserved. Research towards synergic use of all the assets will determine the future development of the state.

These resources, also referred to as intellectual capital, are defined as the overall non-physical assets: people, businesses, communities, regions and institutions, which, if used appropriately, may be a source of present-day and future welfare of the state. Studies on the impact of such assets reinforced by the potential accumulated in people, their education and experience (human resources), and the potential created by society in the form of trust and responsibility norms (social and relational capital), will improve the effectiveness and efficiency of intellectual capital in shaping social and economic development, enhancing the corresponding use of natural and physical resources.

The development-related changes in the global environment require seeking new sources of progress and competitive advantage. The growing importance of intangible assets is clear here. Strengthening Poland's position in the global intellectual capital development process requires research focussing on setting the conditions for enhancing talents and knowledge-based economy by analysing the barriers and possibilities of improving innovation, creativity and entrepreneurship of citizens, as well as of scientific and educational institutions.

In the nearest future, we will have to deal with a deep demographic change manifesting itself in ever faster population ageing. At the same time, the economic and scientific freedom will improve mobility, while modern digital technologies will change the forms of civil, social and cultural participation.

Therefore we need research into phenomena related to: population-aging, factors linked to professional and social activation of the elderly, the evolving new structure of needs,

access to digital goods and services among the 50+ generation, specifying the consequences of using ICT, systems stimulating a change in the quality of life in an information society, rules ensuring safe functioning of the state, economy and society and the possibilities of promoting proactive attitudes at all ages.

The ever greater market globalisation requires the participants in the governance process developing entrepreneurship, creativity and innovativeness, as well as enhancing effective management methods. The degree to which these attributes will be present in businesses and other organisations contributing to economic and social growth will determine the competitiveness of the national economy.

The priority research directions should address various aspects of the internationalisation of Poland's economy, including its safe development models, impact of foreign trade on economic growth, improvement in the effectiveness of the transport system, conditions for innovative economy development, competitiveness of selected sectors and industries of the Polish economy, effectiveness and efficiency of economic policy instruments in stimulating the competitiveness of SMEs, strategy of foreign market penetration, business development by using modern information technologies and new media, impact of the evolution of the service sector on the country's social and economic development, the role of consumption and consumers in creating an innovative economy and the impact of the tax policy on the delivery of the state's long-term social and economic objectives.

The policy of supporting economic development by corporate networks, including clusters, has ceased to be merely a tool of innovative policy, but instead, has become the mainstream and direct instrument of determining regions' development and their smart specialisation. Hence the huge popularity of the economic growth policy concept based on clusters, promoted in recent years by the OECD. The concept of clusters is becoming an important element of the EU's economic policy, reflecting the priorities of the Europe 2020 strategy for smart, sustainable and inclusive growth. According to European Commission documents, attention must be focused on supporting clusters with substantial growth potential, as this will ensure effective public fund-spending. Clusters can contribute to faster approximation of Polish incomes to the EU average and enhancing the convergence of development between the individual regions, because they can act as growth poles for the whole country and individual regions, also the less developed ones.

Another vital factor contributing to the creation of a 21st-century society is increasing the public awareness of the environmental benefits and threats associated with the implementation of new technologies in managing the state and the economy. Similar challenges requiring the functions and responsibilities of the state to be redefined are linked to the risks of economic crises, unexpected natural disasters, ecological disasters and other global phenomena.

Facing up to these challenges will not be possible without efficient public (state and self-governing) authorities. Therefore it is necessary to carry out research aimed at: streamlining and enhancing the effectiveness of public institutions, especially the public administration, increasing the efficiency of the justice and healthcare systems, improving the legal environment for business operation, monitoring and minimizing administrative burdens, improving the quality and efficiency of public services, mobile government administration, using state-of-the-art knowledge, skills and experience in an efficient way. For research concerning the bodies of public authorities and administration to be used in practice, it should be delivered in an interdisciplinary manner, using the methodology of the legal, economic and sociological sciences and the management science, as well as social psychology and political studies.

Being an EU member since 2004, Poland should also make a vital contribution in scientific and expertise terms to determining the European policy and its sectoral components. Therefore comparative studies addressing the international, and notably the European, aspects of public policies, should serve not only Polish but also European policy-makers, strengthening Poland's role across Europe and worldwide.

Poland has substantial potential of scientific and research institutions: reputable academic centres, Polish Academy of Sciences institutions, specialised research institutes carrying our research into the different aspects of political transformations and stimulating the business, innovation and creativity development processes, both in social and economic terms.

7. STATE SECURITY AND DEFENCE

Ensuring independence and inviolability of Poland's territory and security of Polish citizens is one of the constitutional responsibilities of the state. Poland delivers this commitment by taking appropriate actions in the framework of the internal and external policy, which includes Poland's commitments as a NATO and European Union member.

Ensuring an adequate level of security and defence is a pre-condition for economic, social and cultural development of the state, considering the modern threats and challenges linked to the need to prepare Poland for effective and efficient acting in emergency situations, fighting crime and terrorism and engaging the Polish Armed Forces, the formations controlled by the Ministry of the Interior and Administration and the services subordinate to the Prime Minister not only in domestic but also international operations.

The external aspects of Poland's security, intensive development of the country's economic potential and its growing involvement in active international security management require a gradual optimisation of the forces and resources towards creating an integrated and comprehensive system of national security. What becomes crucial in this context is creating a mechanism facilitating simultaneous use of the state defence system and the crisis management system components. Integrating the elements of planning and preparing the military and civilian components at each response level, a comprehensive approach to emergency solving and regulating and assigning the respective tasks of the public administration, as well as establishing stable sources of their financing provides a leverage for enhancing the national security and an effective tool of its delivery.

The operational effectiveness of the services engaged in the above tasks is being increased, among others, by continuous technology development oriented to the users' operational needs and the adaptability of the system for management and organisation of the security and defence services. Carrying out targeted research and development in this area and translating their results into day-to-day practice are crucial to increasing the above effectiveness. Any effective implementation translates directly into improved general security and public order.

The area of state security and defence is characterised by enormous potential (both at the national and international scale) and a high level of diffusion of innovation into other economic sectors. Research and development carried out for state security and defence needs

create an opportunity for strengthening the implementation aspect of the state security policy, combined with scientific, technology and social and economic development.

This approach corresponds to the new rules on the development policy making adopted by the Council of Ministers in 2009.

In terms of R&D in the area of security and defence, it should be noted that it is possible and advisable to exploit the synergy between the domestic and European research agendas. International cooperation in this area is an opportunity, on the one hand, for further development and delivery of the valuable domestic programmes, and on the other, for establishing common and universal solutions, as well as standardising the procedures and equipping public order services across Europe. Moreover, the knowledge acquired while working for international R&D consortia may be a starting point for initiating domestic programmes.

This reflects the policy pursued by Poland following the entry into force of the Lisbon Treaty and the European Parliament resolution of 11 May 2011 on the common security and defence policy, in which the EP:

- encourages close cooperation between the European Defence Agency and the European Commission with a view to enhancing dual-use capabilities in order to find the most comprehensive approach to security-related research;
- calls for the establishment of a strong partnership between the European Commission, the European Parliament, the European Defence Agency and the participating Member States on the preparations for subsequent framework programmes with a view to investments in technology areas of common interest at EU level, bearing in mind not least that the amount spent in Europe on investment in defence-related R&D is currently equivalent to about 10% of the US figure.

The possibility of practical application and commercialisation of research outcomes should be the fundamental goal of research and development activities. To achieve it, efforts must be made to ensure close cooperation between science and industry and focus research and funding on the projects which reflect the needs of the state institutions responsible for security and defence. This will translate into more efficient management of the limited research funding and systematisation of security- and defence-related research, contributing to the creation of solutions preventing double funding from the state budget. The process will be supported, among others, by cooperation between the Ministry of National Defence, the Ministry of the Interior and Administration, the Ministry of Science and Higher Education and the Internal Security Agency with a view to exchanging information on the needs to develop new - especially dual-use (civilian and military) - solutions and technologies. Actions in this respect are coordinated by the Steering Committee of the National Centre for Research and Development, which is responsible for establishing strategic R&D programmes in the area of state security and defence (Article 17 item. 1 of the Act on the National Centre for Research and Development).

STATE SECURITY

A crucial factor for improving the protection of population is targeted R&D is support of the process of crime detection and fighting, state border protection, reliable operation of the crisis management and critical infrastructure protection system and the rescue and fire fighting system. Fast detection, response and counteraction in case of the above threats, and

effective removal of their consequences, are a measure of the state's efficiency in this respect. As a result, the following priority areas for developing internal security technology have been set:

1) Modern technologies and innovative solutions in threat detection, fighting and neutralisation,
2) forensic techniques,
3) Personal protection equipment,
4) Social prevention, victimology, criminology and social studies,
5) Organisation and management,
6) Modern technologies and innovative solutions in ICT security, information security in ICT systems and networks, and national cryptography.

STATE DEFENCE

The objective of state defence R&D is to support the process of enhancing the operational capacity of the Polish Armed Forces. This objective is to be achieved by harmonising research with the operational needs of the Polish Armed Forces, using investment mechanisms in an effective way, financing security and defence R&D from the state budget for science, mainly through the National Centre for Research and Development, and increasing the engagement of the Polish Armed Forces in projects delivered in the framework of international cooperation.

In accordance with the political guidelines adopted, the priority operational capacities to be developed by the Polish Armed Forces within the next 10 years include in particular:

1) the commanding capacity,
2) the reconnaissance capacity,
3) the firing capacity,
4) operation support capacity combined with redeployment and mobility capacity,
5) capacity to survive and protect troops, including the capacity to secure the battlefield in medical terms,
6) capacity to support the non-military system in case of non-military threats.

After analysing the priority operational capacities, the following priority technology areas have been defined:

1) information and network technologies,
2) sensors and observation;
3) precision weapons and weaponry,
4) unmanned (autonomous) platforms,
5) protection and survival in the battlefield,
6) modern materials, including high-energy and smart materials.

The delivery of relevant R&D work should contribute to developing the operational capacities which the Polish Armed Forces plan to achieve in the future, as well as to reducing costs and minimising the risk of failure.

Moreover there is a need for investments into completely new disruptive technologies, whose development and application may lead to achieving new, previously unknown capacities, likely to change radically the future situation on the battlefield.

The NATO Research & Technology Organisation has developed a list of 20 disruptive technologies: quantum technologies, cloud computing, intelligent autonomous systems, wireless networks, sensors, low-cost night vision, directed (beam) energy, microsatellites, virtual and augmented reality and cognitive interfaces, unconventional weapons, intelligent materials, nanorobotics (nanotechnology), high-temperature superconductivity, power supply and energy storage systems, biotechnology, medicine progress, social networking, supersonic platforms and drives, miniaturized electronics and “stealth” and “anti-stealth” technologies.