



Science in Latvia

National Research Programmes

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Rīga
2010



**Dear Readers of the Publication
“Science in Latvia. National Research Programmes”,**

“Science in Latvia. National Research Programmes” is the first publication compiled by the Ministry of Education and Science on the results of the nine national research programmes, which now round up an important period for Latvian science that started in the year 2005.

National research programmes are a public commission of scientific research in prioritised sectors with an aim to facilitate the development of Latvia. Programmes are implemented in priority scientific areas approved by the Cabinet of Ministers and funded from the budget of the Ministry of Education and Science. The aims and objectives of the programmes are in their turn determined by the ministries of the relevant sectors together with the Latvian Council of Science and the Latvian Academy of Sciences.

Results achieved in programmes contribute significantly to the development of intellectual potential in Latvia and to the continuing engagement of our researchers in international projects, thus acquiring new knowledge and creating innovative ideas. Scientists, by their results achieved during these years, have contributed to the creation and development of a knowledge/innovation based economy. At the same time it is a specific foundation for further strengthening the cooperation between science, higher education and national economy within the framework of the newly established national research centres and competence centres, as well as further opportunities provided for the Latvian scientists through participation in different national and international projects and programmes.

The publication: "Science in Latvia. National Research Programmes" provides an overview of the results of the national research programmes implemented within the period from 2005 to 2009, describes the system of the Latvian science and reflects information on scientific support programmes, their aims and particulars. Furthermore, the publication provides insight into the aims and objectives of the five programmes set forth for the period of 2010-2013 that coincide with the aim of the flagship initiative "The Innovation Union" of "Europe 2020 – a Strategy for Smart, Sustainable and Inclusive Growth", namely, to ensure that innovative ideas are turned into products and services that create growth and employment.

I am grateful to the Latvian scientists, research institutions and everyone who engaged in the implementation of the national research programmes. Investment of intellectual resources and provision of organisational work have yielded important results. I therefore wish that this publication allows every reader to become better acquainted with the achievements of Latvian scientists, to understand the importance of those achievements for the further development of the state and strengthening of international competitiveness!

Yours sincerely –

A handwritten signature in blue ink, appearing to read 'Broks', with a stylized, flowing script.

Rolands Broks,
Minister of Education and Science

CONTENTS

Introduction	7
1. Development of Science in Latvia	9
1.1. National research and development policy and its formation	9
1.2. Priority scientific areas	11
1.3. Institutional system	14
1.3.1. Administrative structure	15
1.3.2. Scientific institutions	17
1.3.3. Scientific personnel	18
1.3.4. National research centres	21
1.3.5. Technology parks and centres	22
2. Scientific Support Programmes	25
2.1. Fundamental and applied research	25
2.2. Market-oriented research programme	26
2.3. International scientific cooperation	29
2.3.1. Framework programmes	29
2.3.2. EUREKA	31
2.3.3. COST	33
2.3.4. International infrastructures	34
2.3.5. Participation in the European Space Agency	37
2.3.6. EUROSTAR	37
2.3.7. ARTEMIS	38
2.4. European Union's structural funds for science	38

3. National Research Programmes	41
3.1. Innovative technologies for high-quality, safe and healthy food production from genetically, physiologically and biochemically diverse plant and animal material	43
3.2. New medicines and biocorrection tools: design, transportforms and mechanisms of action	48
3.3. Research and elaboration of modern methods and developed technologies in the field of energy: environmentally friendly energy, security of energy supply and energy efficiency	51
3.4. Scientific foundation of information technology	56
3.5. "LETONIKA" (Latvian studies): studies of history, language and culture	59
3.6. Development of advanced functional materials for microelectronics, nanoelectronics, photonics, biomedicine and constructional composites, as well as related technologies	63
3.7. Substantiation of deciduous trees cultivation and rational utilisation, new products and technologies	67
3.8. Multi-disciplinary research consortium on major pathologies threatening the life expectancy and quality of life of the Latvian population	73
3.9. Climate change impact on water environment in Latvia (KALME)	77
3.10. National research programmes (2010 – 2013)	82
4. Statistics of Research and Development	89

INTRODUCTION

Knowledge and innovation are the key resources of Latvia for the achievement of national development aims. Contrary to the countries that have the possibility to choose from a number of resources or to combine the same, Latvia indeed does not have any other alternative except human-based and with human capacity improvement-related way of development. To reach the quality of life of every individual and the entire society that is characteristic to the developed countries, knowledge and rational and purposeful utilisation thereof is our most valuable resource.

The main tasks of science are: 1) to create intellectual environment for quality development of higher education and the society in general, 2) to establish a base for the development of new modern technologies, development of their implementation mechanisms, as well as to facilitate wider application of scientific methods and approaches in the public administration and national economy, 3) to stimulate dynamic and balanced social and economic development of the society and to ensure study and preservation of national identity and cultural heritage.

A knowledge-based model of development sets forth education and science, along with the development of technologies and innovations related thereof as preconditions for successful and sustainable development of the state. The intellectual potential is the drive for utilisation of capital, technological development and workforce quality, hence stimulating economic growth.

The publication: "Science in Latvia. National Research Programmes" provides a short insight into the system of science in Latvia, information on scientific support programmes, their aims and specific features, an overview of the results of national research programmes implemented in 2005-2009 and the aims and objectives set forth for the national research programmes within the period of 2010-2013.



1. DEVELOPMENT OF SCIENCE IN LATVIA

The successful development of a knowledge-oriented economy cannot be imagined without the potential created by science and research. In opposition to the countries that have the possibility to choose from a number of resources or to combine the same, Latvia indeed does not have any other alternative except a human-based and with human capacity improvement-related way of development. To reach the quality of life of every individual and all of society that is characteristic of the developed countries, knowledge and rational and purposeful utilisation thereof is our most valuable resource.

1.1. NATIONAL RESEARCH AND DEVELOPMENT POLICY AND ITS FORMATION

Since the state declared independence, radical changes have taken place both in politics, economy and culture and in science and research, bringing about an entirely new environment for its development.

The Law on Scientific Activity, having taken effect on 18 May 2005, is presently the chief document governing legal regulation for the science and technology development policy. The law stipulates:

- ✓ uniformity of science and higher education;
- ✓ rights, liability, independence and academic freedom of scientists;
- ✓ professional and social guarantees;
- ✓ competence and obligations of state authorities related to ensuring scientific activity.

To increase the general competitiveness of the state, purposeful implementation of the innovative government policy that would facilitate accelerated development of new, knowledge-based industries and increase of the proportion of goods with high added value in the traditional industries is required.

To achieve better coordination of the Latvian economic policy in the direction of innovative action development policy, the Entrepreneurship Competitiveness and Innovation Promotion Programme for 2007-2013 was approved by the Cabinet of Ministers in the middle of 2007, uniting in one document the former government

policies and the contents of a number of planning documents. The main aims of the programme are:

- ✓ to ensure favourable conditions for the development of commercial activities within the borders of Latvia with an aim to increase the competitiveness of undertakings, especially of small and middle-sized enterprises, the establishment and development of new undertakings, and to reduce the negative socio-economic development gaps within the country's regions;
- ✓ to facilitate increase of the capacity and effectiveness of the National Innovations System through creation of a regulatory, financial and informative environment favourable to the innovative activities;
- ✓ to achieve considerable improvement of competitiveness and efficiency in the industrial sector through promotion of the growth in production volumes of goods with high added value and increase of the proportion of high-technology goods in the manufacturing and export structure by expanding application of innovative technologies and progressive management methods in all industrial sectors.

Key emphasis in the development of the innovation policy is placed on the facilitation of research requested by industry, development and strengthening of infrastructure in line with innovations, as well as support for innovation and research projects within the European Union's Framework Programme and stimulation of cooperation between scientific research institutions and manufacturers.

Furthermore, on 16 September 2009, the Cabinet of Ministers approved Guidelines of the Science and Technology Development for 2009-2013. The aim of the Guidelines is to determine the science and technology development policy in Latvia by identifying the problems and stating the objective, underlying principles and courses of action. The following basic principles were considered in the development of this policy-planning document:

- ✓ science and research are the basis for competitive higher education and a knowledge society;
- ✓ research and development of technologies are the basis of research-intensive products and technological manufacturing industries;
- ✓ science and technology development is the decisive factor of sustainable development of the Latvian economy, ensuring of public welfare and preservation of environmental and nature resources;
- ✓ science and research, especially humanities, are the basis of national culture, national identity and self-confidence and a necessary precondition for the development thereof;

- ✓ Latvian science, research and innovation are a harmonious and integral part of the European Research Area;
- ✓ funding for scientific activity is basically allocated through competition.

The main aim of the science and technology development policy is to shape science and technologies as the basis for the long-term development of civil society, economy and culture by ensuring implementation of a knowledge-based economy and its sustainable growth.

Four key objectives have been set forth for the achievement of the aim:

- ✓ to facilitate upgrading and development of the intellectual potential and infrastructure of scientific activity through shaping universities as internationally competitive science and development centres through the cooperation with which the higher education establishments in regions develop, and to facilitate the development of other public and private scientific institutions;
- ✓ to ensure increased state investments in science and technology development, achieving that the fund allocation mechanism would provide for growing attraction of investments from the private sector;
- ✓ to facilitate competitiveness of scientific activity at the international level by stimulating international cooperation in the field of science and technology development;
- ✓ to facilitate transfer of knowledge and technologies by creating an institutional environment that is favourable for innovative activity and organising support measures, to facilitate public and private partnership.

The knowledge-based development model sets forth education and science and the related technological development and innovation as the priority preconditions for successful and sustainable development of the state. Therefore the key stress in the creation of science and technology development policy is placed on the facilitation of knowledge-based activity in every industry, craft and sector, on the shaping of economy open to innovations and hence favourable environment for the development of the state and its regions and for creative work by every member of society.

1.2. PRIORITY SCIENTIFIC AREAS

To provide for increasing state investments in science and technology development at the same time facilitating more intensive attraction of investments from the private sector, the priority scientific areas were determined according to the needs and means of the government.



In 2001 the Cabinet of Ministers approved the priority scientific areas for the first time in Latvia, determining the scientific sectors in Latvia to be supported as a priority.

In order to support the development of scientific potential in Latvia and to facilitate the development of innovative scientific sectors, as well as to facilitate creation of research-intensive technologies in nationally important and profit-bearing sectors, the priority scientific areas for fundamental and applied research were for the first time approved in Latvia in 2001:

- ✓ Information technologies – new system and software engineering technologies, telematics, multimedia systems and telecommunications.
- ✓ Organic synthesis and biomedicine – new biologically active substance synthesis technologies, gene therapy.
- ✓ Materials science – nanomaterials, new materials in the sectors of microelectronics, photonics and optoelectronics, biomaterials and other composites.
- ✓ Forestry science and wood technologies – development of forests, rational use of wood biomass, wood deep-processing technologies.
- ✓ “Letonika” (Latvian Studies) – Latvian language, culture and history.

In 2005, as a result of studies, seminars and discussions in the Working Group for Education, Science, Technological Development and Innovations of the Strategic Analysis Commission the priority scientific areas were determined for the period from 2006 to 2009:

- ✓ Agrobiotechnology – innovative, environmentally friendly food production technologies;
- ✓ Biomedicine and pharmacy – genetic technologies and synthesis technologies of new biologically active substances;
- ✓ Energetics – environmentally friendly energy, security of energy supply and energy efficiency;
- ✓ Information science – reliable software, integrated information and communication systems and networks, electronic technologies;
- ✓ “Letonika” (Latvian Studies) – studies of history, language and culture;
- ✓ Materials science – nanotechnologies for acquisition of functional materials, composite materials of new generation;
- ✓ Forest science – sustainability, new products and technologies;
- ✓ Medical science – development of clinical medicine based in technologies of applied sciences;
- ✓ Environmental science – climate change regional impact on water ecosystems and adaptation, sustainable management and protection of the Baltic Sea and inland waters.

The priority scientific areas are selected at two levels: the first is a selection of priority scientific sectors followed by selection of priority scientific areas within the relevant sectors.

The priority scientific areas mark the sectors within which fundamental and applied research projects and national research programmes are being implemented within the particular period of time.

In 2009 again, in cooperation with the representatives from ministries of the relevant sectors, science and economics sectors the priority scientific areas were determined for the period from 2010 to 2013:

- ✓ Energy and environment (technologies of renewable energy resource extraction and utilisation, technologies diminishing climate change, and biological diversity);
- ✓ Innovative materials and technologies (computer science, information and signal processing technologies, nanostructured multifunctional materials and nanotechnologies);
- ✓ National identity (language, history of Latvia, culture and human safety);
- ✓ Public health (preventive, treatment, diagnostic means and methods, biomedical technologies);
- ✓ Sustainable use of local resources (mineral deposits, forest, food and transport) – new products and technologies.

In defining the priorities the likely effect of and contribution by the sector for the development of the country's national economy, ensuring sustainable development of Latvia and safeguarding of intangible cultural heritage is considered. The priority scientific areas are closely linked with the creation of competitive innovative technologies, provision for sustainable development of Latvia and the processes of development of the Latvian state and society.

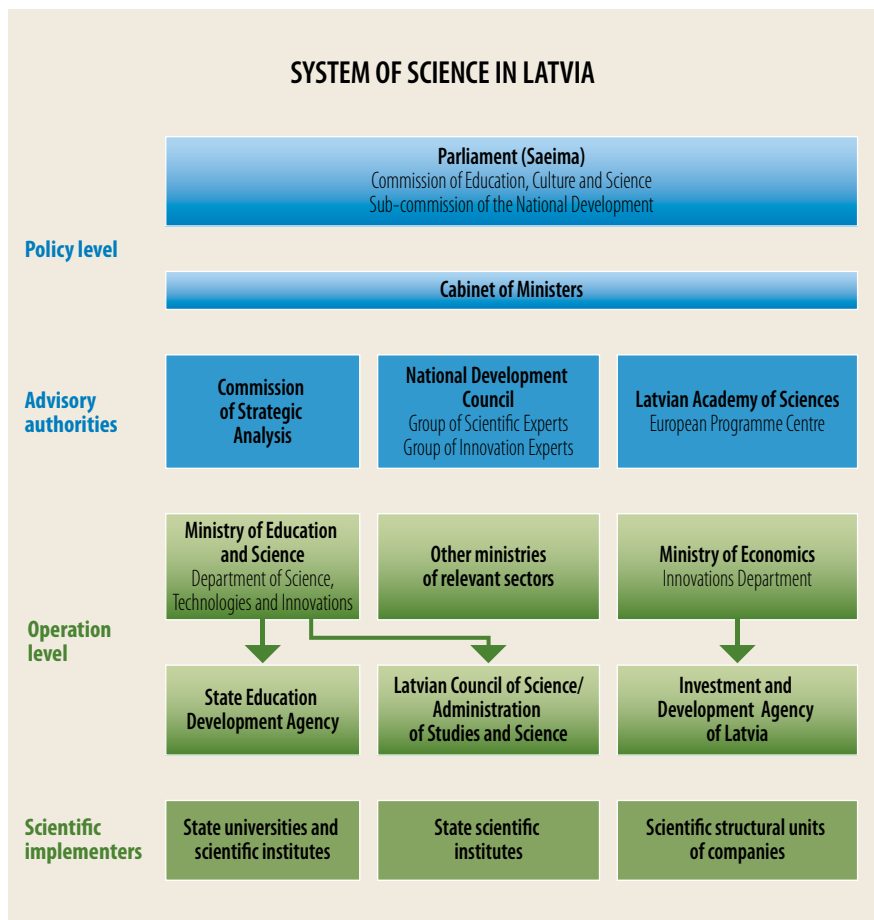
1.3. INSTITUTIONAL SYSTEM

The scientific system of Latvia is still undergoing formation and change, therefore the economic crisis that started in 2008 was a great challenge for it, calling for the need to implement structural changes in order to overcome the crisis. The structure, obligations and the connection between the key system elements, i.e. the scientific policy maker, the provider of funding and the advisor for structures and executors are continuing to develop.

1.3.1. ADMINISTRATIVE STRUCTURE

Authorities of different levels and competence are involved in the organisational structure of administration in the field of Latvian science and research:

- ✓ Saeima (Parliament) of the Republic of Latvia;
- ✓ Cabinet of Ministers;
- ✓ Ministry of Education and Science;
- ✓ Latvian Council of Science;
- ✓ Latvian Academy of Sciences;
- ✓ Ministry of Economics;
- ✓ other Ministries of relevant sectors;
- ✓ state research institutes and organizations, state higher educational establishments.



The most important state authorities that ensure the development and implementation of the science and technology development policy are the Saeima (Parliament) of the Republic of Latvia, the Cabinet of Ministers, the Ministry of Education and Science, Latvian Council of Science and Latvian Academy of Sciences.

The Saeima (Parliament) of the Republic of Latvia is a state authority who makes decisions regarding the allocation of state budget funds for different science and technology development support programmes. The Saeima has established the Commission of Education, Culture and Science from representatives of the respective sectors. The main task of the Commission is to make decisions regarding science and technology development policy, to review the state budget for science and to forward the decision thereof for ratification by the Saeima.

At the political level, top-level decisions are made and priorities are determined by the Cabinet of Ministers. The Cabinet of Ministers determines the science and technology development and innovation policy approves regulations that stipulate matters in the field of science and research and approves the prioritised scientific areas and state research programmes, as well as passes other decisions related to the implementation of the science and technology policy.

The Ministry of Education and Science is the central authority of the Latvian science and technology development policy – it is the leading public administration authority in the field of science and technology development policy and it is directly engaged in the implementation of the policy, funding of research and administration of research support programmes of both domestic and international scale.

An important role in the scientific system is played by the Latvian Council of Science whose aim it is to facilitate implementation and coordination of the science, technology and innovation policy, as well as to ensure assessment of scientific research project and programme applications and results. The Latvian Council of Science is a directly subordinated authority under supervision of the Ministry of Education and Science; the duration of its competence is three years.

The Latvian Academy of Sciences provides for the government's top-level official scientific expert team in Latvia.

The Latvian Academy of Sciences carries out the mission of a classical Western European academy of sciences. It can be considered that the Latvian Academy of Sciences unites both the local Latvian and foreign intellectual potential attracted to Latvian science. The Academy is an autonomous legal subject consisting of elected members and subsidised from the state budget. The Latvian Academy of Sciences estimates processes of the development of Latvian science, educates the public and the government regarding scientific forecasts regarding desirable and adverse

consequences of different national economy, cultural and social processes and projects. The position of the Latvian Academy of Sciences as an expert within the organisational system of the government has strengthened in recent years.

1.3.2. SCIENTIFIC INSTITUTIONS

Chief institutions to carry out the most important research and development activities in Latvia are the scientific institutions – state scientific institutes, state and private higher education establishments, scientific institutes of higher education establishments (agencies of higher education establishments) and research units within private sector. The majority of state research institutions are supervised by the Ministry of Education and Science, while certain institutions related to the sectors of agriculture, health, environment or culture and arts are supervised by the Ministries of Agriculture, Health Environment and Culture.

DIVISION OF SCIENTIFIC INSTITUTIONS REGISTERED IN THE REGISTER OF SCIENTIFIC INSTITUTIONS (Data as at 01.12.2010)

Scientific institutions	Number	%
1. Scientific institutes:	82	60.3
1.1. Public agencies, incl. a state agencies, municipal agencies	2	1.5
1.2. Derivative public bodies, including the Latvian Academy of Sciences	13	9.6
1.3. Structural units of state higher education establishments	52	38.2
1.4. Agencies of state higher education establishments	15	11.0
2. Higher education establishments, including:	9	6.8
2.1. State higher education establishments	7	5.3
2.2. Private higher education establishments	2	1.5
3. Business companies	19	14.3
4. Other scientific institutions	26	18.8
Total:	136	100.0

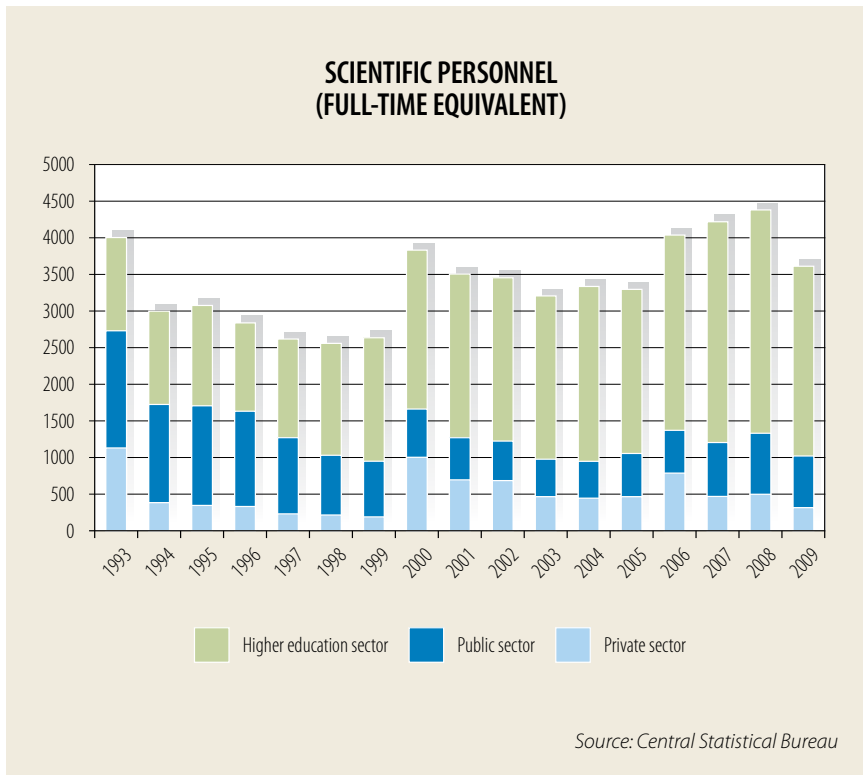
Source: Ministry of Education and Science

1.3.3. SCIENTIFIC PERSONNEL

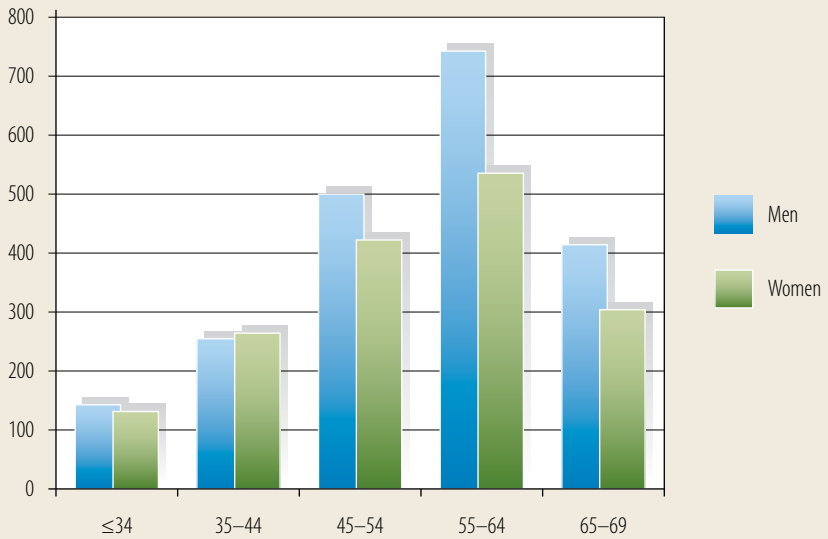
The number of people engaged in science and their qualification is an important factor for creation of the knowledge potential.

In 2009, there were in total 3621 scientific employees (as full-time equivalent) in the science sector in Latvia, of whom 2596 worked in the higher education, 708 in state research institutes and 317 in private sector.

The majority of persons employed in science sector in Latvia currently represent the age group from 45 to 64 years, while the number of men employed in science exceeds the number of women by 11%. Ageing of the personnel engaged in science pertains to both university professors and scientific staff at research institutes. Lack of students should be mentioned especially regarding natural and engineering fields of study in which the number of students graduating Latvian universities equal only half of the relative average level in Europe and less than one third in comparison with Ireland or Finland.

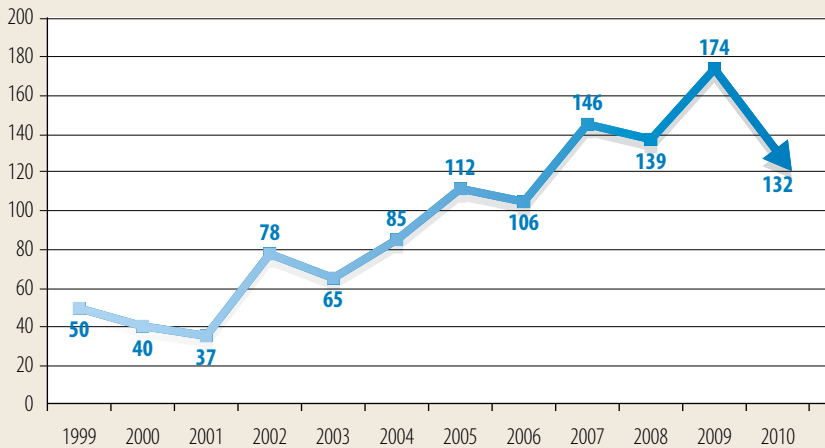


DOCTORATE HOLDERS BY AGE GROUPS AND GENDER

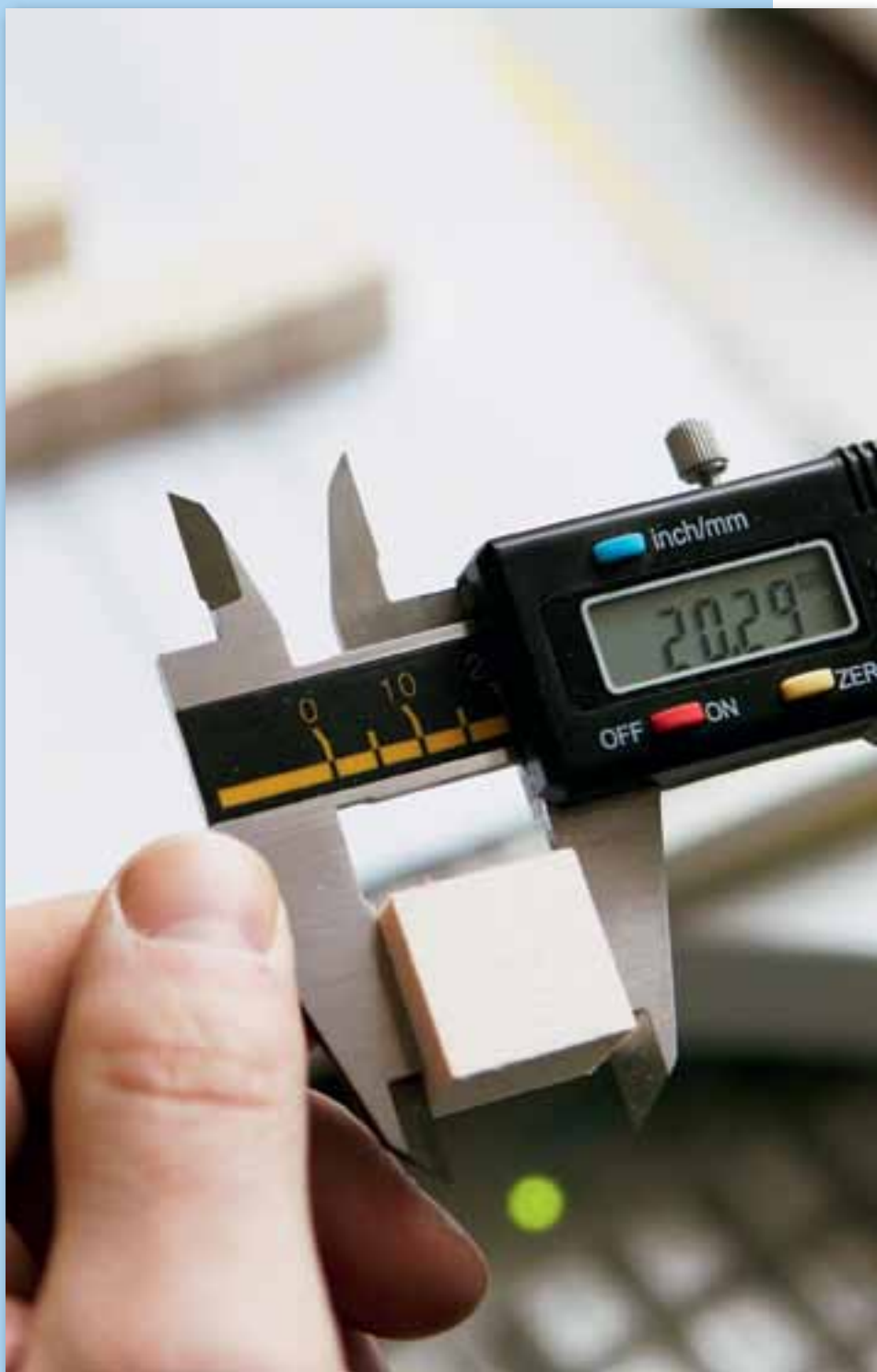


Source: Central Statistical Bureau

DYNAMICS OF PhD GRADUATES IN LATVIA



Source: Ministry of Education and Science



With emergence of such situation special attention is paid to the development of systematic programmes aimed at preparation of specialists representing priority sectors and being demanded on the market.

Since 2004, measures have been implemented in Latvia for augmenting academic and scientific personnel at universities and scientific institutions. One of these measures, also being implemented during this academic year, is the support from the European Social Fund within the framework of the activity "Support for Implementation of Doctoral Study Programmes". The aim of the activity is to boost the number of higher qualification specialists with a doctoral degree in all thematic groups of education, who are able to plan, create and introduce for manufacturing high technology products. Support is intended for doctoral studies in all thematic groups of education through allocation of earmarked grants to doctoral students and thus stimulating the increase of the number of students at the level of doctoral studies and increasing the number of PhD graduates.

With an aim to provide moral and financial support to outstanding, internationally distinguished scientists after their retirement, the system of state emeritus scientists was established in 1995. Besides granting the status of emeritus scientist, a lifetime grant is allocated to the respective candidates in addition to their old-age pension. Since 1996 the honorary status of the state emeritus scientist has been granted to 413 most outstanding scientists of different fields of science. In 2007 it was conferred to 23 scientists while in 2008 the honorary status was conferred to 34 more distinguished scientists. In 2009 the lifetime grant was received by 301 scientists, while in 2010 – by 284 state emeritus scientists.

1.3.4. NATIONAL RESEARCH CENTRES

Within the framework of current structural reforms, subject to operative strategies of scientific institutions as approved by sectoral ministries, the Ministry of Education and Science has assessed the spatial development strategy for scientific institutions and determined the research centres of national importance.

National research centre is a framework of cooperation between research institutions for the purpose of concentration of scientific resources for European-level research within the priority scientific area, thereby facilitating the development of the priority sectors of the national economy and society in Latvia.

Within the scope of these centres close cooperation will be ensured between the research institutions engaged thereof in using the infrastructure available to

the priority scientific area, planning concentration of resources and investments, including for the needs of the centre, the development of joint infrastructure and consolidation of research institutions.

At the first stage of project proposal selection under the Sub-activity "Development of Scientific Infrastructure" within the Supplementation 2.1.1.3.1 of the Action Programme "Entrepreneurship and Innovations" of the European Regional Development Fund establishment of the following national research centres was supported:

- ✓ National Research Centre of Technologies of Acquisition and Sustainable Use of Energy and Environmental Resources (additionally comprises development of the centre for Transport and Machinery);
- ✓ National Research Centre of Pharmacy and Biomedicine (this centre comprises, among other, establishment of a study and research centre of pharmaceutical technologies and a centre of bio-pharmacy);
- ✓ National Research Centre of Information, Communication and Signal Processing Technologies (this centre comprises, among other, establishment of a centre of Space Data Processing);
- ✓ National Research Centre of the Latvian Language, Cultural Heritage and Creative Technologies;
- ✓ National Research Centre of Use of Agricultural Resources and Food Technologies;
- ✓ National Research Centre of Forest and Water Resources;
- ✓ National Research Centre of Nanostructured and Multifunctional Materials, Structures and Technologies;
- ✓ National Research Centre of Public Health and Clinical Medicine;
- ✓ National Research Centre of Social Economy and Public Management.

It is planned to establish in total nine National Research Centres covering respectively the priority scientific areas and its sectors.

1.3.5. TECHNOLOGY PARKS AND CENTRES

Successful conduct of innovative activities in Latvia is ensured through the implementation of effective support instruments. One of the instruments to be singled out is technological parks and centres. In 1992, the Ministry of Education and Science worked out the concept of the development of technology centres, taking into account the experience of European countries (Germany, Finland, Sweden, Ireland, England, France), the United States of America (Silicon Valley), Israel and Japan. The first technology centre – the Latvian Technological Centre had already been established in 1993.

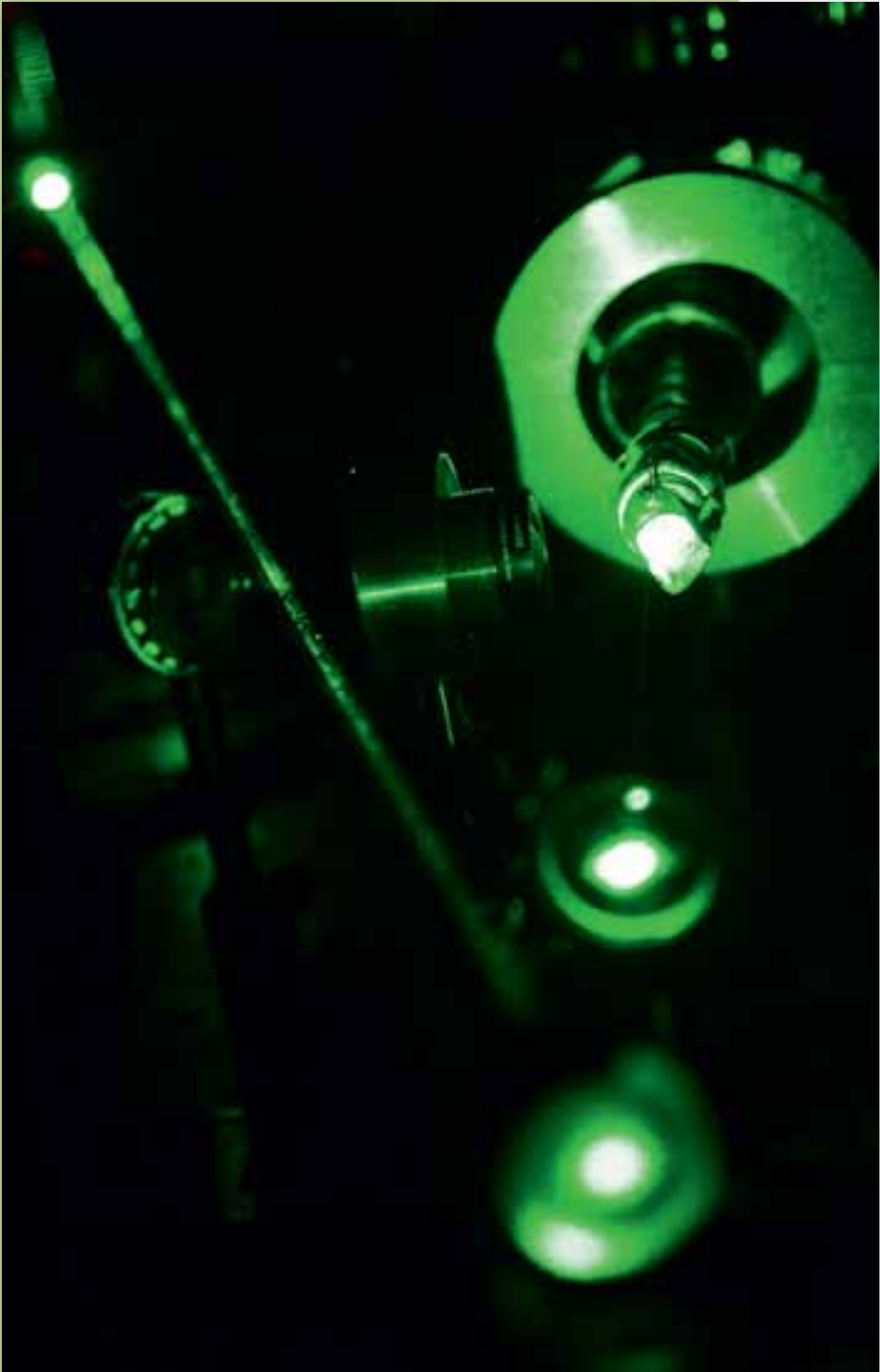
Technology parks and centres have been established according to the principle of business incubators and the strategic aim thereof is to support the development of technologically oriented enterprises and to provide for the possibility of cooperation between scientists and entrepreneurs.

In 1996 the Latvian Association of Technological Parks, Centres and Business Incubators was founded by 3 technology parks – the Latvian Technological Park, Latvian Technological Centre and Business Innovation Centre of Latvian Electronic Industry. The Association unites the biggest technology parks, centres and business incubators in Latvia. The members include a number of private individuals who have significantly contributed to the establishment and development of the Association. The aim of the Latvian Association of Technological Parks, Centres and Business Incubators is to facilitate the development of technology oriented businesses, to coordinate activities of structures of support for technology oriented businesses in Latvia and to represent their interests at the Latvian, foreign and international organisations.

With an aim to increase the competitiveness of businesses and to facilitate cooperation of research and industrial sectors in the implementation of industrial research, new product and technology development projects the Ministry of Economics is providing for the implementation of the Activity “Competence Centres” under the Action Programme “Business and Innovations” of the European Union’s Structural Funds.

A competence centre is a non-profit company aimed at stable and long-term partnership between public, science and private sectors through performance of collective research in scientific, education and technological development areas and receiving state support for the aim thereof in order to claim the best world leader roles.

It is planned to support projects of 5-6 competence centre activities within the European Union’s Structural Fund planning period of 2007-2013.



2. SCIENTIFIC SUPPORT PROGRAMMES

A successful development of science and research, like any other field of operation, cannot be imagined without financial investments in the form of support programmes. In the development of the national research policy an important role was played by the reform in administrative system of science, by establishing a system of grants, i.e. a system that corresponds to the principles of funding scientific research accepted in the world practice and ensures internal competition.

2.1. FUNDAMENTAL AND APPLIED RESEARCH

To ensure a balanced representation and development of scientific areas, at the same time retaining high research quality, the Ministry of Education and Science financially supports projects of fundamental and applied research in the determined priority scientific areas by allocating grants.

The aim of fundamental and applied research projects is to facilitate creation of new knowledge, to promote development of technological findings that may be without direct relation, putting them to immediate industrial and commercial use, and to support implementation of new and competitive scientific studies as applied for by scientists.

Themes, aims and objectives of fundamental and applied research are formulated by the scientist. The key criterion for the allocation of the grant is the scientific quality of the project evaluated by the Latvian Council of Science. To determine the highest quality and most perspective fundamental and applied research projects the Latvian Council of Science organises a project competition every year.

Projects of fundamental and applied research are divided as follows:

- ✓ thematic research projects comprising solution of a particular scientific problem and being implemented by a scientist or a scientific group whose members may be from one or several research institutions;
- ✓ projects of scientific cooperation involving inter-sectoral research to solve scientific problems linked by a unifying aim, including use of a particular re-

search infrastructure object (e.g. a collection, database, a unique piece of equipment). Scientists or scientific groups from at least three scientific institutions participate in the implementation thereof.

166 fundamental and applied research projects, including 150 thematic research projects and 11 cooperation projects were implemented in 2010.

2.2. MARKET-ORIENTED RESEARCH PROGRAMME

To support facilitation of the cooperation between science and business, the Ministry of Education and Science financially supports implementation of market-oriented research projects. Within the framework of market-oriented projects scientists and manufacturers cooperate to develop new products and technologies. In this way, scientists do research in close collaboration with manufacturers, receiving state budget funds for scientific work, while manufacturers get new competitive products.

The aim of market-oriented projects is to facilitate integration of science and manufacturing through supporting cooperation between scientists and entrepreneurs in the development of joint research projects, development of new technologies and products and to facilitate the development of technology-oriented sectors.

The market-oriented research project support programme as one of the most customer-friendly innovation support programmes has been highly valued by the experts of the European Commission.

In 2009, successful implementation of 27 projects launched in the years 2006-2008 continued and 12 projects were finished. 15 market-oriented research projects are still implemented in 2010 and implementation of 4 projects continues in 2011.

Some of the significant results of the market-oriented research projects in recent years

- ✓ The Institute of Polymer Mechanics of the University of Latvia in cooperation with the Latvian Luge Sports Federation in the project “Creation of an Optimum Structure Sports Sled” achieved results that were used for designing and production of sports sleds for the Winter Olympics in Vancouver where Latvian sportsmen won silver medals.
- ✓ The potential benefit of the technology developed by the Biomedicine Research and Study Centre is a development of a product – human cell cultures for laboratory tests, facilitating export to international markets. The potential turnover of financial resources annually might reach ~200 thousand lats. The prospective consumers of the product are researchers and scientists, especially from Asian countries. The initial market research shows that the product price may fluctuate from 600 to 800 USA dollars per 1 million cells.
- ✓ During the implementation of the market-oriented project by the Institute of Solid State Physics of the University of Latvia and the Limited Liability Company Fonons a new technology of hydraulic pressing of the heat collector for Latvia was designed. The results acquired during the project implementation have considerably accelerated launch of the production of heat pumps in Latvia and are presently used in production. A new production site is being built in Garkalne to expand manufacturing of heat pumps.
- ✓ In 2006-2009 the Andrology Laboratory of Riga Stradiņš University conducted the study “Development of New Methods for Diagnosing of Men Infertility” during which two new methods of diagnosing men infertility were successfully found. The project’s cooperation partners from the manufacturing sector, the Limited Liability Company Ģimenes un seksuālo problēmu centrs and the Limited Liability Company Klīnika Pīramīda have already successfully implemented the CTIA method (determining the condition of chromatin structure of spermatozoa by means of cytometry of Toluidine-blue image analysis) in clinical practice. The project results can be used in further fundamental research that may provide a deeper insight into understanding processes of spermatogenesis.



2.3. INTERNATIONAL SCIENTIFIC COOPERATION

Scientists of Latvia as a Member State of the European Union successfully participate in the European Union's science and technology support programmes. The government in its turn ensures, and the Ministry of Education and Science allocates financial support for participation of the scientists in these international cooperation programmes, among others, the Framework Programme and the European Cooperation in Science and Technology programme, as well as in the EUREKA programme. To support participation of Latvian scientists and entrepreneurs in the European Union's science and technology development programmes, operation of the Latvian National Contact Point within the Seventh Framework Programme is ensured.

In exercising participation of Latvia in the development of the European Union's scientific policy the Ministry of Education and Science, when working out the Latvian national position, expresses the opinion of Latvia regarding scientific issues at the European Union's Competitiveness Councils of Ministers and informal European Union's Competitiveness Councils of Ministers.

2.3.1. FRAMEWORK PROGRAMMES

One of the most successful programmes to be mentioned is the European Union Framework Programme for Research and Technology Development in which Latvian scientists have actively participated since 1999. This programme is one of the most important European Union's initiatives for the research development within which different European-scale research projects in sectors of European importance are funded.

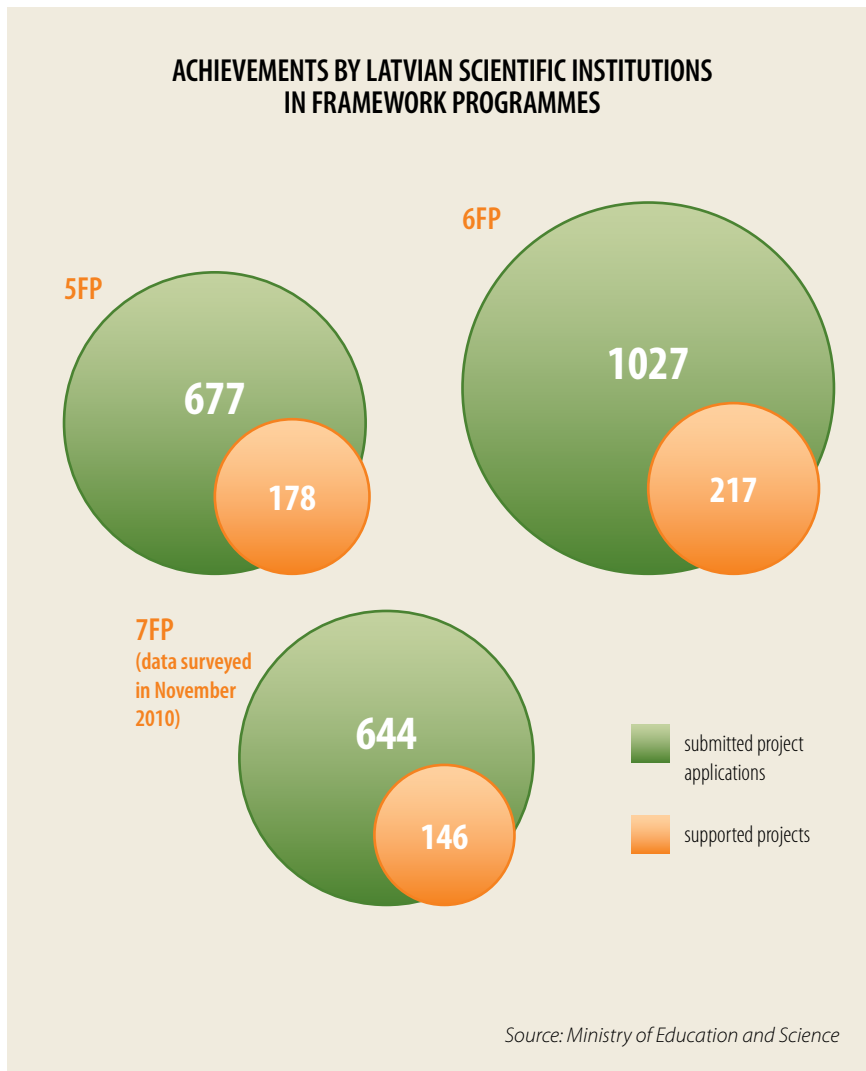
Within the Fifth Framework Programme of the European Union 677 project applications were submitted from Latvia, out of which 178 projects were successful and received the European Union funding.

During the Fifth Framework Programme the Institute of Solid State Physics of the University of Latvia despite fierce competition was awarded the title of the European Union Centre of Excellence in the materials science sector.

Between the years 2002 - 2006, when the Sixth Framework Programme was active, 1027 research and technology development project applications were prepared and submitted to the European Commission collectively with participants from Latvia. The European Commission allocated funding for 217

projects implementation. Although the average achievement indicator dropped slightly, Latvia still was among the most successful new European Union member States within the Sixth Framework Programme.

Currently the Seventh Framework Programme, valid through 2013, is launched. The strategic aims of the Seventh Framework Programme are to strengthen the scientific and technological base for the European industry and to facilitate research in Europe. Engagement of small and middle-sized enterprises in the Seventh Framework Programme is defined as one of the priorities of this programme. The total programme budget is approximately EUR 50 billion.



The aim of the Seventh Framework Programme is to facilitate competitiveness of the European Union and to solve presently urgent socially economic, environmental, public health and industrial problems.

Within the programme during 2010 Latvian participants took part in the preparation of 644 project proposals of which 146 project proposals were selected for funding. Diminishing success is explained by the increasing competition among the European Union Member States.

2.3.2. EUREKA

Latvia also is a successful participant in the EUREKA programme – European programme for international cooperation between business companies and scientific institutions to promote development and implementation of high-technology, new, competitive products and services.

The aim of the EUREKA programme is to facilitate closer cooperation between companies and scientific institutions of the European Union countries in the field of development and production of modern technologies demanded on the market.

The EUREKA programme emerged as a political initiative for facilitation of the cooperation among the European Union countries in the field of research, development and implementation of civil technologies chiefly in small and middle-sized enterprises. Within EUREKA programme the Ministry of Education and Science allocates state funding for implementation of projects in the field of research, technology development and innovations.

In 2010 Latvian scientists engaged in the implementation of 3 EUREKA projects on which contracts have already been concluded. It should be mentioned however that 18 contracts on implementation of 6 EUREKA projects were concluded in 2009.



Some of the significant results of EUREKA projects in recent years

- ✓ Scientists from the Faculty of Food Technology of the Latvia University of Agriculture in cooperation with the specialists of Lāči bakery in a EUREKA project founded and tested in practice a new method of spontaneous leaven preparation with biologically activated rye added. The new technology of leaven preparation is used in Lāči bakery to produce new types of bread.
- ✓ The Limited Liability Company GroGlass in cooperation with the Institute of Solid State Physics of the University of Latvia conducted research within a EUREKA project and developed a commercially viable product – tempered greenhouse glass with a light non-reflective coating for the greenhouse industry.
- ✓ Within another EUREKA project with the Latvia University of Agriculture and the Limited Liability Company Bioefekts developed a new product – microbiological fertiliser for lilies that prevents formation of many pathogens (microorganisms harmful for the plant), stimulates blooming and development of healthy bulbs.

2.3.3. COST

European Cooperation in Science and Technology or the COST programme is an international cooperation support programme established to support cooperation of scientists and researchers at the European level in different fields of science and technology development. The aim of the programme is to support chiefly pre-competition research and studies solving topical public problems. COST programme is established to support cooperation of scientists and researchers in different fields of science and technology development.

The aim of COST programme is to support chiefly pre-competition research and studies solving topical public problems.

COST programme was established with support from the European Union in 1971 by 18 European Union countries – all 15 Member States and Norway, Switzerland and Turkey. Presently 35 countries are participants in the COST programme and Latvia is one of them.

Within COST programme support is granted for scientist cooperation in the research areas where studies are funded from national programme budgets in order to facilitate:

- ✓ development of cooperation networks in the form of COST events;
- ✓ organisation of scientific conferences and seminars;
- ✓ short-term working visits by scientists;
- ✓ issue of joint scientific publications.

COST programme is based on the “bottom-up” principle – the initiative to start cooperation (a new COST event) comes from the potential participants. New themes of COST events are freely chosen and applied for by the participants themselves representing at least five COST programme member states. Scientists of COST programme member states may join and engage in the operation of the already supported COST events.

In 2009 and 2010 the Ministry of Education and Science concluded on average 20 contracts per year with scientific institutions to support COST project implementation.

2.3.4. INTERNATIONAL INFRASTRUCTURES

In 2008 project CLARIN (*Common Language Resources and Technologies Infrastructure*) was launched.

The aim of the CLARIN is to establish a common scientific language resource and technologies infrastructure for humanities and social sciences.

The project unites all of the most important research institutes and companies of language technologies of the European Union countries. From the very beginning Latvia has been represented in this project by the Institute of Mathematics and Computer Science of the University of Latvia and the leading developer of language software tools in the Baltic States, the Limited Liability Company Tilde. The central costs of the project are covered by the European Commission while the national costs are funded from the budgets of the project member states.

Latvia also participates in the implementation of the social science project European Social Survey – an academically-driven social survey designed to chart and explain the interaction between Europe’s changing institutions and the attitudes, beliefs and behaviour patterns of its diverse populations. The survey reveals the processes that most significantly influenced and continue to influence change of attitudes and values in the 21st century. Activities of the centralised management, coordination and methodology development committees of the survey are funded by the European Commission while field studies should be covered by each participating Member State. In 2010 the memorandum of

understanding was concluded between the Ministry of Education and Science and the project administration.

The academic computer network LATNET (presently *SigmaNet*) maintained by the Institute of Mathematics and Computer Science of the University of Latvia is involved in the project GÉANT (*Gigabit European Academic Network*) which already has a 10 year pedigree to facilitate communication and exchange of knowledge among European scientists, academic and scientific institutions.

GÉANT is a scientific research infrastructure – an academic computer network consisting of European national computer networks connected in one separate increased security and high performance network.

Thanks to GÉANT, scientists in throughout Europe and even worldwide can jointly engage in principally new research in real time. Currently this network supports more than one million researchers from 40 European countries, including Latvia. It provides for considerable data transmission capacity necessary for joint use and processing of huge amounts of information.

In Latvia, GÉANT is used not only by scientific institutions. Education and culture establishments are also connected to the network. These include schools, universities, vocational education and additional education establishments, along with libraries, archives and museums. Actually, GÉANT network can be also used by companies, provided such use is for academic purposes, namely, scientific research.

Considering direct and indirect technological opportunities that would arise in the format of commercial options and new, technologically oriented companies, and taking into account the long-term advantages thereof by developing a common system of support for the future scientific projects, at the beginning of 2009 the government of Latvia expressed support to the project of construction of the European Spallation Neutron Source in the Swedish city of Lund.

On 28 May 2009 the memorandum of understanding between the government of the Republic of Latvia and the government of the Kingdom of Sweden was approved regarding the International Platform for European Infrastructure of Neutron Scattering.

The cooperation will provide for participation of Latvian scientists in a large-scale European materials research infrastructure project. Implementation of this project in Sweden will give an opportunity to Latvia to develop its scientific activity and to strengthen its position in international projects, especially in the area of liquid metal pumping technologies.



2.3.5. PARTICIPATION IN THE EUROPEAN SPACE AGENCY

To widen the opportunity for the Latvian scientists to engage in space study and space technology development projects and to apply the results of these high added value projects to the national economy and also to develop the Latvian space programme, a treaty between the government of the Republic of Latvia and the European Space Agency was signed in 2009 regarding cooperation in the space industry for peaceful purposes.

The Working Group of State Space Technology Development was established at the end of 2009, uniting representatives of competent state authorities, scientific institutions and commercial companies. An aim of Working Group is to facilitate the development and implementation of the national space policy. Presently the Working Group has made a decision to work out the Space Technology Development Guidelines with a corresponding implementation plan. It would serve as an intermediate level space sector development and planning document for 5-7 years.

2.3.6. EUROSTAR

To facilitate competitiveness of European industry and economy on the global market, with signing an agreement between the Republic of Latvia and EUREKA Secretariat the implementation of EUROSTAR programme will start in Latvia in 2011 through supporting small and middle-sized enterprises that conduct research work of designing innovative, market-driven products, technologies and services.

EUROSTAR is a EUREKA programme and a common European Union programme for research and development performing small and middle-sized enterprises.

Within the EUROSTAR programme the project theme is determined by the project applicants themselves and a project may be submitted in any sector of national economy. The programme does not support projects with military purposes. The leading member of a EUROSTAR project is a research and development performing, small or middle-sized enterprise that operates in any of the 31 EUROSTAR countries, including Latvia.

2.3.7. ARTEMIS

Through introduction of a new instrument – joint technology initiative for the facilitation of the public-private partnership in research and development of innovative technologies at the European scale, by uniting research programme of the European Union and its Member States and resources of private business companies, operation of ARTEMIS Joint Undertaking (progressive research and technologies in the field of embedded intelligence and systems) was started in 2008.

By organising project proposal competitions ARTEMIS provides for the implementation of research priorities stated under the Research Strategic Agenda of the Joint Technology Initiative developed by the industry of the respective sector.

By engaging in the ARTEMIS project proposal competitions the Latvian research institutions and enterprises can establish close cooperation in the development of innovative products with the European companies and scientific institutions working with this area through jointly solving topical problems of the sector and attract funding of the European Union for research and development of innovative technologies.

On 11 December 2009 an agreement was signed between the Republic of Latvia and ARTEMIS Joint Undertaking, hence Latvian scientists have the opportunity to participate in the project competitions organised within ARTEMIS framework.

To ensure improvement of the scientific potential and increasing the competitiveness of the sector the Ministry of Education and Science implements bilateral and trilateral cooperation in the field of science and technology development within the:

- ✓ Cooperation Foundation of Taiwan, Latvia and Lithuania;
- ✓ Cooperation programme between Latvia and Belarus;
- ✓ “Osmoze” – cooperation programme between France and Latvia for the development of science and technology.

2.4. EUROPEAN UNION'S STRUCTURAL FUNDS FOR SCIENCE

In the programming period of 2007-2013 EU fund support is foreseen mainly for the development of education and innovative technologies as well as science and research in order to promote the creation of a knowledge-based and sustainable economy and the improvement of the quality of life in Latvia.

The purpose of the European Social Fund is to invest in human resources, thereby supporting the development and quality of and access to education and science. Whereas in the 2007-2013 structural fund implementation period European Social Fund funding for the development of science is earmarked at LVL 40.3 million.

European Social Fund funding for the education and science sector is intended for:

- ✓ facilitating engagement of young scientists in projects and their management;
- ✓ creating new scientific groups;
- ✓ attracting to scientific work scientists who would return to work in Latvia and foreign scientists.

Estimated result: 1000 full-time equivalent scientific employees attracted additionally to science and supported; increased proportion of workers employed in science and research – 0.8% of all able-bodied inhabitants of the country by 2013. Currently there are 623 full-time equivalent scientific employees attracted in the projects of European Social Fund.

The priority of the European Regional Development Fund is the development of infrastructure and innovations in order to develop a knowledge-based society. Latvia has received funding for the development of education and science from this fund since 2004.

It is planned to invest LVL 185.6 million in science from the European Regional Development Fund for the development of scientific competitiveness and infrastructure under the action programme “Business and Innovations” within the planning period of 2007-2013.

European Regional Development Fund funding in the education and science sector is planned for:

- ✓ outfitting work places for newly recruited scientists and upgrading scientific and research equipment;
- ✓ promoting and developing international cooperation in science;
- ✓ providing support to leading national research centres for purchase of world-class scientific equipment and facilities, reconstruction and renovation of buildings, modernisation of infrastructure;
- ✓ establishing next-generation data transmission network for ensuring scientific activity (Latvian academic backbone network).

Estimated result: 114 supported practical research projects; 20 supported international cooperation projects; established 9 national research centres, including by modernisation of 35 scientific institutions (purchased equipment and modernised institutes will provide opportunities for implementation of new practical projects that will result in new products and technologies both for export and domestic market); one academic backbone network established.



3. NATIONAL RESEARCH PROGRAMMES

National research programmes can be considered a significant and possibly the only medium-term government commission for research since reestablishment of independence of Latvia. They provide integrated solution of complex and current economic problems, involvement of experts in various branches of science and efficient application of material and technical resources of scientific institutions.

National research programmes are state commissions for the performance of scientific research in a specific economic, educational, cultural or other sector of priority to the state with the purpose of promoting the development of such sector.

National research programmes provide opportunities for scientific institutions to improve their scientific capacity, conduct applied, result-oriented studies and researches, as well as to develop scientific research, attract and prepare new qualified specialists for further scientific activity.

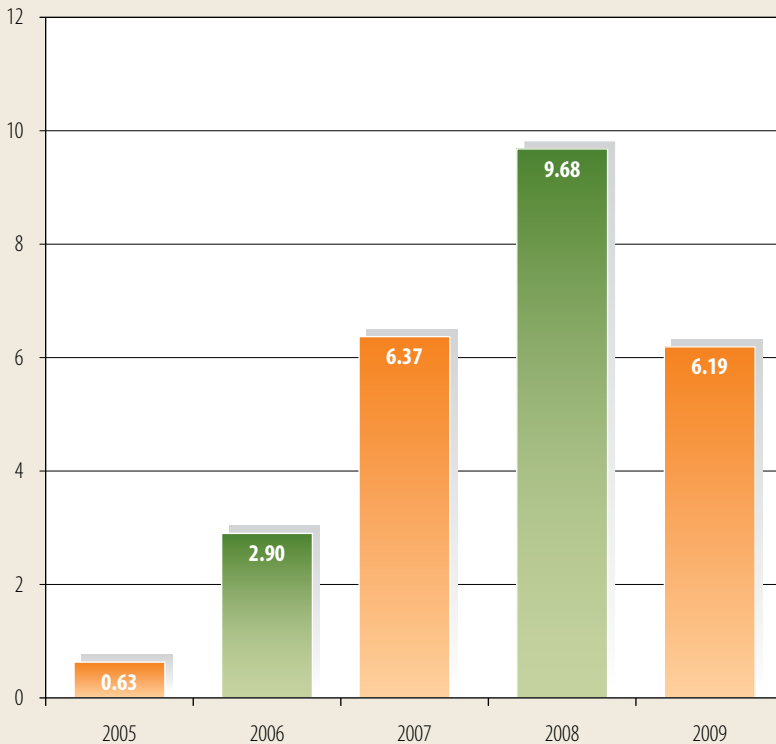
To facilitate performance of high-qualified and to the national economy relevant scientific research and to ensure aimed investment of financial resources in the development of priority scientific areas, the following national research programmes were implemented within the period from 2005-2009:

- ✓ Innovative Technologies for High-Quality, Safe and Healthy Food Production from Genetically, Physiologically and Biochemically Diverse Plant and Animal Material;
- ✓ New Medicines and Biocorrection Tools: Design, Transportforms and Mechanisms of Action;
- ✓ Research and Elaboration of Modern Methods and Developed Technologies in the Field of Energy: Environmentally Friendly Energy, Security of Energy Supply and Energy Efficiency;
- ✓ Scientific Foundation of Information Technology;
- ✓ "Letonika" (Latvian Studies): Studies of History, Language and Culture;

3. NATIONAL RESEARCH PROGRAMMES

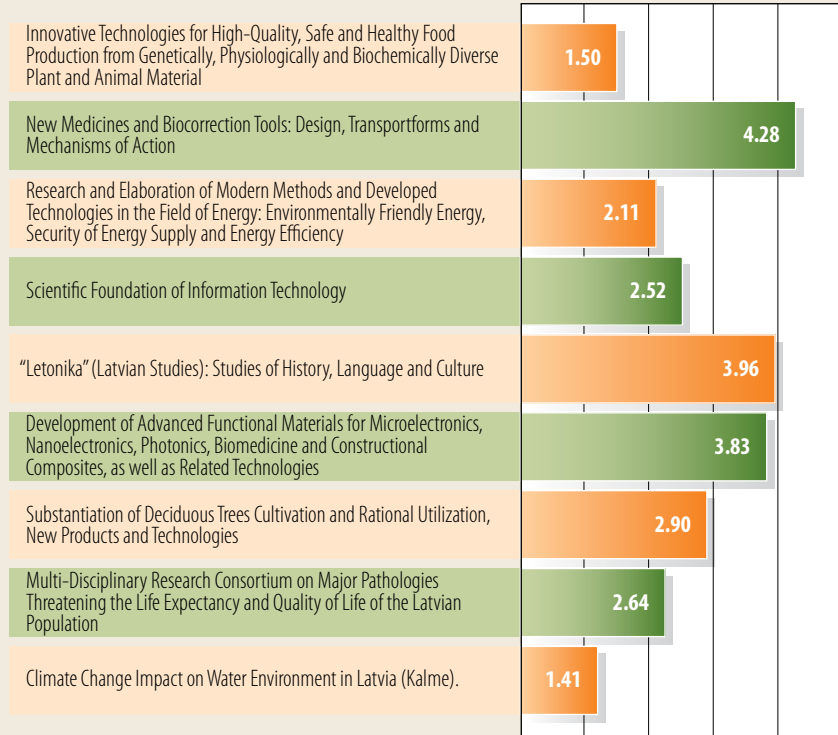
- ✓ Development of Advanced Functional Materials for Microelectronics, Nanoelectronics, Photonics, Biomedicine and Constructional Composites, as well as Related Technologies;
- ✓ Substantiation of Deciduous Trees Cultivation and Rational Utilization, New Products and Technologies;
- ✓ Multi-Disciplinary Research Consortium on Major Pathologies Threatening the Life Expectancy and Quality of Life of the Latvian Population;
- ✓ Climate Change Impact on Water Environment in Latvia (Kalme).

FUNDING ALLOCATED FOR IMPLEMENTATION OF NATIONAL RESEARCH PROGRAMMES (MILLION LATS)



Source: Ministry of Education and Science

TOTAL NATIONAL RESEARCH PROGRAMME FUNDING DURING IMPLEMENTATION, 2005 – 2009 (MILLION LATS)



Source: Ministry of Education and Science

3.1. INNOVATIVE TECHNOLOGIES FOR HIGH-QUALITY, SAFE AND HEALTHY FOOD PRODUCTION FROM GENETICALLY, PHYSIOLOGICALLY AND BIOCHEMICALLY DIVERSE PLANT AND ANIMAL MATERIAL

Priority scientific area: agrobiotechnology – innovative, environmentally friendly food production technologies.

Programme Director: *Dr. sc. ing.* Daina Kārklīņa, Latvia University of Agriculture.

Programme implementation period: 2006–2009

Programme implementers: Latvia University of Agriculture, Research Institute of Biotechnology and Veterinary Medicine Sigrā of the Latvia University of Agriculture, University of Latvia, Latvian State Institute of Fruit-Growing of the University of

Latvia, Institute of Biology of the University of Latvia, State Stende Cereal Breeding Institute, State Priekulji Plant Breeding Institute, the Limited Liability Company Pure Horticultural Research Centre, the Limited Liability Company Latgale Agricultural Research Centre.

The aim of the programme is to develop innovative technologies for safe and healthy Latvian agricultural plant and animal food production.

Projects within the programme:

- ✓ Evaluation of Latvian field crop diversity and enhancement of breeding by application of modern biotechnologies;
- ✓ High-quality Latvian berries: from the varieties to a quality, healthy and safe product;
- ✓ Extraction, study and use of concentrates of physiologically active substances of Jerusalem artichoke;
- ✓ Study of genetic, physiological and biochemical features of animals for high quality, healthy and safe food of animal origin;
- ✓ Technologies of production of new food products rich in functional components.

Research performed within the programme is oriented towards further development of the Latvian agriculture by applying advanced research methods and scientifically substantiated new findings in plant breeding, horticulture and cattle breeding, as well as disclosing biochemical composition of certain raw materials of crop and animal origin and the importance thereof in producing healthy and safe food.

Scientific results acquired at the Latvian scale should be valued as an important achievement in the application of molecular biology methods in breeding to create plant and animal breeds for producing high-quality food materials.

Out of achievements applicable in practice development of different molecular marker systems should be mentioned in relation to crop cultures for which they were not available before, as well as development of a number of laboratory methods for assessment of some agriculturally important traits established in the form of methodology descriptions.

As a result of studies a comprehensive description of three most important Latvian crop cultures (barley, oats, potatoes) and the technical culture (flax) has been produced and surveyed, which provides a long-term base for further genetic work and its development in Latvia, creating new varieties with

improved qualities that are suitable for production of high quality, healthy and safe food. A complex evaluation of genetic resources of barley, oats and potatoes, including local varieties, breeding lines and clones, within field studies has been conducted, integrating the theoretical and technological achievements in genetics, biochemistry and physiology. Within the programme creation of experimental mapping populations for the purposes of identification of markers linked to traits affecting food quality, as well as content and composition of functional substances. A new spring barley variety "Austris" was registered and new raspberry varieties "Viktorija" and "Liene" and blackcurrant variety "Karina" have been submitted for registration.

New methods for accelerated assessment of raspberry, sea-buckthorn and blackcurrant breeding materials and selection of desirable genotypes have been developed. Methodologies are adjusted for analyses of complicated, multi-level *Ribes* interspecific hybrids, as well as genetic study of sea-buckthorn subspecies, which is a significant contribution in the genetic study of the aforementioned taxons at the global scale. The specified raspberry, sea-buckthorn and blackcurrant genotyping profiles are summarised in a database for initial analysis, data are arranged in the format that corresponds to the Latvian Tree Genetic Resource Data Bank. The Latvian national genetic resource sample data are entered in this database and are available online at <http://85.254.224.236:8888/koki/faces/index.jsp>.

Methodologies have been developed for multiplication of raspberries, blackcurrants and sea-buckthorn in-vitro, initial solutions have been found for treating raspberries of RBDV (raspberry bushy dwarf virus), by combining multiplication in-vitro, chemotherapy and thermotherapy. Solutions have been found for better adaptation of microplants in non-sterile environment, which is a significant contribution in recovery of berry plant sprouts, which will facilitate development of highly productive gardens in Latvia. The molecular marker (RAPD) methodology has been developed also for the Jerusalem artichoke hybrids grown in Latvia and morphological and biochemical composition of the Jerusalem artichoke hybrids has been determined. The achieved Jerusalem artichoke research results can be used in acquiring new functional food products and development of innovative waste-free technologies by utilising the entire complex of biologically active substances in the tubers. Hence, the developed new product technologies differ from the globally used processing technologies.

The research results may provide the basis for the formation of a new, scientifically founded research sector of "Nutrition Genomics" in Latvia.

Three genes (PRL, OPN and ABCG2) have been associated with the improvement of breeding work with the dairy cows of the breed Latvian Brown and production



of milk with increased biological value and functionality, which expands the perspective of using genetic markers in the breeding of Latvian Brown cow.

Within the programme conditions of producing calves, broiler chicken and eggs of innovative composition have been developed by purposefully applying flax seed oil in combination with rapeseed, sunflower and soybean oils and antioxidant-containing complex supplements in the biotechnological solution.

A new biotechnological method has been developed for sealing of silage trenches thus ensuring preparation of high-quality fodder for feeding of cattle. It was the first time such method has been used in the Baltic States.

A number of new product processing technologies have been developed that are used in manufacturing of new products by the Latvian companies working in the food sector.

New product processing technologies have been developed and are used in manufacturing of new products: “sea-buckthorn-strawberry nectar” by the Limited Liability Company Lāses, “sea-buckthorn jam”, “sea-buckthorn sweet-and-salty sauce” by the Limited Liability Company Dienvidi Plus, “candied blackcurrants” by the Limited Liability Company Daro. The following products have been delivered to companies for adaptation: raspberry marc to the Limited Liability Company Aptiekas Produkcija for production of food supplements, raspberry and blackcurrant marc to the Limited Liability Company Lāči for production of confectionery, Jerusalem artichoke flour (to LLC ES-Saule), mixture of flax seed pressings and Jerusalem artichoke flour (to LLC Iecavnieks), Jerusalem artichoke slices (crisps) (to LLC ES-Saule), Jerusalem artichoke extract, Jerusalem artichoke syrup, flavoured Jerusalem artichoke slices (crisps), flavoured Jerusalem artichoke flour, fruit or berry syrups with inulin (to LLC ES-Saule).

Technologies have also be developed for production of crisp bread from hullless oat meal, wheat bread with hullless barley addition and wheat bread with hullless oats addition, hullless barley and hullless oat flake production (LLC Baltās naktis, LLC Zelta Vārpa); also a new meat product drying technology by means of microwave-vacuum kiln, production of chicken fillet with vegetables and fruit-berry mixture and preparation of ostrich meat by means of sous vide method. The breakthrough of the 8 newly developed technologies has been confirmed by conferring a Latvian patent on them.

Most of the technologies have been developed with the wishes and suggestions of manufacturers in mind, using the information surveyed by the Latvian Food Technology Platform. Hence, a part of these technologies have already been launched into production at a number of Latvian food production companies.

The research base obtained from the implementation of the programme and the infrastructure improved with new equipment allowed to engage into and launch the implementation of the new programme “Sustainable use of local resources (underground resources, wood, food and transport) – new products and technologies (NatRes)” in 2010 and to engage in the projects of activities co-financed by the European Structural Funds.

The results achieved from research are used for further improvement of breeding technologies – new methodologies have been introduced in breeding work (e.g. assessment of resistance to fusarium head blight, assessment of resistance to pre-harvest sprouting, identification of genotypes with lowered phytate content). Launching the production of the varieties characterised by high productivity and quality that were submitted for registration during the implementation of the programme will improve the competitiveness of growers. Varieties have been submitted for examination in Sweden and Germany and in the event of positive outcome will bring earnings in the form of royalty.

More information about the programme and its results:
www.inoteh.lv/inoteh_eng/

Contact information:

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3.2. NEW MEDICINES AND BIOCORRECTION TOOLS: DESIGN, TRANSPORT FORMS AND MECHANISMS OF ACTION

Priority scientific area: biomedicine and pharmacy – genetic technologies and synthesis technologies of new biologically active substances.

Director of the programme: *Dr. habil. chem.* Ivars Kalviņš, Latvian Institute of Organic Synthesis

Programme implementation period: 2005–2009

Programme implementers: Latvian Institute of Organic Synthesis, Latvian Biomedical Research and Study Centre, Latvian University Faculty of Medicine, Latvian Centre of Oncology, Latvia State Institute of Fruit-Growing

The aim of the programme was to develop original approaches for preparation of new medicines, vaccines and diagnostics for treatment of cardiovascular diseases, cancer and central nervous system disorders, as well as for diagnostics of plant virus infections and application of the virus proteins for development of new vaccines.

Projects within the programme:

- ✓ Development of methods for preparation of enantiopure CNS and cardiovascular medicines, using chemical and chemoenzymatic methods;
- ✓ Studies of synergy and multi-resistance phenomenon of anti-cancer substances in order to develop new anti-cancer medicines;
- ✓ Studies of new therapeutic approaches and molecular mechanisms of action of drug substances in CNS and cardiovascular pharmacology;
- ✓ Development of new cardiovascular agents and environmentally friendly technologies for synthesis thereof;
- ✓ Structural studies of biologically significant proteins and modelling of receptor – ligand interaction;
- ✓ Technology development for preparation of recombinant vaccines on virus-like particle basis;
- ✓ Ligands of G-protein binding receptors – new potential medicines;
- ✓ Application of alphavirus vectors for development of new vaccines and gene therapy tools;
- ✓ Development of serologic diagnostic kits of malignant tumours;
- ✓ Artificial virus-like particles as a new transport form of bioactive substances;
- ✓ New screening instruments of anti cancer medicines;
- ✓ Plant virus model for construction of subunit vaccines and identification of viruses.

The execution of the programme basically addresses:

- ✓ development of new drug substances and their modification approaches by chemical and/or biotechnological techniques;
- ✓ pharmacology and molecular biology studies that would provide useful knowledge for design of new drug substances;
- ✓ development of vaccines, transport forms of drug substances and diagnostic tools using molecular biology techniques.

During implementation of the programme considerable differences in pharmacological effect of enantiomers of the derivatives of several classes of biologically active compounds on both cardiovascular and nervous system, as well as anti cancer effects of these substances were discovered and described for the first time. This knowledge is currently being used for development of innovative medicinal products on the basis of these compounds. Along with

studies of pharmacological properties of individual substances, several new unique combinations of active compounds have been discovered, i.e. compositions thereof where the total effect of combined application of substances significantly exceeds the sum of the effects of each individual ingredient. As a result original combinations possessing high anti cancer efficiency or causing delayed increase of the body mass of animals in diabetes model, have been patented. Some of these discoveries are now being developed further together with Latvian pharmaceutical manufacturers.

During implementation of the programme new technologies for manufacturing of active pharmaceutical ingredients were developed. Some of them are now in scale-up process together with Joint Stock Company "Olainfarm" and "Grindeks".

Original preparation methods of optically active drug substances were developed using different types of organic and enzymatic asymmetric induction catalysts. The knowledge gained have been successfully used for development of manufacturing methods of second generation nootropics, several patents were filed.

Prospective antihypertensive compounds were obtained, as well as environmentally friendly and efficient procedure of manufacturing Latvian made medicinal product – amlodipine was developed and patented. Meanwhile combining gene engineering and organic synthesis approaches resulted in several new gene transfection agents, which may prospectively be used for commercialization.

An innovative methodology allowing diagnostics of melanoma and gastric cancer with 100% specificity and high sensitivity has been developed within the framework of the programme.

Similarly within the framework of the programme unique approaches of experimental pharmacology have been developed, which allow research of cardioprotective effects on the background of diabetes and metabolic syndrome.

Research has been performed, as a result of which development of high performance screening systems for search of anti cancer medicines have become possible. Molecular mechanisms of interaction of different natural substances with the molecules of DNA have been established. Preliminary works for technologization of obtaining virus-like particles have been performed, which allow for development of highly efficient forms of transport of anti cancer medicinal products. Possibilities

of using measurements of autoantibodies in diagnostics of malignant tumours have been researched.

The importance of the results of the programme not only on national, but on international scale as well has been confirmed by 8 international patents issued to methods and technologies developed within the framework of the programme.

7 European Regional Development Fund projects have been initiated and are being implemented for further development of the programme results based on the experience and knowledge acquired during implementation of the programme. These projects refer both to development of new medicinal products and search of technological solutions for medicinal substance development. This fact allows us to conclude that the scientific research performed within the framework of the programme has contributed considerably to development of innovative products on the local and international scale and confirms serious interest of the manufacturers of pharmaceuticals in the results of the programme and further use thereof.

More information on the programme and results:
www.osi.lv Section *Projects*

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3.3. RESEARCH AND ELABORATION OF MODERN METHODS AND DEVELOPED TECHNOLOGIES IN THE FIELD OF ENERGY: ENVIRONMENTALLY FRIENDLY ENERGY, SECURITY OF ENERGY SUPPLY AND ENERGY EFFICIENCY

Priority scientific area: energetics – environmentally friendly types of renewable energy, of energy supply and energy efficiency.

Director of the programme: *Dr. habil. phys.* Juris Ekmanis, Institute of Physical Energetics.

Programme implementation period: 2006–2009

Programme implementers: Institute of Physical Energy, University of Latvia, Institute of Solid State Physics of the University of Latvia, Riga Technical University.



The aim of the programme is to develop methods and solutions that would promote faster progress of Latvian energy sector towards the development of sustainable and secure energy supply system, in compliance with the basic standpoints of Latvian energy policy. To constitute grounds for development of new technologies that would promote wide application of renewable energy resources, rational use of energy resources and security of Latvian energy supply.

Projects within the programme:

- ✓ Research and evaluation of technologies for application of renewable energy;
- ✓ Optimisation of methods of extraction and use of biofuel;
- ✓ Research and development of technologies for production and use of hydrogen;
- ✓ Methods of increasing energy supply safety, technologies and analysis of the key factors thereof;
- ✓ Improvement and management of methods and technologies for effective energy use;
- ✓ Methods and technologies for planning of sustainable and safe energy supply for Latvia;
- ✓ Information system for evaluation of sustainability of the transmission network and power generation system in Latvia.

To facilitate the aims set forth for the Latvian energy industry that are focused on balanced, qualitative and sustainable supply of energy for the national economy and the households, the main research areas of the programme are:

- ✓ Research and development of technologies for use of environmentally friendly types of renewable energy (biomass, hydrogen, wind and solar energy);
- ✓ Effective use of energy through the development of preconditions for the improvement of energy efficiency of residential and industrial buildings and energy production and generation sources, for the implementation of clean coal and combined heat and power technologies;
- ✓ Study of the energy supply security and safety with consideration of technological, economic and social factors.

Methods and models for determining the options of application of renewable energy resources in Latvia, assessment of the economic and environmental impact of the application thereof and development of recommendations for effective energy use in different sectors of energy consumers, as well as for the management of energy efficiency measures and application of technologies increasing energy efficiency in the Latvian conditions were developed as a result of implementation of the programme. It is expected that the developed methods and models will

facilitate safety of energy and fuel supply and sustainable development of national economy in Latvia.

New knowledge has been acquired, theoretical understanding has been expanded and innovative technological solutions regarding new options of use of renewable energy resources and hydrogen, as well as effective use of energy have been achieved.

For the first time in the Latvian scientific research the effect of use of renewable energy resources together with the socially-economic effects (employment assessment, tax flow) caused thereof has been specifically characterised by means of a quantitative model. So far these correlations were studied only by means of qualitative models. The work results in a prepared scientifically methodological base for the assessment of the socially-economic effect caused by use of renewable energy resources in Latvia.

Activities of the programme included development of a scientifically methodological base along with a model for estimation of the fuel consumption and emissions produced by the transport sector and a set of development scenarios have been analysed, providing substantiated qualitative and quantitative results. Effect of new technologies on the emission reduction strategies in the transport sector has been studied. Analysis of scientifically substantiated information on the consumption of resources and its forecasts will allow Latvia to use effectively the greenhouse gas (GHG) emission trading instrument stipulated under the international climate agreements. Additional revenue from the trade in the permitted GHG emission units may amount to as much as LVL 250 million by 2020.

The new methods and technological solutions will facilitate development of implementation of new technologies in Latvia, expanding use of renewable and other environmentally friendly resources, increasing the energy supply safety and improving effective use of energy. Better application of renewable energy resources and installation of new effective technologies will render energy saving and costs reduction per one generated unit of energy. The results of the programme include assessment of technologies for better utilisation of biomass. If the biomass technologies elaborated in the research programme are introduced in cooperation with industrial partners, the savings can be up to 1 million lats annually.

A methodology of processing and use of climatology data from Latvian regions to provide for energy efficiency of buildings and optimise engineering system loads, allowing precise estimations of saving energy consumption planned for new buildings and assessment of actual energy efficiency of existing buildings.

Within the programme the volume and quality of usable biomass has been determined, the possibilities of preparation, storage and utilisation of solid biofuel in the Latvian conditions have been analysed. Furthermore, solid biofuel quality criteria in Latvia have been analysed and biomass compacting methods and expansion of pyrolysis options have been studied. Recommendations have been developed for utilisation of biomass from agricultural by-products.

The scientific activities in the programme have facilitated practical application of hydrogen in Latvian national economy. Successful cooperation has been started with a number of small enterprises in order to establish water gas generators for second-hand cars. Thus, the motor vehicles in Latvia will become more environmentally friendly.

The programme both at the research stage and upon implementation of results paved the way for close cooperation between scientists and a number of business companies. The companies have expressed interest in introduction of new, modern methods and technologies in their business – Joint Stock Companies Latvenergo, Rīgas Siltums, Latvijas Gāze, Limited Liability Companies Jauda, Filter, Viessmann, to mention a few. For example, the Strategic Plan of Energy Supply for Riga used by Joint Stock Companies Latvenergo, Rīgas Siltums and Siltumelektroprojekts provided the basis for passing strategic decisions (cogeneration plants, heating network development) for the total amount of LVL 200 000 000.

More information about the programme and its results:
www.innovation.lv/fei/national1.html

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3.4. SCIENTIFIC FOUNDATION OF INFORMATION TECHNOLOGY

Priority scientific area: information technology – reliable software, integrated information and communication systems and networks, electronic technologies.

Director of the programme: *Dr. hab. sc. comp.* Ivars Biljinskis, Institute of Electronics and Computer Science.

Programme implementation period: 2005–2009

Programme implementers: Institute of Electronics and Computer Science, University of Latvia, Institute of Mathematics and Computer Science of the University of Latvia, and Riga Technical University.

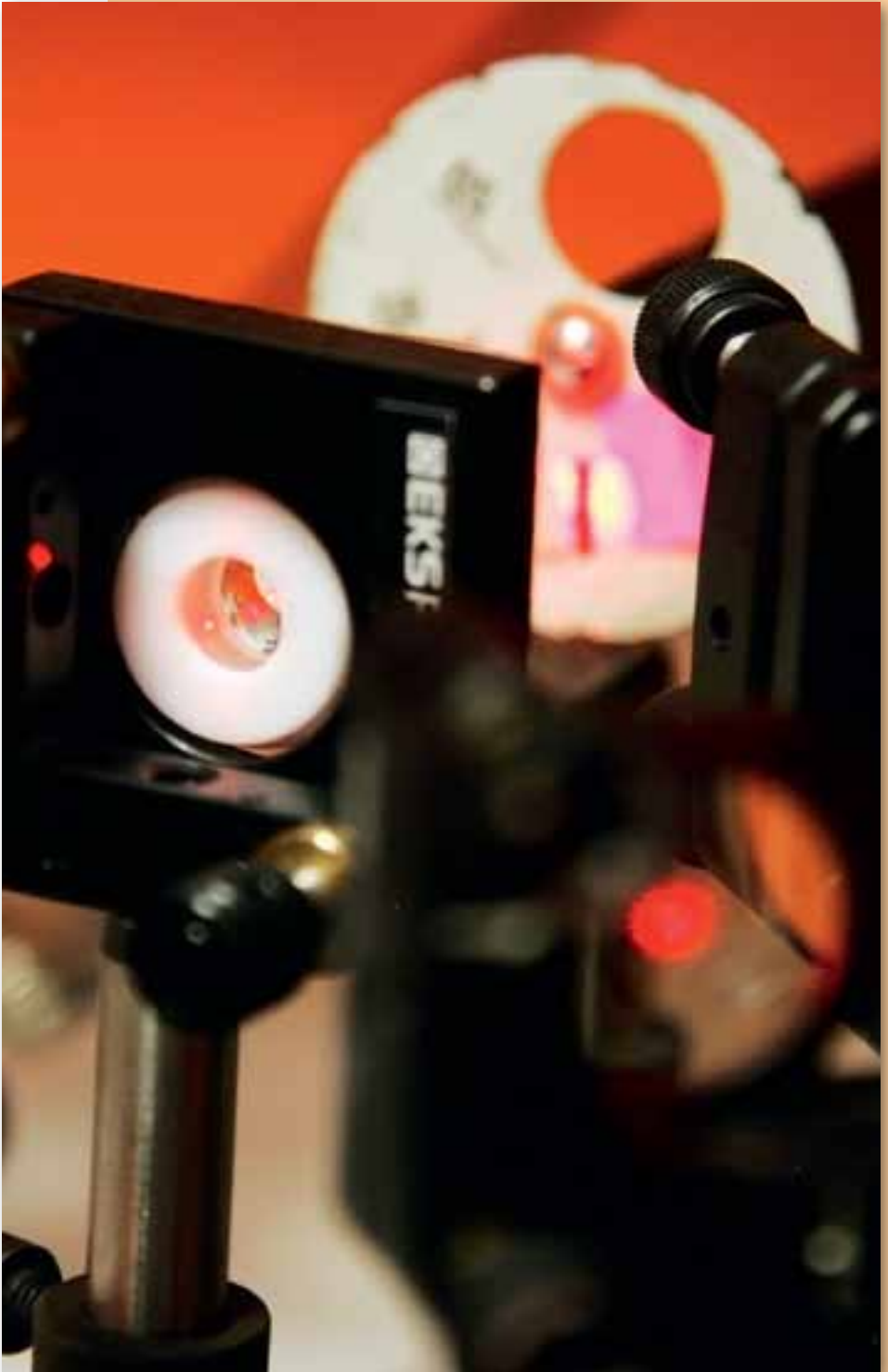
The aim of the programme is to build scientific basis for Latvian information industry, to prepare specialists of higher qualification and engage them into Latvian IT labour market thus fostering competitiveness of Latvia's information technology industry on the global market, and to develop scientific background of national information technology projects for tackling substantial economic issues through application of IT potential.

Projects within the programme:

- ✓ technology development of systems based on model transformations;
- ✓ study and development of the semantic web with adjustments to the Latvian requirements;
- ✓ creation and studies of original signal processing methods for development of competitive information technologies;
- ✓ research and application of new technologies in the field of electronic engineering;
- ✓ new electronic communication technologies.

Scientific basis for national information technology projects has been developed in the framework of the programme addressing important national economy problems and targeting their resolution by application of the potential provided by information technologies. That also increases the competitiveness of Latvian scientists at their attempts to win European Union's projects in the sector of information technologies.

Within the scope of the programme the scientific basis of the Latvian computing industry has been improved. Large scale scientific studies have been conducted and scientific foundation has been developed for national information technology projects targeting resolution of important national economy problems. The research and development activities within the programme were aimed at:



- ✓ support for the development of advanced model-based information systems;
- ✓ development of competences in the state-of-the-art internet technologies in Latvia, studies of principally new internet application areas, their further development and adjustment to Latvian requirements;
- ✓ creation of original signal processing approaches and methods, design of new equipment;
- ✓ development of the modern electronic communication technologies.

Two basic technologies have been created within the programme as the basis for development of the advanced model-based information systems, namely, the model transformation language MOLA, its support tools and tool building platform GrTP (*Graphical Tool-building Platform*). It is much easier to apply the graphic transformation language MOLA in the field of model-based development than other existing transformation languages. The support tools, specifically, a convenient graphic editor based on METAclipse platform, effective implementation techniques support the most popular model repositories and link devices with the most popular modelling tools providing for development of various practical implementations.

In addition, approximately ten innovative technologies for design of new products in engineering have been developed within the programme and offered for practical application.

Three original semantic technologies have been developed, that have been used and developed further after the end of the programme implementation. The semantic web technology is a follow-up of the society computerisation started by the Internet and the international web. It represents a tool for transfer of many commercial processes to network technologies. The aim of semantic web technologies is to make the written information published in the present computer networks “understandable” not only to people, but also to automatic computer programs. Thus this technology paves the way for mass automatization of information processes both within different national economy sectors and the society in general. The aforementioned achievements are scientifically weighty and original both on a Latvian and global scale.

The developed technology for analysis of the Latvian grammar SemTi Kamols is publicly available at the home page www.semti-kamols.lv and is successfully used in Latvian corpus linguistics studies at the University of Latvia and other higher education establishments in Latvia and abroad.

The constantly growing demand for the Discrete Signal Processing devices, systems and software on the world market, as well as for highly qualified specialists in this field, motivated scientific groups to further develop both theory and specific

systems within this field. The developed Discrete Signal Processing systems provide for linking different types of computer systems to the external environment, to the real world objects that are sources of initial information that is processed by computer systems. A number of methodological and technical solutions of significant Discrete Signal Processing problems has been found and respective systems developed. They represent important achievements both scientifically and application-wise. In particular, an experimental version of a stroboscopic oscillograph performing with super-high sensitivity at registration of super-fast broadband signals has been developed, made and tested.

Wide international recognition was gained by system developments for measuring distances to space objects, now successfully competing on the world market.

Within the programme, competences were built in line with the telecommunication modernisation trends and support was provided to the Latvian companies in their efforts at development of telecommunication software for implementation abroad. Knowledge has been produced and experience gained at studies and development of new principles, methods and means for effective resource management at the strata of physical, network, network resource management and user support within multi-level telecommunication network structures, leading to reduction of the prime cost of services and increasing the level of protection in communication networks.

More information about the programme and its results:
www.itprogramma.lv

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3.5. "LETONIKA" (LATVIAN STUDIES): STUDIES OF HISTORY, LANGUAGE AND CULTURE

Priority scientific area: "Letonika" (Latvian Studies) – studies of history, language and culture.

Director of the programme: *Dr. habil. chem, Dr. hist. h.c.* Jānis Stradiņš, Latvian Academy of Sciences.

Programme implementation period: 2005–2009

Programme implementers: Baltic Centre for Strategic Research of the Latvian Academy of Sciences, Agency of the University of Latvia “Institute of Philosophy and Sociology”, Agency of the University of Latvia “Latvian Language Institute”, Agency of the University of Latvia “Institute of History of Latvia”, Agency of the University of Latvia “Institute of Literature, Folklore and Art”, University of Latvia, Riga Teacher Training and Educational Management Academy, Daugavpils University, Liepāja University, Institute of Mathematics and Computer Science of the University of Latvia, Art Academy of Latvia.

The aim of the programme is to work out scientifically justified new conclusions about Latvian language, history and culture of Latvia in order to develop areas of humanities, which build unity of nation and cultural identity, and protect basic human values through collective memory and future vision.

Projects within the programme:

- ✓ Awakening of the Latvian consciousness and experience of non-violent resistance (1945–1991);
- ✓ Occupation regimes in Latvia and their consequences: political, economic, legal, social and ethical aspects, 1940–1965;
- ✓ Latvia in World War II;
- ✓ Ethnic and socio-political processes in Latvia: analysis of stereotypes;
- ✓ Study of computerisation of Lettonic sources;
- ✓ Language and environment;
- ✓ Structure, functions and elements of the Latvian language;
- ✓ Linguistic peculiarities of age groups in Latvia: the linguistic, social and cultural aspects;
- ✓ Database of Latvian glossaries and new borrowings;
- ✓ European values in Latvia and the formation of intellectual traditions (from the Enlightenment to the knowledge society of the 21st century);
- ✓ Intercultural communication: Latgale-Latvia-Europe;
- ✓ Culture and power: interaction within the Latvian language, literature and folklore;
- ✓ Collective and individual identity in life stories;
- ✓ Study of the creative work by Latvian writers, of the culture of Latvian theatre and music;
- ✓ Traditional culture in Latvia: historical and modern aspects;

- ✓ Discourses of the history of the Latvian art in the 21st century.

Within the programme extensive and systematic studies have been conducted in history, language and culture, based on the works of humanities scientists over a century – original sources, systemised literature, databases, archives, applied research materials – as well as qualified scientific personnel. Implementation of the programme has provided the possibility to improve and introduce innovations to the sectors of history, archaeology, ethnography, cultural anthropology, arts, linguistics, literature science, philosophy, academic religious studies and culture semiotics.

Surveys in archaeology and ethnography of Latvia and in history of sciences have been published. The study by J. Stradiņš “The Beginnings of Science and Higher Education in Latvia” won the Baltic Assembly Award in Science.

New findings have been arrived at regarding disputable issues of the history of Latvia – World War II, genocide brought about by the Nazi occupation against the Latvian population, Soviet occupation power policy and repressions in 1940-1941 and 1944-1990, resistance against Soviet and Nazi occupation and our unique experience of non-violent resistance and taking over power in a non-violent way at the end of the 20th century. Research results are reflected in the public monographs “Latvia in World War II (1939–1945)” and “Regaining Independence: Non-violent Resistance in Latvia (1945–1991)” and other research based on original sources and documents.

Within the framework of the programme encyclopaedia “One Hundred Latvian Women in Culture and Politics” has been published and the old city of Jelgava has been visualised by publishing a CD-Rom “Jelgava: Virtual Reconstruction of Architecture and Art” in Latvian and German.

Within the programme collection and preservation of national values both according to traditions and through application of modern technologies have been surveyed and expanded. In this respect, of inestimable national and international significance alike are the acquired collections of spiritual and material treasures created or developed by the people. Within the programme collection catalogues and 26 databases have been established and available both to Latvian and foreign scientists.

For the first time in the history of Latvian linguistics Latvian dialects have been extensively studied in the context of Baltic languages. In cooperation with the project funded by the University of Latvia, the project of the Latvian Council of

Science "Study of Morphology and Phonetics of the Latvian Language Dialects from the Geo-linguistic Aspect" and Lithuanian dialectologists an important publication has been produced within the context of complex studies of Baltic languages "Atlas of the Baltic Languages. A Prospect." (2009), with texts in Latvian, Lithuanian and English.

An important publication of complex studies of Baltic languages "Atlas of the Baltic Languages. A Prospect." has been produced.

Relations between the European cultural values and the trends of intellectual life in Latvia and emergence of culture identities have been studied and analysed historically and systematically, paying main attention to the approval of European values, Christian values, relations between Latvian culture and European Enlightenment traditions, liberalism, ideas of social fairness, justice and moral values and individualism at the same time assessing the impact of traditions, unconscious layers of culture and cultural archetypes. Common European Union approaches in relation to the values in Europe in the 21st century and the understanding of modern values and emergence of the knowledge society by the Latvian society have been analysed.

Within the programme series of humanities books have been launched for the first time in Latvia, thus guaranteeing continuation and diversity of studies, "The Philosophical Library", "The Baltic Literature", "The Linguistic Heritage", to mention just a few. Furthermore, organisation of humanities congresses has been started for the first time in the history of Latvia, there have been three congresses of "Letonika" (Latvian studies) studies, and several regional congresses, for example, the congress of Sēlija and the congress of Latgale.

Research in humanities cannot and will never yield profit, studies can never become a direct component of industrial manufacturing or a source of extensive funding. The importance and sense thereof is much deeper and more lasting. It is manifested through intermediation, as an incentive for the quality of work, conscience, cultural and moral stance of the people engaged in national economy. In this manner "Letonika" (Latvian studies) studies may influence, especially through the system of education, and help to diminish the effect of the negative trends that have emerged in recent years, namely migration of workforce to foreign countries and unwillingness of the people who have left to return to Latvia, to strengthen the people's link with Latvia, their national and local patriotism, their attachment to the Latvian language and culture.

In total 162 monographic publications, including 1 encyclopaedia, 3 thematic dictionaries of the Latvian language, 2 CD-Roms regarding issues of ethnic history, culture-historical relations, the course of the development of traditional culture, as well as unique iconographic and written evidence of the end of the 18th century and be-

ginning of the 19th century have been published within the framework of this programme. 1300 articles and conference reports have been prepared and publicised.

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3.6. DEVELOPMENT OF ADVANCED FUNCTIONAL MATERIALS FOR MICROELECTRONICS, NANO-ELECTRONICS, PHOTONICS, BIOMEDICINE AND CONSTRUCTIONAL COMPOSITES, AS WELL AS RELATED TECHNOLOGIES

Priority scientific area: materials science – nanotechnologies for acquisition of functional materials, composite materials of new generation.

Director of the programme: *Dr. habil. phys.* Andris Šternbergs, Institute of Solid State Physics, University of Latvia.

Programme implementation period: 2005–2009

Programme implementers: Institute of Solid State Physics of the University of Latvia, Institute of Physics of the University of Latvia, Institute of Polymer Mechanics of the University of Latvia, University of Latvia, Riga Technical University, Institute of Inorganic Chemistry of the Riga Technical University, Riga Stradiņš University, Daugavpils University, Institute of Physical Energy, Latvian Institute of Organic Synthesis.

The aim of the programme is creation of prerequisites for production of science-intensive products with high added value – nanomaterials, nanocomposites and constructional composites of new generation – for Latvian and global market, using original technologies for production of these materials.

Projects within the programme:

- ✓ Perspective inorganic materials for photonics and energetics;
- ✓ Perspective inorganic materials for optoelectronics and microelectronics and advanced methods in structure research;
- ✓ Materials for photonics and nanoelectronics based on new functional low-molecular and high-molecular organic compounds;



- ✓ Perspective biomaterials and medical technologies;
- ✓ Development of nanoparticles, nanostructural materials and thin-film technologies for creation of functional materials and composites;
- ✓ Design of functional materials/nanocomposites, development of technologies and properties thereof;
- ✓ Ensuring participation of Latvian scientists in ERA-Net programme MATERA within the European Union Sixth Framework Programme;
- ✓ Functional materials for resistive switching memory;
- ✓ Modelling dynamics of adaptive multifunctional materials and structures.

Within the programme different important studies have been conducted, with the results divided across different areas of application, e.g. in electronics, photonics, biomedicine and other fields.

Applications in electronics: successfully conducted solid surface field studies by using high-resolution atomic spectroscopy methods, with the results applicable in sensitive magnetometers that allow detection of magnetic field in nanometre areas and in adaptive optic elements. DNA injection via a needle coated with nanoporous anodised aluminium oxide has been performed and transfer of DNA from one microglobule to another has been demonstrated. This provides further opportunities for miniaturisation of optoelectronic and microelectronic devices. Al_x-Ga_{1-x}N thin films with high Al concentration have been created. Their electrical and optic properties have been determined thus providing good preconditions for the design of high-frequency high-mobility transistors.

Applications in photonics: modification of surface (appearance of spatial relief) of amorphous halcogenide films and polymer films with azobenzene derivatives under impact of laser radiation during holographic recording. By improving the related technologies it is possible to produce devices with a holographic diffraction grating. For the first time spectral properties of oxygen bond scission in the deep ultraviolet spectrum area of glassy SiO₂ material, which allows reviewing the presently valid findings regarding the reasons of causing reduction of glass permeability due to impact of ultraviolet laser radiation (solarisation). Changes in the composition of gases in electrode-free lamps made of SiO₂ glass have been studied and formation of OH groups in the interaction of the oxygen in the glass walls with the gas discharge plasma and ultraviolet radiation has been shown. The results of the studies of spectral parameters of the radiation of electrode-free lamps containing helium, argon and hydrogen and the results of the studies of interior surfaces of the lamp will allow development of better spectral radiation sources for analytical or industrial applications.

Applications in energetics: models developed as a result of theoretical research allow understanding of imbalance processes in such important devices as Li-batteries, fuel cells, ceramic membranes. A system of hetero-transitions of organic

materials photosensitive within a wide spectrum of energy has been obtained, which can be used for the development of light sensors and organic solar elements after optimisation of its composition and electrodes. By changing the thermal processing of the transparent ZnO coatings fine-grained coatings and coatings with needle-like structure have been obtained, the application of which is perspective for use with both solar cells, in optoelectronics and sensor technologies.

Applications in sensor technology: zinc and zirconium oxides have been studied in the form of single crystals and nanocrystals and it has been demonstrated that zirconium nanocrystals can be used as an active material for the design of an oxygen sensor. An extremely fast (sub)nanosecond luminescence in activated zinc oxide nanocrystals has been observed, which can be developed further for the design of fast scintillators in x-ray visualisation systems and radiation gauges.

Applications in biomedicine: implants with specifically oriented pore structure have been produced to increase bioactivity. The developed porous ceramic has been tested in vitro and in vivo medicine infiltration for the development of medicine-modified implants. Diagnostic potential in skin pathology assessment has been developed for two methods.

Composite applications in technology: technologies for the production of nanocomposites of biologically degradable modified starch/nonmodified layered silicate montmorillonite type of different composition in laboratory conditions have been developed. Technologies of nanocomposite extraction and production of certain products based on use of Latvian nature resources have been developed. It has been established that due to the intercalated nanocomposite structure the elasticity module and tensile stress increase several times already at a low content of nanofilling. Under the impact of the formation of a specific coplanar structure, the barrier properties of the studied nanocomposites increase considerably.

Quantum interference from carbon nanotubes as a new, perspective quantum information processing device has been modelled for the first time.

Within the programme the immersion holographic record method has been worked out, allowing recording holographic grids with a very small (50 nm) period, and effective luminescent detector materials of new type have been designed for use in determining the oxygen amounts. Furthermore, a new optic memory device of a greater capacity, consisting of several thin films of tungstate has been developed. Properties of strontium titanate surfaces have also been studied, allowing considerable improvement of operation of information processing devices, and new organic materials have been designed for direct recording of surface relief holograms in the red part of the spectrum.

In addition to the research work, extensive labour has been contributed to considerable improvement of the experimental infrastructure of the programme, utilising the project financing in combination with the opportunities provided by the structural funds. This allowed improving the quality of research and student/doctoral student training and bringing the experimental capacity of the involved laboratories nearer to the level required for successful cooperation with manufacturers.

A number of manufacturers, the Joint Stock Company Sidrabe, limited liability companies GroGlass, Evopipes, Baltijas Gumijas fabrika, the Joint Stock Company Latvijas Dzelzceļš and state organisations, e.g. Latvian Association of Road Carriers, among others have already expressed interest in the programme achievements in the field of development of innovative nanocomposites (nanostructured composite materials of thermoplastic matrix with improved barrier and resistance deformation properties, pressure and steam sensors).

The themes developed within the programme have provided a basis for launch of several international cooperation projects, the functional material studies and developments having been included, among others, in ERA-NET MATERA, MATERA+ and EURATOM projects in which scientists from Latvia also participate.

More information about the programme and its results:
www.cfi.lu.lv/eng/projects

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3.7. SUBSTANTIATION OF DECIDUOUS TREES CULTIVATION AND RATIONAL UTILISATION, NEW PRODUCTS AND TECHNOLOGIES

Priority scientific area: forest science – sustainability, new products and technologies.

Director of the programme: *Dr. chem.* Bruno Andersons, Latvian State Institute of Wood Chemistry

Programme implementation period: 2005–2009

Programme implementers: Latvian State Institute of Wood Chemistry, Latvian State Forest Research Institute “Silava”, Latvia University of Agriculture

The aim of the programme is to work out innovative, ecologically and economically justified technological solutions for sustainable use of forest and non-forest land for growing deciduous woods and for the development of industries based on the utilisation of forestry production.

Projects within the programme:

- ✓ Development of perspective deciduous tree growing technologies in forest and non-forest land to provide consumers with forest materials;
- ✓ Use of broad-leaf wood in mechanical processing to generate new products;
- ✓ Use of broad-leaf wood in production of improved wood materials and new products;
- ✓ Economic assessment of deciduous tree products and technologies.

The programme resulted in the implementation of new knowledge acquired on growing the broad-leaf softwood and timber utilisation options that are important for the Latvian national economy for producing high quality materials and high added value products. Within the programme, recommendations have been developed for the assessment and inspection of the progress in the growth of grey alder stands, breeding of planting stock, renovation of stands and treatment that allows the management of grey alder stands on the scientific basis. Great interest in the application of recommendations has been shown by private forest owners who manage approximately 905 grey alder stands.

To facilitate the use of broad-leaf softwood for lumber, a methodology has been developed for determining the quality of round assortments of grey alder and aspen, the industrial wood assortment result from the trunk has been explained and a methodology has been provided for choosing a rational trunk cutting scheme. Complex research has been performed regarding the structure and physical properties of the common aspen and hybrid aspen bred and grown in Latvia as a potentially perspective wood. Grey alder and aspen lumber drying treatments have been developed that ensure the quality drying according to Class E or Q in line with the EDG (European Wood Drying Group) methodology intended for companies that dry broad-leaf softwood.

As a result of the research, a thermal modification technology has been developed that allows biocide-free production of materials with improved bio-resistance properties and stability of form for use in outdoor structures.

Broad-leaf softwood gluing treatments have been developed and offered for modified materials used in glued structures – furniture, panelling, covers, garden elements, etc. in outdoor and increased humidity conditions, e.g. in saunas.

A conclusion can be drawn from the results acquired from the research, that thermal modification in a water steam environment is a suitable method to generate a new product with higher added value and wider application options. The acquired experiment data provide a sufficient presentation of the hydrothermal modification of alder wood to consult the prospective modified timber manufacturers or users.

Thermo-mechanical compacting treatments have been developed for aspen, allowing increasing the surface hardness and use of the material for the production of wood flooring, furniture and furniture parts. Chemical modification – acetylation technological treatment – has been developed for grey alder and aspen wood; the properties and useful lifetime of acetylated wood have been estimated. Grey alder and aspen burning parameters have been explained; the impact of different fire retardants on the burning reaction thereof has been specified. The options of using these materials in construction and manufacture of wood products have been assessed from the point of view of fire resistance of the wood.

It has been proposed to use grey alder and aspen wood for production of pallet forms and pallet structures instead of the traditionally used coniferous softwood. A computer programme has been designed for fast and operative estimation of the pallet form cross-cut measures and pallet load-bearing capacity. The data can be used in companies manufacturing Euro-pallet type bases.

Worldwide, research into the replacement of fossil industrial raw materials with renewable resources becomes more and more topical not only for generation of energy but also a wide range of chemical compounds (green chemistry). Within the programme, different technologies have been studied for producing of high added value and the so-called niche products. A rational technology with a minimum amount of waste has been developed for producing of dense, mechanically durable granulated carbon sorbents from broad-leaf softwood processing waste or branch wood.

Mechanically durable activated charcoal has been derived with the pore surface area and pore volume that is compliant with the best sorbents – coconut shell activated charcoal. The production of acetic acid from the technological alder wood chips has been optimised. The kinetics of acetic acid formation has been studied, and the parameters, at which the greatest acetic acid formation reaction speed is reached, have been determined.

It has been established that bark of Latvian grey alder is a perspective raw material for production of valuable products and chemicals – diarilheptanoids and tannins, and the possibility of using alder bark components for medical treatment purposes has been proved experimentally.



A flow diagram of waste-free processing of grey alder bark within the general scheme of bio-refining wood materials has been proposed. An effective sorbent of heavy metals, especially copper and lead, can be obtained from grey alder bark and from cellolignin after extraction of acetic acid. An original method for utilisation of processed sorbents containing heavy metals has been developed by working the sorbents into polymer systems, as a filling. Surveying the results of the study, a flow diagram has been developed for complete utilisation of raw materials and manufacturing of products in fundamentally new ablation-type fast pyrolysis equipment. The flow diagram includes the use of all fast pyrolysis wood products and by-products and allows changing the product assortment within an extensive range and thus the adaptation to the market demand.

A semi-industrial manufacturing technology has been developed for production of birch microcrystalline cellulose (MCC) tablets with additives of natural medical substances (dried pollen, chitosan). A method has been developed for production of MCC gels of relevant strength and viscosity for practical use.

It has been established that the hemicelluloses extracted from grey alder wood are suitable for production of vegetable oil emulsions and use in skin treatment products, while effective heat insulation materials can be produced from the large-tonnage by-product of broad-leaf cellulose – tall oil.

Options of rational use of industrial by-products and recycled materials for producing of new products, for example, atmosphere-resistant and mechanically strong geo-composite materials developed on the basis of birch lignosulfonates generated in veneer production, have been investigated. The research allows recommending the developed lignin binder as a dust remover in treating gravelled road surfaces. Effective heat insulation materials can be produced, in their turn, from the large-tonnage by-product of broad-leaf cellulose – tall oil, with a wide range of applications, e.g. hot and cold water tanks, heating mains, residential and public building, manufacturing sites, etc.

The options of strengthening recycled paper fibre and paper made from it by means of different additives have been established. As a result, the mechanical strength properties of recycled fibre paper have been improved, especially in moist conditions. A basis of the technology for reuse of tetrahedral package fibres has been developed.

Tetrahedral package fibres have been extracted from packaging, and paper has been made for the first time in Latvia at the paper manufacturer's site, and strength indicators of the produced paper have been determined.

The results of the research showed that valuable products can be generated from the broad-leaf wood, components, bark and scrap wood in deep recycling by means of hydrolysis, pyrolysis, steam explosion and extraction technologies: composite materials, binders, pharmaceutical and chemical products, sorbents, film and insulation materials. It facilitated joining of these methods in a unified cascade-type bio-refining scheme, where waste products of one process are used further as a raw material for generating another product. This scheme allows approaching zero emission production.

The programme research results and acquired information may be used for further planning of wood processing and wood recycling powers and products, as well as for strategic planning of the forestry sector and national development. Wood processing companies, including the joint-stock company Latvijas Finieris, Limited Liability Companies Dendrolight Latvija, 4Plus, Dores, pallet and wood pellet manufacturers, etc. have been informed and have shown interest in the studied technologies and products.

More information about the programme and its results:
www.kki.lv section *Scientific Activity*

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3.8. MULTI-DISCIPLINARY RESEARCH CONSORTIUM ON MAJOR PATHOLOGIES THREATENING THE LIFE EXPECTANCY AND QUALITY OF LIFE OF THE LATVIAN POPULATION

Priority scientific area: medical science – development of clinical medicine based in technologies of applied sciences.

Director of the programme: *Dr. med.* Valdis Pīrāgs, Pauls Stradiņš Clinical University Hospital, Clinic of Internal Medicine.

Programme implementation period: 2006–2009

Programme implementers: Pauls Stradiņš Clinical University Hospital, University of Latvia, Riga Stradiņš University, Riga Eastern Clinical University Hospital, Latvian Biomedical Research and Study Centre, Institute of Mathematics and Computer Science of the University of Latvia, Latvia State Agency of Tuberculosis and Lung Diseases, Infectology Center of Latvia, Agency of the Riga Stradiņš University “Augusts Kirhenšteins Institute of Microbiology and Virusology”.

The aim of the programme is to investigate resources for improving population health and extending the working life of people in Latvia.

Projects within the programme:

- ✓ Development of new methods for early diagnostics, prevention and treatment of cardiovascular diseases;
- ✓ Effective and contemporary development of cardiac surgery in Latvia – development of new treatment methods and optimization of the existing ones;
- ✓ Development of the diagnostic methods for determining malignant tumour risk factors, early diagnostics of tumours and pre-tumorous states, optimization of the therapy of tumours;
- ✓ Hereditary tumours, clinical and molecular research thereof, prevention and development of early diagnostic strategy;
- ✓ Development of contemporary early diagnostics, prevention and therapy measures for the diseases that affect child mortality and disability;
- ✓ Development of modern technology based algorithms for diagnostics and treatment of congenital pathologies for children in order to reduce patient mortality, increase life expectancy and improve quality of life;
- ✓ Reduction of child mortality rate by improving early diagnostics, treatment results and prevention of life-threatening dangerous infectious diseases in Latvia, through implementation of the methods of modern molecular biology, cytometry and immunogenetics;

- ✓ Development of contemporary early diagnostics, prevention and therapy measures for the diseases caused by excessive obesity and diabetes;
- ✓ Long term prospective monitoring programme (register) of the risk factors and clinical forms of the cardiometabolic syndrome;
- ✓ Blood-borne viral infections affecting human life expectancy: Persistence of viruses in the body of the patient, diagnostic and therapy paradigms;
- ✓ Immune modulating viruses, strategy of diagnostics thereof and possibilities of therapy correction;
- ✓ Development of the most topical modern diagnostics, epidemiology, prevention and treatment measures for pathogens resistant to antimicrobial agents;
- ✓ Prompt and effective diagnostics of chronic respiratory diseases, introduction of new therapy methods into the clinical practice;
- ✓ Development of united database on prevalence of principal pathologies affecting life expectancy and quality of life and risk factors thereof among residents of Latvia, which would be accessible to all researchers.

The topics of the research studies implemented within the framework of the programme basically correspond to principal pathology groups endangering life expectancy and quality of life of the residents of Latvia: Cardiovascular diseases, malignant diseases, endocrine and metabolic diseases, infectious diseases, childhood diseases and most significant chronic lung diseases.

Large scale epidemiological research studies of international scale have been performed as a result of the program, medical databases on principal pathology groups endangering health of the residents of Latvia were developed and analyses of the data collected therein has been performed.

A large cross-sectional study with 6000 randomly selected participants on risk factors of cardiovascular diseases of the population of Latvia, international secondary prevention study Euroaspire III and study on consumption of antibiotics by the residents of Latvia at general practitioner practices and hospitals were performed within the framework of the program. A systemic inflammatory response syndrome cohort study was also performed at the Children Clinical University Hospital, as well as epidemiologically genetic study on clinical and molecular peculiarities of the most frequent hereditary cancer syndromes characteristic to Latvia.

Latvian cardiac surgery database and congenital heart disease registration system were developed. Analysis of the data of Acute Coronary Syndrome Register and Latvian Cancer Patient Register was performed, epidemiological data on infant mortality were analysed and diagnostic drawbacks of the most frequent congenital

surgical anomalies in Latvia were assessed with pursuant development of proposals for improvement of the situation. System of monitoring the most dangerous pathogen bacteria to the health of the residents of Latvia was performed as well, an extensive database of prevalence of the risk factors of cardiac diseases and unified health and heredity database of the residents of Latvia, which contains DNA and serum samples available to all researchers. A united medical data warehouse containing anonymous data from the disease registers of the national scale was established and online access of authorized researchers to this database was provided.

During the implementation of the programme several original studies of diagnostic biomarkers were performed. A study of genetic markers of cardiac patients after percutaneous coronary intervention and a study of genetics of a new cardiac and vascular disease marker adiponectin must be mentioned here especially. Systemic inflammation response syndrome marker studies in infected children without systemic inflammation response and in children with sepsis of different degrees of severity were performed at Children Clinical University Hospital.

In the group of oncological diseases a study of metastatic tumours of unspecified origin was performed with the aim of improving the treatment possibilities of such patients and their life expectancy indicators.

Dynamics of the level of antioxidants in blood and interrelation thereof with other cell functions was studied during the research of blood-borne infections at the Infectology Center of Latvia. Localized mutations for determining the resistance to kanamycin were localized in samples of mycobacteria in a genotyping study of multidrug-resistant tuberculosis. The molecular genotyping methods developed as a result of the study, as well as polymerase chain reaction based methods of mutation analysis for determining drug resistance are being introduced into clinical practice.

Congenital cancer screening study by examining breast cancer, ovarian cancer, colorectal cancer, uterine cancer and prostate cancer patients was performed at the oncological clinics of Latvia with the aim of development of screening methods and early diagnostic of the disease. It was found that some of these cases of cancer have developed within the limits of congenital cancer syndrome, which is why diagnostics of congenital cancer may become a significant weapon in early diagnostics of cancer in Latvia. Genetic testing was performed on all examined patients with breast and ovarian cancer. A new method for early diagnostics of pre-cancer states of the stomach was researched at Riga Eastern Clinical University Hospital and determining of pepsinogen I/II proportion was recommended for practical use.

Meanwhile, within the framework of the study of cystic fibrosis genetics, molecular diagnostics methods for diagnosing of CFTR (Cystic fibrosis transmembrane conductance regulator) gene in the population of Latvia were developed and a large scale cystic fibrosis screening study of the newborns was performed, during which 7040 newborns were tested.

Modern diagnostics tests, innovative technologies and efficient treatment methods capable of improving the health status of the residents of Latvia and to improve their life expectancy were introduced into clinical practice.

53 patients with rare congenital metabolic diseases were identified using selective screening. Amino acid metabolism defects and lysosomal storage diseases accounted for the majority of the findings. Based on the results of clinical and laboratory data analysis, indications for referring the patients to clinical geneticists were developed, in order to exclude or confirm congenital metabolism diseases.

An original study on the use of electronic olfactory sensors in differential diagnostics of lung diseases was performed

During the research the applicability of olfactory sensor for examination of risk groups of different lung diseases (lung cancer, bronchial asthma, chronic obstructive pulmonary disease, etc) was determined.

The applicability of the FINDRISC questionnaire developed in Finland for Latvian conditions was tested during diabetes mellitus screening study, including 256 participants from separate general practitioner practices of Riga. The results of the study showed that majority of these patients have increased risk of glucose metabolism disorders. Comparison of the results of FINDRISC questionnaire and laboratory examination results showed that this questionnaire is applicable as a screening method for selection of the risk group of type 2 diabetes mellitus patients.

New therapy methods were developed and experimentally tested.

A new method of closing ventricular septal defect after trans-apical heart valve replacement procedure was developed at Pauls Stradiņš' Clinical University Hospital, which allowed for minimally invasive type of surgery without opening the chest. A method of creating quick flexible silicone models of aorta and heart using three dimensional printer was developed and tested in order to enable precise interpretation of anatomic structures before trans-apical surgery.

Studies enabling assessment of the correspondence of the existing bioprostheses for the native heart valves, as well as providing information for development of new bioprostheses were performed within the framework of the program. Substantial studies on changes of haemodynamics and tissue perfusion during heart surgery were performed, allowing reduction of perioperative mortality and morbidity. An analytic method for determining the chemotherapy agent Paclitaxel in human

serum using reversed phase high performance liquid chromatography technology was developed and clinically validated.

Research of the therapy results of congenital pathologies in children with oesophageal atresia, duodenal atresia, omphalocele and gastroschisis was performed at the Children Clinical University Hospital. An algorithm for pre-surgery preparation, surgery, as well as post-surgery monitoring of such patients has been developed.

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3.9. CLIMATE CHANGE IMPACT ON WATER ENVIRONMENT IN LATVIA (KALME)

Priority scientific area: environmental science – regional climate change impact on water ecosystems and adaptation, sustainable management and protection of the Baltic Sea and inland waters.

Directors of the programme: *Dr. hab. chem.* Māris Kļaviņš, University of Latvia, Faculty of Geography and Earth Sciences, and *Dr. biol.* Andris Andrušaitis, University of Latvia, Faculty of Biology.

Programme implementation period: 2006–2009

Programme implementers: University of Latvia, Institute of Biology of the University of Latvia, Latvia University of Agriculture, Latvian Institute of Aquatic Ecology, Latvian Fish Resources Agency, Daugavpils University.

The aim of the programme is to evaluate the impacts of short-term, mid-term and long-term climate variability on the environmental quality and ecosystems of inland waters and the Baltic Sea, and to create scientific basis for adaptation of the environmental policy and sector policies of Latvia to climate change.

Work packages within the programme:

- ✓ Climate change impact on runoff, nutrient flows, and regime of the Baltic Sea;
- ✓ Climate change impact on nutrient turnover in the drainage area;
- ✓ Climate change impact on Freshwater Ecosystems and Biological Diversity;



- ✓ Coastal processes;
- ✓ Bio-geo-chemical processes and primary production in the Baltic Sea;
- ✓ Climate change impact on ecosystems and biological diversity of the Baltic Sea;
- ✓ Runoff extremes caused by the climate change and their impact on territories under flood risk;
- ✓ Adaptation of the environmental and sectoral policies to climate change;
- ✓ Programme management and dissemination.

Research resulted in integration of climatic, hydro-chemical and biological, providing understanding on the processes occurring in the freshwater and marine environment. New knowledge and findings acquired and recommendation produced during implementation of the programme are being used in the decision-making processes at the national and local government levels.

Methodologies to assess and correct systematic errors in the regional climate model performance have been designed in order to prepare the artificial climate data series on territory of Latvia for the future 30 years.

To be able to predict the potential changes in the ecosystems of Latvia's waters methodologies have been developed for the assessment and comparison of regional climate model performance and correct systematic errors. These methodologies were applied in generating artificial climate data series with the range of 30 years were prepared for the territory of Latvia. Climate data projections correspond to the modern climate as well as the climate change scenarios B2 and A2:

- ✓ a double-ensemble approach has been developed for assessment of the climate change impact on the river drainage basins, and a set of hydrological models for Latvia's drainage basin regions has been designed and calibrated. These models produced river runoff data series for the drainage basin regions in Latvia;
- ✓ a plant nutrient runoff model has been developed for the Lielupe drainage basin region and nutrient loading data series for the Gulf of Riga drainage basin have been calculated;
- ✓ a three-dimensional physical model of the Baltic Sea waters in Latvian territorial sea and EEZ and a one-dimensional vertical stratification model of the Gulf of Riga have been developed to calculate climatic marine condition data series.

Studies performed within the programme allow a number of important conclusions in regard the climate change, e.g. the average annual air temperature

in Latvia is predicted to rise by 2.6 to 4.0 °C and the total annual precipitation to increase by 8 to 12 %. It has also been concluded that the weather conditions in Latvia corresponding to future climate projections will be characterised by (1) considerably shorter (even by 3 months) winters, mostly reduced to the month of February, (2) arrival of spring by half a month earlier, (3) summer longer by two months (May – September), (4) enjoyable, relatively dry and warm early autumn (October, beginning of November), and (5) longer late autumn with more rain (including January).

Field data series collected over several years allow to analyse nitrogen and phosphorus emission and runoff regimes with monthly and seasonally resolution. By calibration of the water quality model and modelling of nitrogen and phosphorus runoff for the Bērze River sub-basins, the river's pollution load has also been analysed across the types and sources of pollution. In addition, the total annual nutrient runoff increase due to climate change by approximately 6-20% depending on the climate change scenario has been predicted. This allowed hypothesizing that even with insignificant changes or even decrease of in river runoff, agricultural pollution may increase considerably in future.

An assessment of climate change impact on the abiotic and biotic components of surface freshwater environment was performed for the first time.

By the increase of the parameters characterising the content of organic matter – water colour and chemical oxygen, it has been established that considerable impact on surface freshwater may be expected. With winters becoming warmer and maximum amounts of precipitation increasing, the surface runoff grows, causing changes in the chemical composition of surface water and alternating the functioning of aquatic ecosystems. Controlling leaching of various substances from soil in winter periods will become critical to maintain ecological quality of Latvian water bodies.

Studies addressed also changes in freshwater fish communities, dominant fish species and their distribution, as well as, migration and growth. It has been projected that during the next 50-70 years composition of fish communities will change considerably: the number of coldwater fish will decrease and the number of warmwater fish will increase.

Potential impact of winter hydro-meteorological conditions characteristic to the future climate on phytoplankton and zooplankton of the Daugava floodplain lakes was assessed based on seasonal observations over the last 5 years. Recommendations for reduction of the erosion risk in the potentially threatened territories were developed.

The first classification of geological structure, relief forms, morphometric parameters and dynamics of modern processes covering the entire coastline of Latvia has been developed.

A 15-20 year coastal retreat projection has been produced the country in general and for the territories of each coastal local government. Potential are of the inundated territories has been estimated, and digital maps designed. A map atlas "The Baltic Sea Coastal Processes in Latvia" has been prepared and published in Latvian and English. This atlas contains 25 maps characterising changes of the Latvian sea coast over the last century, during the last 15 years and in a number of fiercest storms of the last years; a series of digital cartographic data on the coastal erosion risk zone for the years 2023 and 2058 has been prepared. Threat of coastal erosion and flooding caused by storm surge has been assessed for the territories of all coastal local governments. Most important economic and social objects within the risk zone have been identified.

Indicators for evaluation of the seacoast erosion and flood risk degree have been adapted to the local conditions of Latvia. Coastal area has been zoned according to the degree of risk.

The short-term experimental works performed within the programme in combination with field studies and analysis of multi-annual data series of observation in the Baltic Sea waters provided an opportunity to formulate a conceptual forecast of the potential changes in the marine ecosystem ecosystem and biological diversity.

In general the programme results indicate that substantial restriction of the human pressures on marine ecosystems will be necessary to ensure sustainability of resources under conditions of climate change. Nutrient loads, including the cross-border, reduced to the extent possible, prudent fisheries policy and observation of the status of the marine protected territories are the key preconditions for sustaining viable marine ecosystems. Implementation of the KALME program has resulted in a number of proposals for climate change adaptation measures. Being adapted to the impact of climate changes in Latvia these proposals specify further the general framework of adapting measures provided at the EU level. In addition to more than fifty peer-reviewed scientific papers and several monographs, KALME programme has produced a popular book on climate change adaptation measures in Latvia and a text book in Latvian.

In order to ensure the performance quality and visibility at international level, an international advisory board comprising leading experts in the climate change issues from the Baltic Sea region and other European countries monitored the implementation of the programme. Three international advisory board sessions resulting in valuable recommendations for enhancement of research quality and stakeholder work were held.

More information about the programme and its results:

kalme.daba.lv/en

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3.10. NATIONAL RESEARCH PROGRAMMES (2010 – 2013)

Pursuant to the Cabinet of Ministers Decree No. 294, dated 29 May 2010, "Regarding National Research Programmes" five national research programmes in the prioritised scientific areas for the years 2010 to 2013 were approved and their implementation was launched in 2010:

1. Innovative Technologies of Acquisition and Use of Power Resources and Provision of Low Carbon Emissions Through Renewable Energy Resources, Supporting Measures for Restriction of Environmental and Climate Degradation

Programme manager – *Dr.habil.phys.* J.Ekmanis, Institute of Physical Energy.

The aim of the programme is

- ✓ to develop methods, models and solutions for the development of new innovative technologies in the energy industry that would facilitate diversification of energy resources, development of the energy supply system by means of regional availability of renewable energy resources and the integration thereof into the state energy supply system, thus considerably expanding the scope and types of renewable energy resources used in Latvia and contributing to diminishing of climate change and ensuring biological diversity;



- ✓ basing on an integrated energy system and consumption development study and considering the effect of the dynamic trend of energy efficiency measures and development of energy efficiency technologies on the resource demand, environmental quality and socially-economic development, to establish a scientifically methodological substantiation for the development of the state energy system.

Objectives of the programme:

- ✓ to work out a comprehensive state energy system development planning model and energy efficiency improvement measures, with consideration of technological, economic, environmental and social factors;
- ✓ to survey and analyse data on the options of Latvian regions to use optimally diverse energy resources on the basis of availability of renewable energy resources, biological diversity, potential energy efficiency measures and economic sustainability;
- ✓ to study options of adapting the best available technologies of generation and use of renewable energy resources (biomass, wind, sun and other types) and effectiveness of the practical usability thereof in Latvian conditions;
- ✓ to study hydrogen generation, storage and energy release methods and to develop prototypes;
- ✓ to study the biomass gasification technology and develop a prototype for extraction of such fuels that would be more effective to use in generation and cogeneration of energy.

More information on the programme:

www.innovation.lv/fei

2. Development of Innovative Multifunctional Materials, Signal Processing and Information Technologies for Competitive Science Intensive Products

Programme manager – *Dr.habil.phys.* A.Šternbergs, Institute of Solid State Physics, University of Latvia.

The aim of the programme is to develop highly qualified scientific competence in the field of innovative materials, signal processing and information technologies, thus providing local companies with the opportunity to manufacture competitive products on the basis of knowledge generated in Latvia and to facilitate export and growth of Latvian national economy.

Objects of the programme:

- ✓ develop technologies for generation of multifunctional materials and their nano-order multilayer coatings and application thereof in energy converter devices (radiation-electric energy, electric energy-radiation), to study their photophysical properties and to optimise energy conversion effectiveness, as well as to develop materials and structures from high

optic durability or nonlinear optic materials intended for light wires and spectral devices;

- ✓ to develop perspective signal registration and processing technologies for improvement of embedded system effectiveness and mobility, development of picosecond metering systems, ultra-broadband signal generation and supersensitive detection, biometric signal processing, transmission of sensor network data, using sensors and other modern materials;
- ✓ to develop self-reinforced multifunctional polymer composites with innovative nanostructured modifiers and relevant technologies for production of functional engineering composites for obtaining specific coatings, super-elastic electronic and photonic elements, thermoprecipitation materials, products with antistatic properties and properties of absorbing electromagnetic radiation;
- ✓ to develop innovative solid tissue replacement material and fixing concrete according to bone structure model systems, to conduct complex investigation thereof and develop innovative technology for creation of cell scaffolds for tissue engineering and recombined protein composites with nano-size biomaterial particles, as well as to study skin chromophore and fluorophore division in-vivo with multispectral imaging and laser fluorescence methods;
- ✓ to develop an original system meta-modelling method based on ontology and high-level transformation language, which will work directly with ontology. To expand the domain-specific tool idea by developing a domain-specific system concept that will be defined by means of meta-models and model transformations (GRADE-3).

More information on the programme:
www.cfi.lu.lv/projekti/vpp

3. National Identity (Language, History of Latvia, Culture and Human Safety)

Programme manager – *Dr.habil.chem., Dr.hist.h.c. J.Stradiņš*, Latvian Academy of Sciences.

The aim of the programme is to create a knowledge base to build a comprehensive and in-depth understanding of the national identity in Latvia in the 21st century where it meets the culture-historical heritage, socially-economic, political and culture environment changes and offers solutions for ensuring sustainability of Latvia in the future.

Objectives of the programme:

- ✓ to conduct in-depth interdisciplinary, innovative and comprehensive research on the understanding of the national identity in relation to the Latvian language, history, culture and human security;

- ✓ to study plurality of identities within the ethnic, social and culture variety – interaction of national, regional and European identities and effect thereof on modern processes and sustainability of the development of Latvia;
- ✓ by means of methods of social sciences to study identity and capacity, provide in-depth interpretation of the human security issues of importance for the state and the society in the Latvian and international (Baltic States and the European Union) context and a global future vision;
- ✓ to develop studies of the base of the national identity – the Latvian language, to study the dynamics of the linguistic processes of the 21st century, to develop a new academic Latvian grammar, to produce practical input in the modernisation of the language use, among others, in the internet environment;
- ✓ to study the impact of historical processes on the development of the nation's, statehood, national and multi-ethnic identity and changes thereof, especially in the 20th and 21st centuries by producing a practical input in the creation of the civic society in Latvia;
- ✓ to study Lettonic resources (e.g. folklore and folk traditions, literature, art, music, architecture, theatre) thus facilitating preservation, development and modern use thereof.

More information on the programme:

www.nacionalaidentitate.lv

4. Development of New Preventive, Treatment, Diagnostic Means and Methods, Biomedical Technologies For Improvement of Public Health

Programme manager – *Dr.med. V. Pīrāgs*, Pauls Stradiņš Clinical University Hospital, Clinic of Internal Medicine.

The aim of the programme is to create new personalised medical technologies and treatment means for the improvement of public health by applying the methods of clinical medicine, molecular genetics and cell biology, medical chemistry and pharmacy.

Objectives of the programme:

- ✓ to establish integrated research platforms to ensure application of medical, pharmaceutical and biomedical methods for the development of new treatment and diagnostic means and technologies and use thereof to provide for the public health;
- ✓ to develop new individualised preventive and diagnosing approaches, treatment means, innovative biomedical technologies, cell therapy methods and to examine their application in clinical practice;
- ✓ to develop systems of pharmacovigilance by analysing the genetic and medical causes of adverse reactions characteristic to the Latvian population,

in cooperation with chief clinical medical research centres, biomedical and organic synthesis research institutes and entrepreneurs;

- ✓ to identify new therapeutic goals by applying the genome research methods and to produce chemical agents that have a complex effect on the identified goals.

More information on the programme:

www.stradini.lv Section *Science*

5. Sustainable Use of Local Resources (Mineral Deposits, Forest, Food and Transport) – New Products and Technologies

Programme manager – *Dr.chem.* B.Andersons, Latvian State Institute of Wood Chemistry.

The aim of the programme is to study and develop new products and their production technologies by utilising the Latvian underground resources, forestry resources, raw materials of local flora and fauna and to work out proposals for long-term development of transport.

Objectives of the programme:

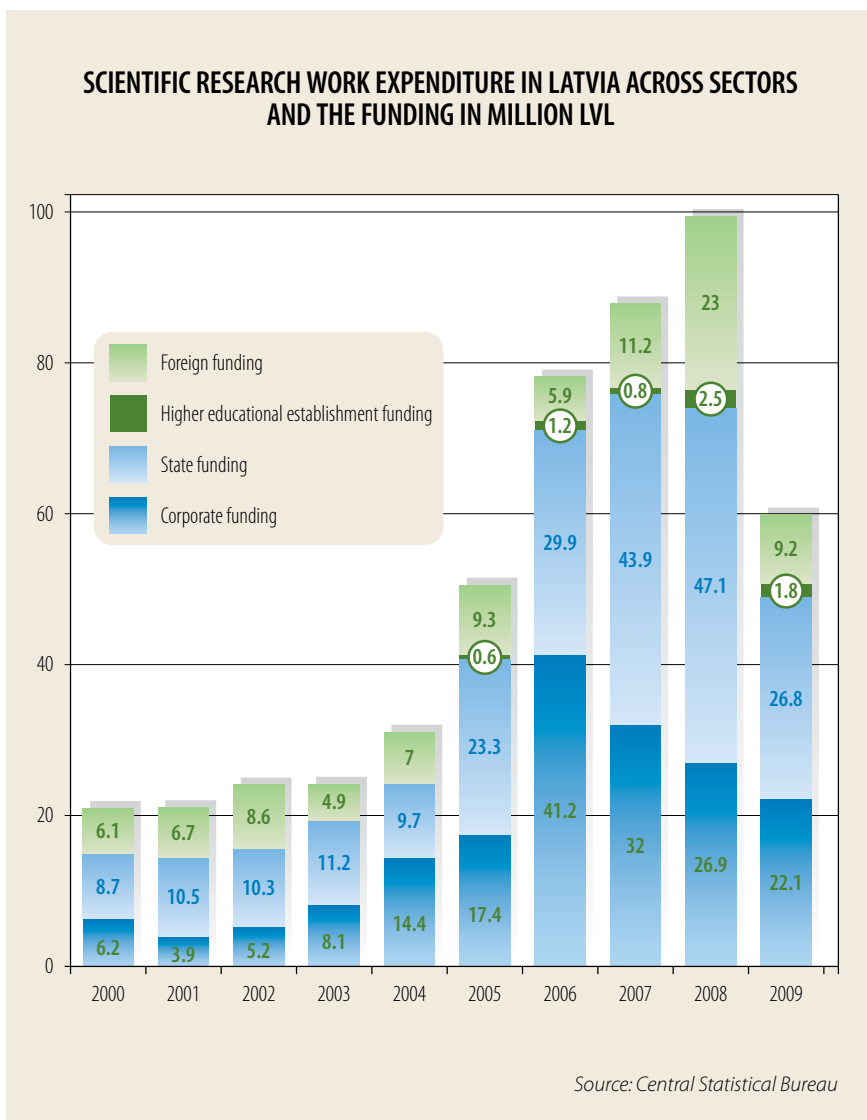
- ✓ to evaluate suitability of the Latvian clay for the development of new products and production technologies thereof and by utilisation of the Latvian clay develop a highly disperse system of the innovative application of the extraction technology in sorption processes, environmental technologies, medicine and cosmetology. To create new ceramic products and technologies, energy-saving technologies of production of highly porous ceramics from the Latvian clay, as well as to study peat and sapropel as valuable raw materials for new technologies and products with high added value and to create new biotechnology products and technologies on ceramics base;
- ✓ to develop new and effective forest growing technologies, wood resource mobilisation options, quality timber, wood and non-wood biorefining technologies;
- ✓ to study quality and safety of raw materials for food products, development of new products for market variation, optimisation of shelf-life terms and quality preservation options and useful utilisation of processing byproducts;
- ✓ to conduct relevant research for the development of competitiveness and efficiency of transport by road, improvement of highway infrastructure quality (connections, accessibility, durability), road traffic safety, effect of the transport by road on the environment, among others, reduction of the greenhouse effect caused by emissions.

More information on the programme:

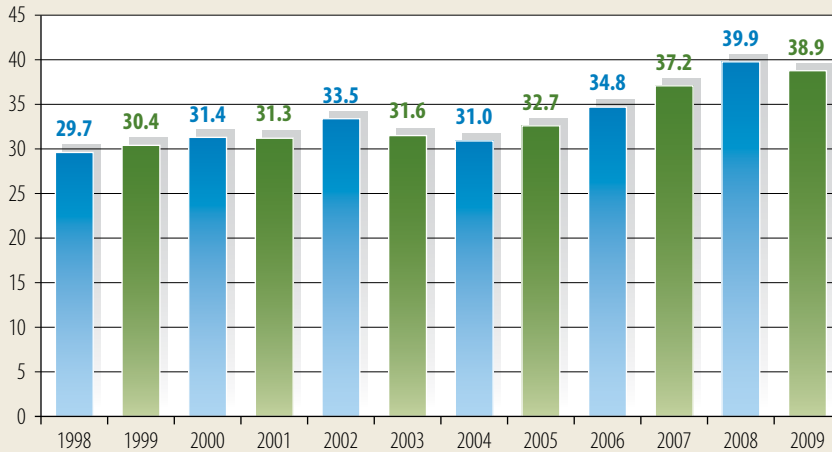
www.kki.lv Section *Scientific Activity*



4. STATISTICS OF RESEARCH AND DEVELOPMENT

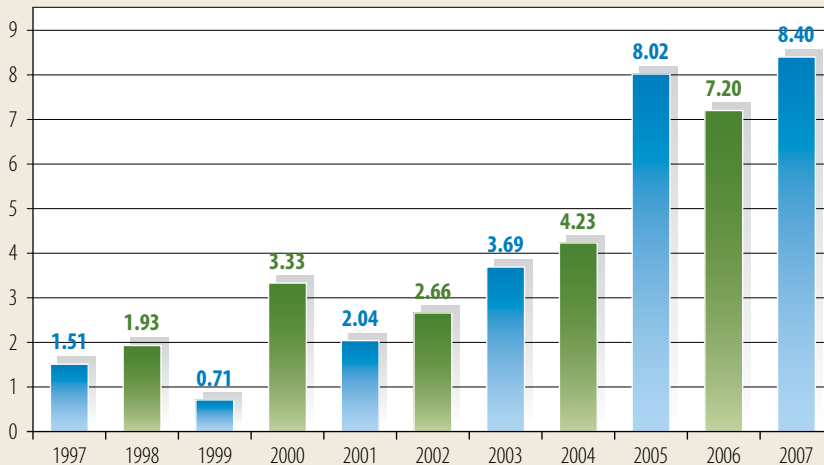


NUMBER OF DOCTORAL STUDENTS IN THE FIELD OF SCIENCE AND TECHNOLOGIES IN LATVIA (% OF THE POPULATION WITHIN THE AGE GROUP 20-29)



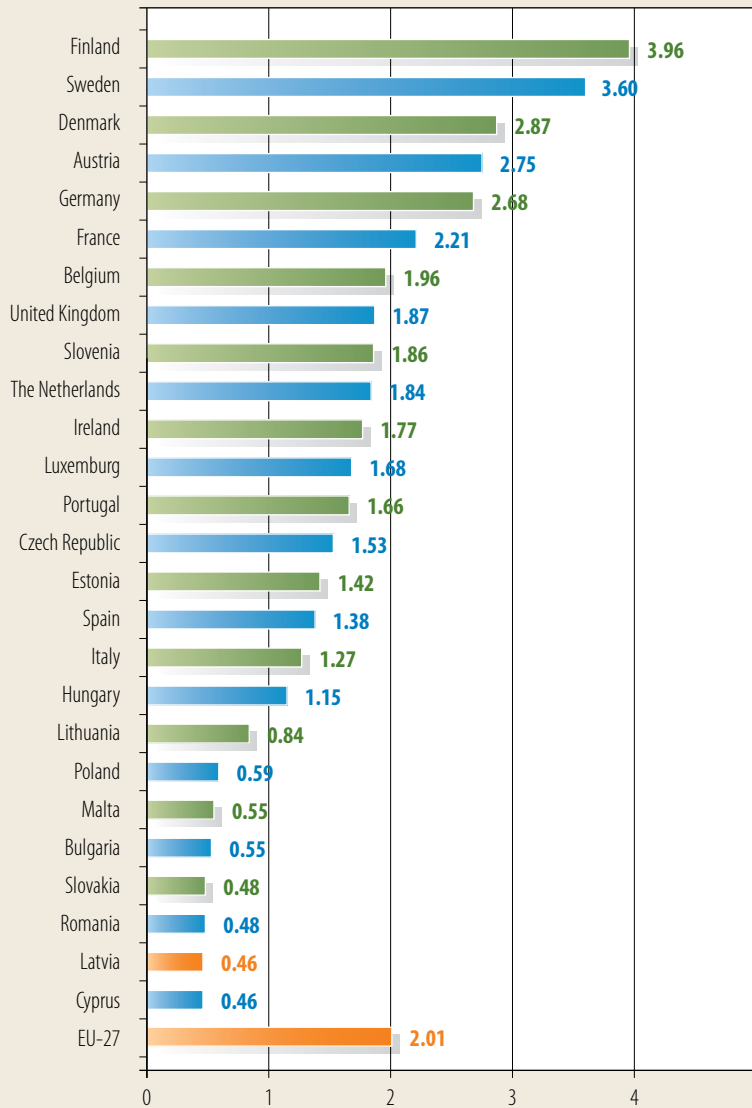
Source: Eurostat

NUMBER OF EUROPEAN PATENT APPLICATIONS (EPO) IN LATVIA (NUMBER OF PATENTS PER ONE MILLION INHABITANTS)



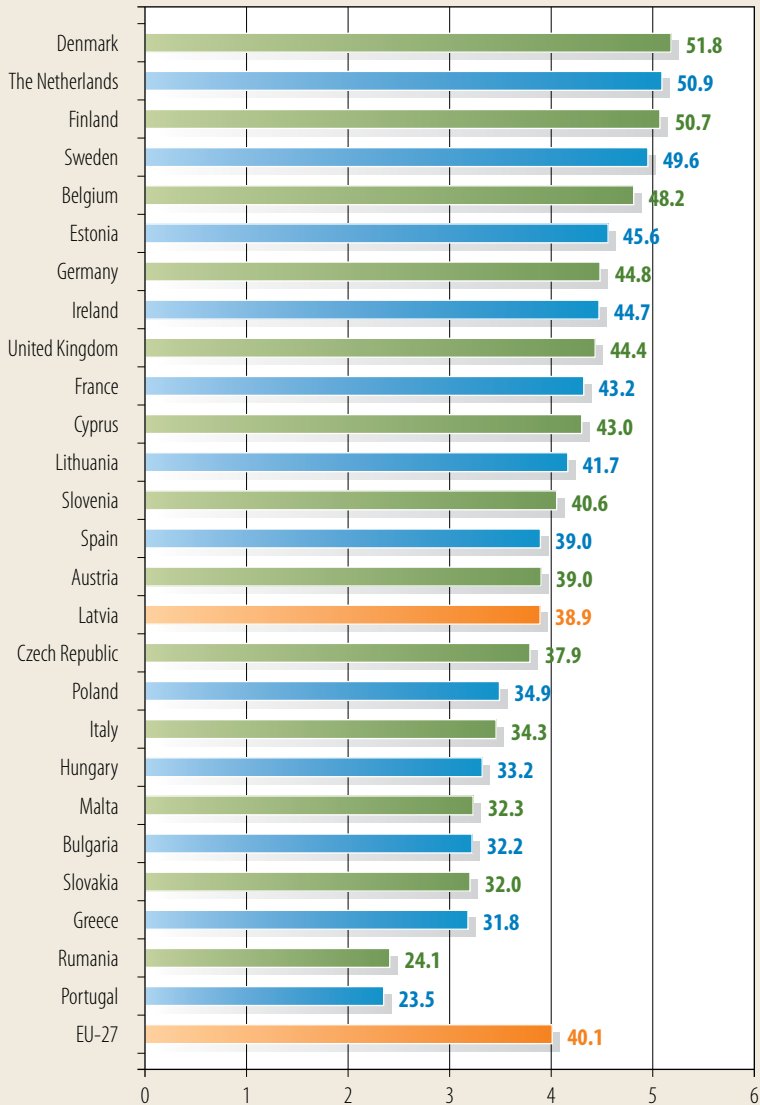
Source: Eurostat

RESEARCH AND DEVELOPMENT EXPENDITURE IN THE 27 EU MEMBER STATES, 2009 (% OF GDP)



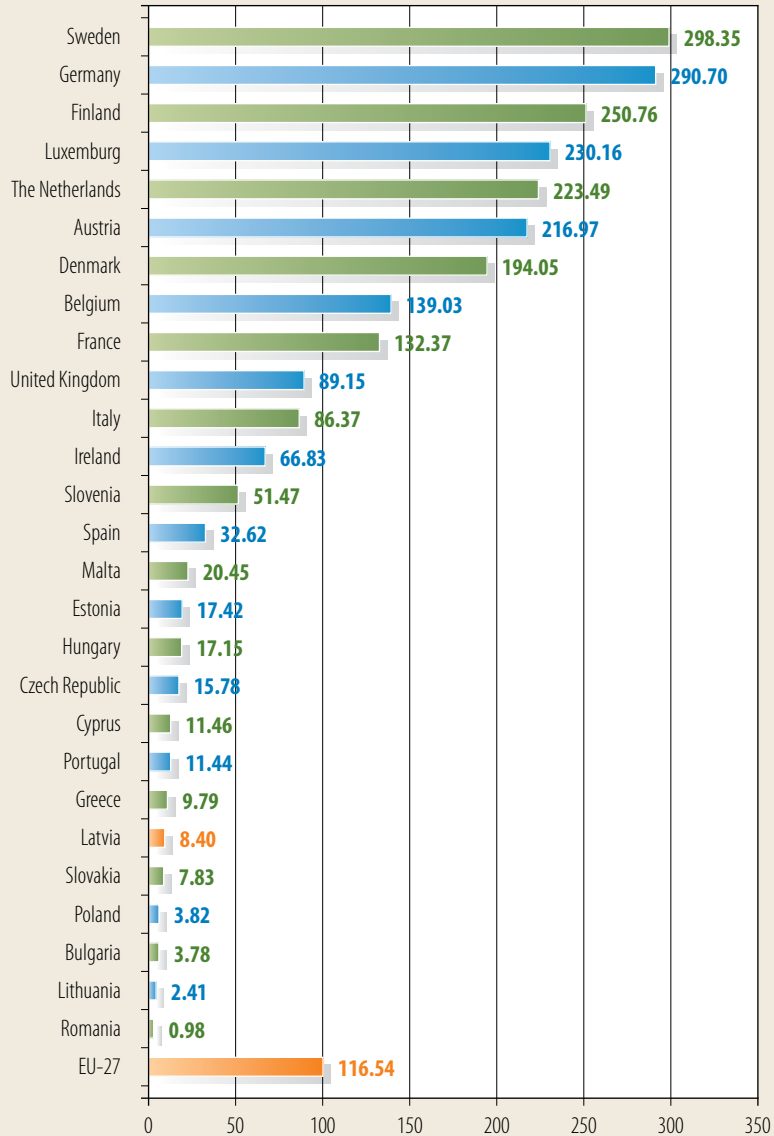
Source: Eurostat

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY, 2009 (% AS A SHARE OF LABOUR FORCE)



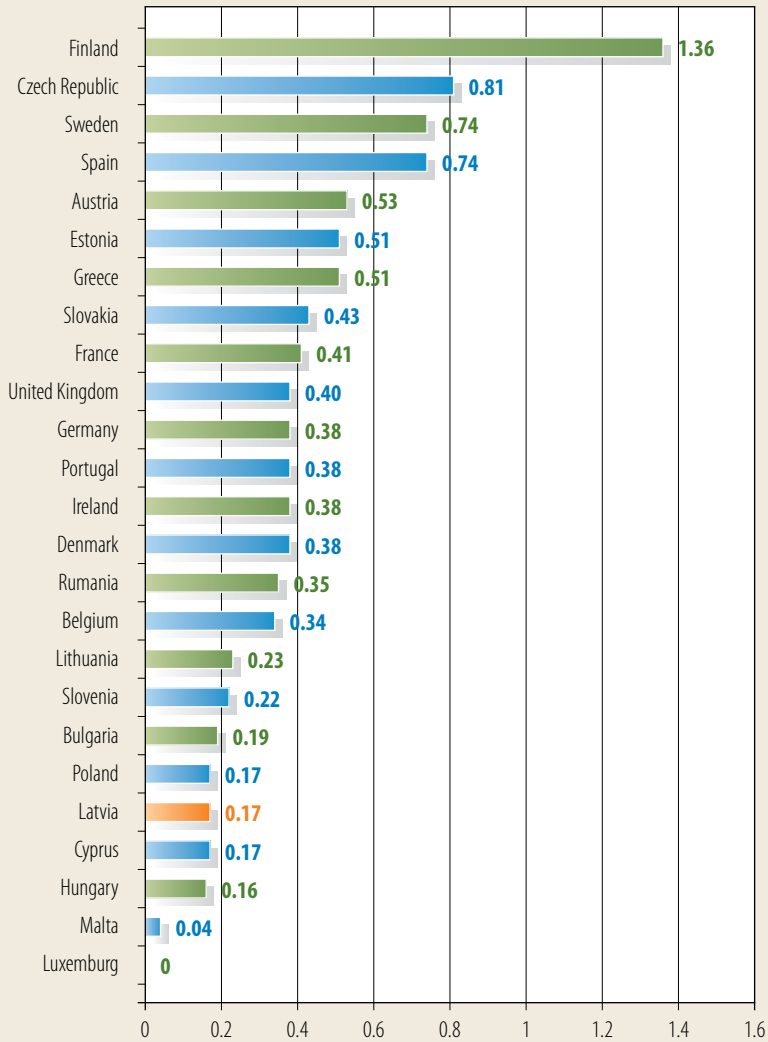
Source: Eurostat

PATENT APPLICATIONS TO THE EUROPEAN PATENT OFFICE (EPO), 2007 (NUMBER OF PATENTS PER MILLION INHABITANTS)

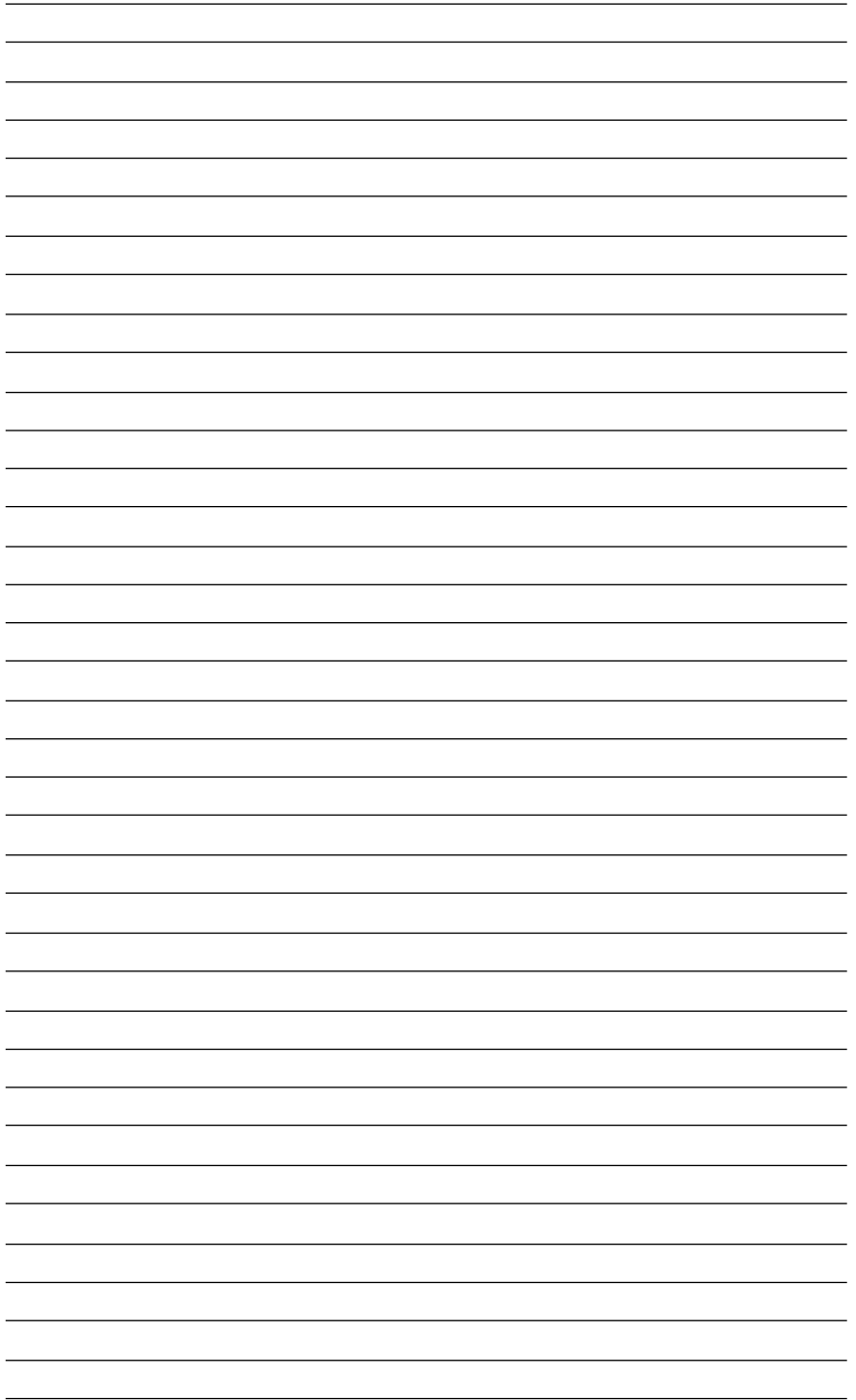


Source: Eurostat

DOCTORAL STUDENTS IN SCIENCE AND TECHNOLOGY FIELDS, 2008 (% OF THE POPULATION AGED 20-29)



Source: Eurostat





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