The Future of Science & Technology in Europe

SETTING
THE LISBON AGENDA
ON TRACK

PORTUGAL 2007

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A Collective Book prepared by European Research Ministers
at the initiative of the Portugueses Presidency
of the Council of the European Union
to be presented to the December 2007 European Council

The Future of Science and Technology in Europe
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Portuguese Presidency

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The Future of Science and Technology in Europe

José Mariano Gago

On the 19th of July 2007 an informal meeting of the Council of Research ministers took place in Lisbon at the initiative of the Portuguese presidency of the Council of the European Union. Ministers from all EU member states and their delegations, as well as from EFTA countries, took part in a somewhat unusual meeting: the future of science and technology in Europe was the only item on the agenda, although the organisation of the debate followed a structured order based upon a choice of some of its main political dimensions: human resources for S&T, public funding, private investment in R&D.

On that evening, participants shared a dinner at a XIX century old liberal club downtown, the Grémio Literário. Ministers and the Commissioner had the rare opportunity of sitting together at a large table set up at the Grémio's library and to speak out their minds with no written notes, and no technical assistance from their staff. Dinner discussions were not recorded. Ministers exchanged their own experience, their national policy objectives and instruments as well as they also shared their doubts, failures and successes. The richness of the debate, a truly European science and technology policy debate based upon real national policies as they had been designed and were being implemented by national governments, motivated my proposal at dinner to produce a collective book by European research ministers in time to be presented to the European December Summit.

This collective book is a unique set of texts by European research ministers on how their own national policies have been conceived and are progressing towards contributing to common European objectives.

I will not attempt to condense the variety of situations, and the diversity of policy instruments, in a synthetic formula. I would nevertheless like to highlight what emerges as common driving factors in current national science and technology policies: the critical importance of qualified human resources, the recognition of the need to strengthen the constituency for scientific development in the society at large and to promote general scientific and technological culture, the commitment to increase public funding for S&T, the perceived need to modernise universities, the importance of increasing the share of competitive funding over historical institution budgets, the commitment to pursue quality at the highest level and to internationalise national research systems, the urge to extend cross-fertilisation between sectors and to focus systematically on joint collaboration between universities, research laboratories and industry, the governments' priority to facilitate private investment in R&D, the need to combine, whenever appropriate, EC funding programmes with national or international ventures, the importance of developing better infrastructure at national, community, bilateral or international levels.

Our collective reflection initiated in July was due to converge at the Competitiveness Council in November. Meanwhile, promoting active participation of the main relevant stakeholders in the political debate was perceived as an essential component in the building up of a renewed common strategy. To be sustainable, such a strategy has to be based upon the interplay of the main actors and upon a shared understanding of the factors shaping the future of science and technology in Europe. We had therefore to devise a series of European events intended to bring together the main stakeholders and to stimulate their active contribution to the European debate. Industry, government, scientists, national and international research performing organisations, research councils, universities, student associations, academies and scientific societies across Europe were invited to share their views and objectives and to contribute effectively to the shaping of the political decision-making process.

The high-level Lisbon Conference on The Future of Science and Technology in Europe was the corner-stone of that process. It strengthened the view that national policies are at the core of a successful strategy for the future of science and technology in Europe, and that commonly agreed European objectives are key to such renewed national policies. It also allowed taking stock of the ongoing controversy launched by the EC paper on the European Research Area within a larger process, setting the role of the EU Framework Programme for R&D as a catalyst for progress.

Clear public statements by the largest national research performing organisations in Europe (namely, the Max-Planck Society, CNRS, CSIC and others) and by EUROHORCS (the combined group of national research funding organisations in Europe) have lent support to these conclusions, and to the need to develop much stronger international partnerships among national funding agencies and research councils as part of renewed national policies emphasizing priority to science and technology.

The Lisbon Conference on the Future of Science and Technology in Europe pointed out the need to define policy targets that would clarify and bring new operational stimulus to the Lisbon and Barcelona objectives. Those were to be found in the critical issue of human resources for science and technology, both concerning the need for a positive net inflow from the rest of the world, and a positive growth of new S&T graduates and PhD holders combined with a larger share of women.

The one thousand participants of the European Conference of Science Centres (ECSITE) held in Lisbon some months earlier had helped to convey that same message of priority to people, from their experience of building up a culture of proximity between scientists and non scientists, schools and research organisations.

The high level Lisbon Conference on the Modernisation of Universities highlighted the need to accelerate reform of Universities as a critical step both to widen the social base of higher education and qualifications in Europe and to help the emergence and strengthening of world-class universities in Europe, able to compete internationally for the best talent. The first World Congress on Research Integrity, held in Lisbon at the initiative of the ESF, ORI, NSF, EC and OECD identified organisational integrity as a new dimension of reforming public research and university systems.

The European Conference on Nanosciences and Nanotechnologies served as a test bed of science and technology policy in a strategic field. It showed considerable progress (namely in the successful preparation of dedicated Joint Technology Initiatives by industry, member states and the EC) but it also revealed considerable lack of a common organisation at EC level as well as the need for a better definition of national or intergovernmental priorities in several countries. However, the recent treaty signed by Spain and Portugal setting up the most recent intergovernmental international research laboratory in Europe (the International Nanotechnology Laboratory, in construction in Braga, Portugal) could open up a new wave of intergovernmental initiatives needed to renew the landscape of competitive R&D centres in Europe in many science fields.

The November Competitiveness Council would therefore break new ground based upon a large participation of those stakeholders whose combined action will shape effectively the future of science and technology in Europe. Unanimous agreement was reached on all Council Conclusions and Resolutions: on the Future of Science and Technology in Europe, on the Modernisation of Universities, on Nanosciences and Nanotechnologies, on Scientific Publishing in the Digital Age. Final unanimous decisions were also taken on the four Joint Technology Initiatives ENIAC (on nanoelectronics), ARTEMIS (on embedded systems), IMI (on innovative medicines), Clean Sky (on aeronautics), as well as on the regulations for the proposed European Institute of Innovation and Technology.

The Competitiveness Council set out therefore a renewed vision for science and technology policy objectives both at national and community levels.

Such a vision recognises the critical role played by science and technology in the development of knowledge-based economies and the increasingly difficult competition for highly qualified scientists, engineers and post-graduate students the EU is facing at world level; and welcomes the initiatives by Member States in this respect to confer high priority to public investments in science and research, to stimulate higher levels of private investment in R&D and to encourage reforms and the internationalisation of higher education and public research systems. It also welcomes the fact that several major S&T stakeholders in Europe have publicly expressed support to the furthering of European Research and stresses the role that National Research Agencies and Research Performing Organisations, International Laboratories, Universities, Scientific Societies, Academies, and European Industry play to contribute to such collective action. It welcomes the launch of the 7th Framework Programme which retains a focus on transnational collaborative research and researchers' mobility while enabling enterprise-focused and other activities, notably the action of the newly created European Research Council to reward excellence in frontier research and reaffirms its support to the independence of the ERC as a condition for its effectiveness and further development.

The Council also acknowledges that, although substantial advances have been achieved since the Lisbon European Council of March 2000 set the objective to make Europe the most advanced knowledge-based society, faster progress has been achieved by other major regions and considers that faster progress is more than ever necessary. It stresses that future progress towards the achievement of European objectives, namely the fulfilment of the Lisbon and Barcelona goals, depends critically on national science and technology policies in Member States and on the increased priority Science and technology should be granted in national reform policies and, hence, invites the Commission and Member States to strengthen the science and technology priority in the next cycle of the Lisbon strategy.

The Council recognises that world competition for qualified human resources for S&T is a critical strategic issue requiring the adoption of consistent and comprehensive national and EU actions on the increase of the attractiveness of S&T for the new generations as well as on the capacity of Europe's R&D public and private institutions to make Europe attractive to the best talent from the rest of the world.

To this effect, the Council suggests the development of the following objectives for the EU as a whole for the next decade: 1) balanced brain circulation between the EU and the US; 2) maintain a positive growth rate of new graduates and PhD in S&T and the appropriate flow to the private sector commensurate with the Lisbon and Barcelona objectives and increase the share of women among new researchers; 3) an appropriate balance of R&D personnel inflow to the EU from the rest of the world for mutual benefit.

The Council also stresses the need to reinforce competitive incentives and market conditions for business research and innovation and invites the Member States and the Commission to enhance data and knowledge sharing, in particular the use of data and results from publicly funded research results across Europe, building upon the existing Communication on knowledge transfer and the Commission's intention to propose a voluntary European Intellectual Property Code of Practice, as requested by Council.
It also invites the Commission together with the Member States and in collaboration with the European Investment Bank and other potential financial partners to continue to study ways to improve conditions for R&D funding.

The Council stresses the need to optimise the use of public resources for R&D programmes, infrastructures and international cooperation. Therefore, it invites Member States to encourage Research Councils and National Funding Agencies in Member States, as well as intergovernmental European Research Organisations, to expand their collaboration and to devise new forms of pooling together their expertise and resources on a mutual voluntary basis for joint objectives. It invites Member States to encourage public and private research institutions to make full use of the emerging distributed forms of research activity (namely eScience) based upon international research networks made possible by the availability and world-class unique quality of distributed European network infrastructures like GEANT and GRID. It also invites Member States and the Commission to deepen their dialogue with regard to the modernisation of European Universities.

The Competitiveness Council finally calls on the European Council to consider the above mentioned objectives in its long term vision for the development of the EU as a world-class competitive knowledge economy and society.

Let me finally thank all colleagues in European governments, and the Commissioner for Research, as well as their staff, the general secretariat of the Council and the Portuguese presidency staff for all their support. I also thank all scientists, science administrators and industrialists in Europe who have energetically supported and shared our initiatives.

Science policy is indeed key to the development of science and technology, as it helps to set the conditions for its development. It has a decisive role in bringing about the conditions to study and to be informed, the freedom of research and the capacity to collaborate, the resources to achieve results and to disseminate the methods and results of research. Science policy, however, is not about science itself. The real impetus for research and new knowledge lies deeply rooted in civilisation and expresses itself in human curiosity and in the motivation to learn, to discover and invent what had not been discovered or understood before. Generation after generation, a growing number of human beings now have the possibility of participating in the human adventure of knowledge. This is the result of policies that aim at delivering the potential for knowledge of individuals and societies. Such is, therefore, our pride and our responsibility.

The Future of Science & Technology in Europe

European
Commission

Janez Potočnik

European Commissioner for Science and Research

Towards an open and competitive European Research Area

Janez Potočnik

LISBON AND THE WORLD:
MAKING EUROPE READY FOR A GLOBAL ECONOMY

Globalisation and high growth in emerging markets are creating a more competitive environment, but also many opportunities for new goods and services that a knowledge-based, innovative Europe should capitalize on. At the same time, the world is facing major challenges such as energy security and climate change, which similarly call for knowledge-intensive and innovative solutions. These two aspects of globalisation are linked as new global challenges often mean new global markets. A case in point is the market for environmentally sustainable products and services, for which a strong demand is rising on all continents and particularly in high-growth countries such as China.

In order to succeed in an increased global competition and to capture the benefits of new markets, Europe must become a leading knowledge-based economy. This was the goal that the European Union set itself at the Lisbon European Council in 2000. Seven years on, it is clear that Europe has the capacity to achieve that goal, but also that there is still considerable way to go.

The Lisbon Strategy focuses on making Europe a leading knowledge economy, exploiting the full potential of research, education and innovation and the interactions between them – the so-called "knowledge triangle". Its implementation was substantially strengthened after 2005, notably with the **Broad-based Innovation Strategy** for the EU adopted in December 2006[1]. It is leading to important reforms to create innovation-driven markets. For example, via the "lead market" initiative, the Community and Member States aim to create the best conditions for the development of innovative markets with high growth and jobs potential, such as e-health or sustainable construction.

[1] European Commission communication *Putting knowledge into practice: a broad-based innovation strategy for the EU*, COM(2006) 502 of 13/09/2007

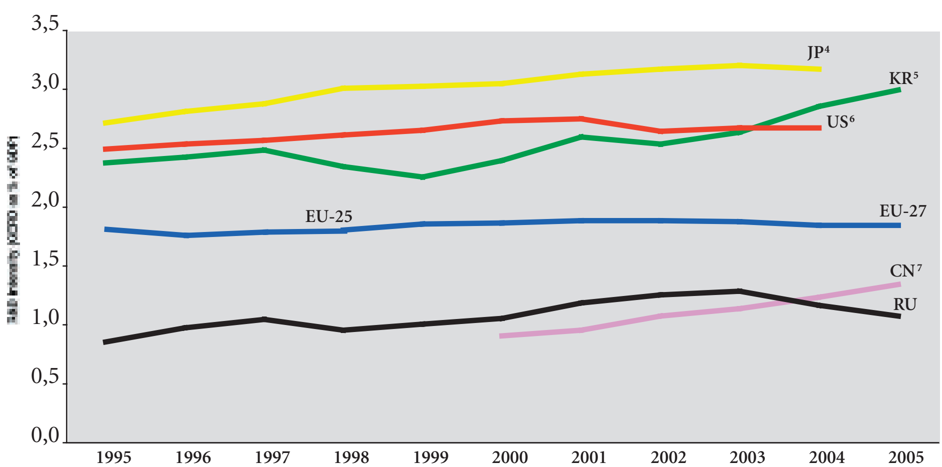
In addition, we need to make sure that Europe's research base is ready to respond to the growing demands of a knowledge economy.

RAISING RESEARCH INTENSITY

A consequence of globalisation is that knowledge production is increasingly distributed across the world. The share of the EU in worldwide R&D expenditure has declined from 29% in 1995 to 25% in 2005. The shares of the US and Japan have also declined over the same period. Gains are mainly found in China, South Korea and other emerging Asian countries[2].

Against this background, EU R&D intensity has stagnated around 1.9% of GDP since the mid-nineties and is clearly a cause for concern. In 2005 its level was 1.84% of GDP, far below those of the US, Japan and South Korea. If the trend continues, China will have caught up with the EU by 2010 (see figure 1).

Figure 1 › **R&D intensity (GERD as % of GDP) in the major world regions, 1995-2005[3]**



Source: DG Research, Key Figures 2007
Data: Eurostat, OECD

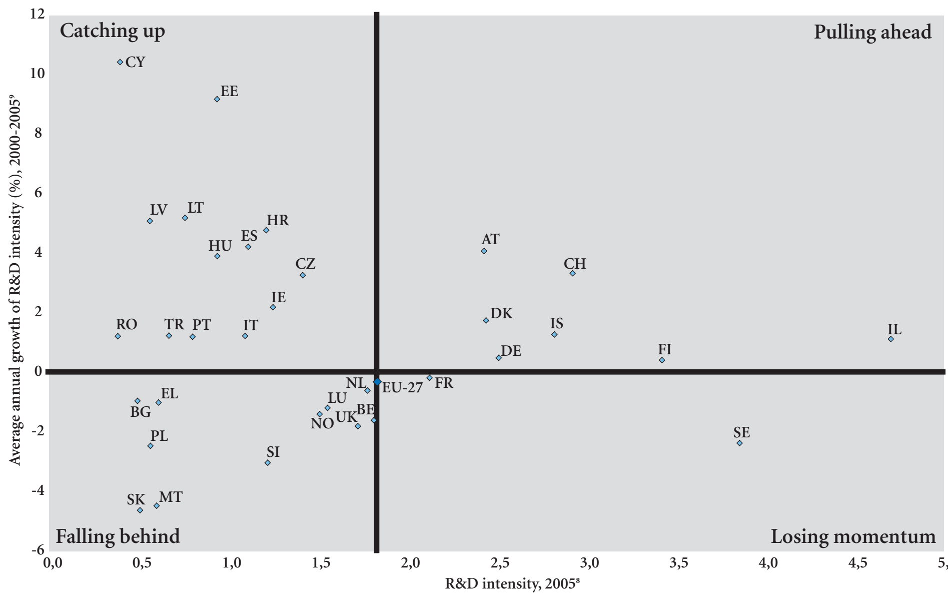
In 2002, the EU set itself the goal to increase research expenditure to 3% of GDP. This target reflects the need for the European economy to increase significantly its knowledge-intensive activities. The lack of visible progress between 2002 and 2005 is largely due to the fact that business research expenditure depends on the structure

[2] For these and other quoted figures, see *Key Figures 2007 on Science, Technology and Innovation,* European Commission, June 2007
[3] US : Break in series between 1998 and previous years; JP : Break in series between 1996 and previous years.
[4] JP : GERD was adjusted by OECD for 1995.
[5] KR : GERD does not include R&D in the social sciences and humanities.
[6] US : GERD does not include most or all capital expenditure.
[7] CN : Hong Kong is not included.

of industry, which evolves slowly. Nevertheless, the broad-based innovation strategy will make Europe increasingly attractive for business investment in R&D. While the 3% target is unlikely to be reached by 2010, it should be maintained as an important benchmark of Europe's progress towards an increasingly knowledge-based economy.

Equally important are the national targets set by all the Member States in 2006. They reflect the different starting points and dynamics of individual Member States and they show that the promotion of research investment is a strong policy priority for most of them.

Figure 2 › **R&D intensity, 2005 and average annual growth, 2000-2005**



Source: DG Research
Data: Eurostat, OECD

[8] IT, NL, RO, UK, HR, TR, IS, CH : 2004; AT, FI : 2006.
[9] IT, NL, RO, UK, TR, IS, CH : 2002-2004; AT, FI : 2000-2006; EL, SE, NO : 2001-2005; HR : 2002-2004; MT : 2004-2005.

The above figure shows the 2005 R&D intensity in each Member State and its evolution between 2000 and 2005. This latest available data pre-dates the 2006 national targets and much of the related policy initiatives taken at both European and national levels. The latter are abundantly illustrated in the other chapters of this book and they should contribute to progress in the years to come.

OPENING NEW PERSPECTIVES FOR THE EUROPEAN RESEARCH AREA

Europe certainly needs more research but more importantly, needs better research. Creating the best conditions for the best research is the purpose of the European Research Area. A truly open and seamless European Research Area, with high levels of competition and cooperation throughout the EU, would in fact establish a Fifth Freedom in Europe: the freedom of knowledge.

The European Commission launched an important public consultation and debate in 2007 with its Green Paper "The European Research Area: New Perspectives"[10]. Around 800 contributions have been received from research centres, universities, companies, European stakeholder organisations as well as from individual researchers. They show strong support for moving forwards in particular via partnership between the Community and the Member States.

The potential benefits are enormous:

› If we offer **researchers** competitive career prospects and enable them to move seamlessly between sectors and across Europe to take advantage of the opportunities arising from a unified labour market, removing for example any social security barriers – then we will attract and keep the best talents allowing research institutions and industry to make the most of their creative potential.

› If we give to **universities** and other **research institutions** the appropriate levels of autonomy and performance incentives – then we will foster the emergence of European centres of excellence competitive on a global scale, notably through a process of concentration and specialisation.

› If we create the right framework and incentives for **national and regional research programmes** to coordinate their activities and to cooperate on major challenges – then we will create the critical mass necessary to take the lead in addressing these challenges, ensuring a considerable return for European industry and society.

› If we join forces to build and operate the major **research infrastructures** and electronic networks needed to underpin future research – then we will maximise both the productivity of European research and the value for money from national budgets.

› If we establish clear and effective common rules and practices for **knowledge transfer** across Europe – then we will boost the exploitation of public research results and all companies, notably SMEs, will gain access to the best knowledge in a Europe-wide "open innovation" market.

[10] European Commission Green Paper *The European Research Area: New Perspectives*, COM(2007)161 of 4/4/2007. See http://ec.europa.eu/research/era

› If we bring greater coherence to European and national policies on **international cooperation in science and technology** and if we speak with a consistent voice to third countries and in international fora – then we will bolster the credibility and the global influence of the EU and individual Member States.

To achieve any of the above objectives, much work is needed both at the European level and national levels. Creating the European Research Area requires equal commitment and concerted action from the Community and all the Member States. And whilst the benefits are obvious, so are the costs of inaction. No time can be lost. For its part, the Commission intends to propose in 2008 new initiatives to move forward on each of the above issues, taking full account of the results of the debate on the European Research Area. Such initiatives will mainly provide frameworks and incentives to facilitate reforms and coordination undertaken by Member States, stronger Community measures being proposed only in cases where this has clear added value.

BUILDING TRUST AND WORKING BETTER TOGETHER

Clearly, the main condition for the success of the European Research Area is our ability and willingness to work together across national and institutional boundaries. EU actions are primarily about building trust and creating frameworks for such cooperation to happen. This entails several levels of cooperation.

For individual researchers and teams, the EU Research Framework Programme is an important source of transnational cooperation projects. Moreover, the best teams across Europe are now entering open competition for funding by the newly established European Research Council, while mobile researchers continue to take advantage of the popular scheme of "Marie Curie fellowships". Besides these funding instruments, the EU has been developing new tools to promote attractive research careers across national and sectoral boundaries. Such tools include the European Charter for Researchers and the Code of Conduct for their recruitment [11].

At the level of research organisations, universities and business, the EU Research Framework Programme offers many opportunities for cooperation. In addition to traditional European projects, the 7th Framework Programme (2007-2013) allows for the launch of major public-private partnerships, called "Joint Technology Initiatives", to address issues of strong industrial and societal interest. Research institutions can pursue a deeper integration of their activities through the Framework Programme's

[11] See http://ec.europa.eu/eracareers

"Networks of Excellence". Beyond Community funding, the EU is promoting the development of a common ground of rules and practices to facilitate cooperation and knowledge transfer between public research and industry[12], as well as open access to published scientific results[13]. It is also looking into the modernisation agenda for universities in close cooperation with the Member States and universities themselves[14]. Such initiatives will at the same time help cooperation and foster competition across Europe.

Other EU-level initiatives have been advancing European cooperation on important topics in recent years. On research infrastructures, in particular, we can build upon the roadmap proposed by the European Forum on infrastructures and agreed by the Council of Ministers in 2007. In a number of key technology areas, European Technology Platforms have been developing common visions and research agendas, which are leading to some major cooperative proposals including Joint Technology Initiatives.

At the level of national and regional programmes, the "ERA-Net" scheme is proving a powerful way of fostering cooperation, from the exchange of information to joint calls for proposals. By the end of 2006, over 50 calls for trans-national proposals had been launched or agreed to be launched or were in the pipeline of these schemes, mobilising over €500 million of national funds. Building on this experience, more ambitious coordination can be progressively developed, using variable configurations and instruments, including article 169 of the EC Treaty, which enables the Community to participate to R&D programmes undertaken by several Member States.

Finally, at the level of national policies, an "open method of coordination" has been implemented since 2003 in the fields of support to R&D investment and human resources in S&T[15]. The method is based on mutual learning, including peer reviews of national policies, and on the exploration of potential progress on precise topics, on a voluntary basis. The method feeds into the wider coordination process which forms part of the Lisbon Strategy. Member States have been showing growing interest and involvement and the method has been building mutual awareness and trust between their administrations. Various examples show the interest, concrete results and the positive influence of the method in the first years of application, in particular the recommendations on how to make optimal use of fiscal incentives for R&D[16] and of the complementarity of the Framework Programme and Structural Funds to support R&D.

[12] European Commission Communication *Improving knowledge transfer between research institutions and industry across Europe – Embracing open innovation*, COM(2007)182 of 4/4/2007, see http://ec.europa.eu/invest-in-research

[13] European Commission Communication *Scientific information in the digital age: access, dissemination and preservation*, COM(2007)56 of 14/2/2007, see http://ec.europa.eu/research/science-society

[14] European Commission Communication *Delivering on the modernisation agenda for universities: education, research and innovation*, COM(2006)208 of 10/5/2006, see http://ec.europa.eu/education/policies2010/lisbon_en.html

[15] Respectively under the aegis of the Committee for S&T Research (CREST) and of the Steering Group on Human Resources and Mobility, both composed of representatives of national administrations.

[16] See the European Commission Communication *Towards a more effective use of tax incentives in favour of R&D*, COM(2006)728 of 22/11/2006, see http://ec.europa.eu/invest-in-research

Foundations have now been laid to focus the process on exploring more ambitious coordinated or joint policy initiatives in areas where many Member States are expressing readiness for a sustained commitment. For example, on-going work on the international S&T cooperation policies of Member States is providing promising bases for improving the coherence between these policies and progressively developing a common international co-operation strategy for the EU and Member States. On this and other important issues, the open method of coordination should now change gear.

The above examples show that, through EU support and with the active involvement of all concerned, we have opened important avenues to enable us to work together across borders, from individual researchers to research organisations, business and administrations.

The challenge now is to draw on these sound bases to move ahead and fully realise the European Research Area and – beyond this – the Europe of knowledge. Judging from what has been achieved I have confidence that, together, we can make it happen.

The Future of Science & Technology in Europe

Slovenia

Mojca Kucler Dolinar

Minister for Higher Education, Science and Technology

Mojca Kucler Dolinar

The future of Slovenian science and technology

Slovenia's Development Strategy (SDS), which the Government has adopted on 23 June 2005, and which also includes Slovenia's commitment to successfully implement the Lisbon Strategy, is a strategic document which gives the role of the main driving force behind growth and employment to knowledge and creativity. Among the most important national objectives are therefore increased R&D, enhanced creativity and innovation and a higher level of technological development. Slovenia has continued to work towards building a knowledge-based society. It is carrying out the measures set out in the core development document on research and development.

Regarding expenditure on R&D, Slovenia ranks close to the average of the EU and has an appropriate ratio of public and private investment in R&D. However, in terms of the share of R&D expenditure in gross domestic product it lags significantly behind the most successful EU countries. In the last few years the number of scientific publications has grown rapidly, but despite this, is lagging behind the EU average in terms of scientific and technological productivity, especially in the area of highly cited papers and patents.

Slovenia's main development document on research and development is the National Research and Development Programme (NRDP) which operationalizes the broadest objectives and policies in this area, defined in national strategic documents, into a comprehensive range of sub-goals and measures for their implementation. The vision of NRDP is to create new knowledge, to transfer internationally accessible knowledge for the public good and for economic consumption, and to increase capabilities for mastering technological advances as the main source of national competitiveness and social and human progress. The enhanced stimulation of joint efforts between the research and business sectors, and stronger initiatives for joint R&D projects between both are needed in Slovenia.

Through its various measures the programme is oriented to the quality and effectiveness of research in Slovenia. It stimulates the mutual linking of education, research and entrepreneurship and improves the mobility of knowledge, ideas and people within society. Parallel to this, other policies must ensure a social and economic climate which generates a demand for knowledge and creativity, provides an increased public investment, and motivates the private sector to boost its investment in research and development, to promote its co-operation with research organisations, to employ top professionals and to begin to look at R&D as an important investment.

In addition to reducing a general public expenditure, the Government is also pursuing the goal of the developmental restructuring of public funds or their partial redirection from the current purposes to development priorities: (i) increasing the expenditure on R&D to the target of 1% of GDP until 2010; (ii) increasing the total expenditure on higher education to the target 2% of GDP until 2010, with the share of public funds amounting to around two-thirds.

1. NATIONAL PRIORITIES IN RESEARCH

Priority fields for Slovenia are those that enable the expansion of knowledge, scientific impetus and economic efficiency based on the values of a socially responsible society, and those which directly support the faster development of fundamental economic areas and where broad European priorities can be followed:

› information and communication technologies (ICT);
› advanced (new) synthetic metal and non-metal materials and nanotechnology;
› complex systems and innovative technologies;
› technologies for a sustainable economy; and
› health and life sciences.

These are areas that according to analyses reveal the greatest potential for increasing the economic competitiveness and productivity, and achieving higher added value in exports, for Slovenia's recognition in the international community, and for the progress of both the economy and the entire society. The selected technologies are those that could have a major impact on economic growth and greater employment and that are important for the benefit of the whole of society. During the 2006-2010 period, funds for these areas of research have to be increased in real terms. New institutions are already being established in these fields (company clusters, technology networks and research centres of excellence etc.), which connect the most influential actors from academia and the business world. The priority areas of research and development also include various other fields that are not directly connected with the target of economic competitiveness, such as the preservation and further development of the National identity and Cultural heritage.

2. BARCELONA GOAL - 3% FUNDING TARGET

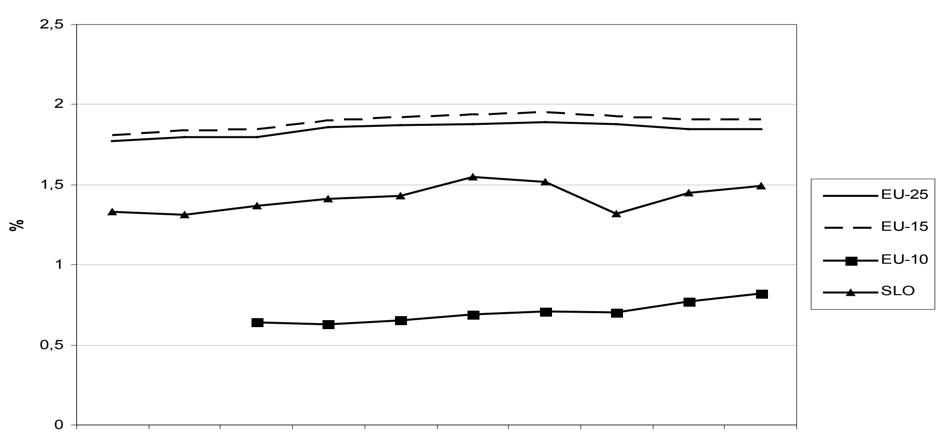
In 2002 and 2003, when Slovenia set the objective to spend 3% of GDP on R&D by 2010, the official figures on gross domestic spending on research and development as a share of GDP were much higher than the figures in the latest official statistical data for 2006. One reason for the inconsistency is a revision of the data on GDP in the 2003-2005 period. Another reason is the divide between the first statistical estimates for 2003 and 2004 and the final data obtained from statistical research of R&D. According to the latest official data, the share of gross domestic expenditure on R&D for 2003 and 2004 decreased compared to previous years, standing at 1.32% and 1.45%, respectively.

Table 1 › **Gross domestic expenditure on R&D as a % of GDP**

GERD as a % of GDP	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	1.33	1.31	1.37	1.41	1.43	1.55	1.52	1.32	1.45	1.49

Source: Eurostat, SORS, September 2007

Figure 1 › **Gross domestic expenditure on R&D as a % of GDP for Slovenia, EU-25, EU-15, and EU-10, 1996-2005**



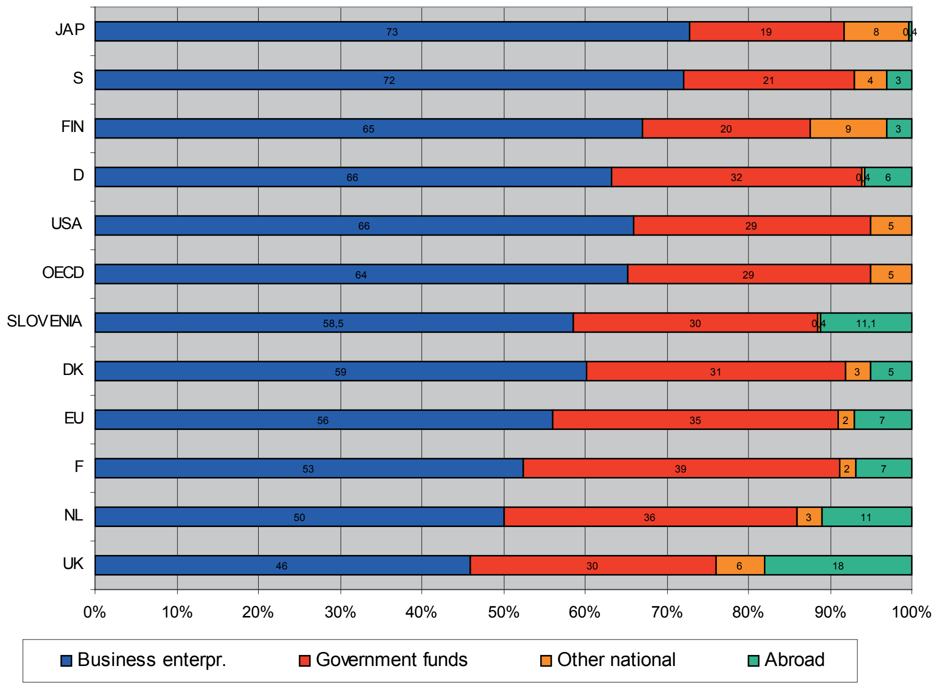
Source: Eurostat, SORS, September 2007

According to the latest statistical data, a public expenditure or financing R&D in Slovenia in 2005 accounted for 0.52% of GDP. In addition to investments in R&D from the national budget, public expenditure on R&D can also be increased through financing from the EU structural funds, the EU framework programmes for R&D, as well as the funds of local communities or regional development agencies. In the next financial perspective, the financing of R&D from structural funds is expected to gradually increase, reaching 0.20% of GDP by 2009.

The expenditure on R&D is distributed among various departments and good co-ordination is necessary for the efficient use of such funds. Related to the set targets, the expenditure on research and development (R&D) had been increasing too slowly until 2005.

3. PUBLIC FUNDING OF R&D

Since the situation in Slovenia was slightly different at the time when Slovenia set the 3% of GDP target for R&D spending, it is possible that this goal will not be achieved by 2010. However, we are determined to spare no effort in trying to achieve this goal as soon as possible. Similarly as at the EU level, the adoption of political documents and commitments for higher investment in R&D in Slovenia has not yet been translated into actual delivery of results. This is a long-lasting process that requires the co-ordination and participation of several policies and players.



The baseline situation regarding the distribution of public funds for R&D between science and technology is unfavourable – the share of expenditure on technology was decidedly too low and accounted for 9% in 2004 and 12% in 2005. The rise to 20% in 2006 indicates that the financing structure is gradually changing in the desired direction.

As regards raising the share of existing public funds for applied and developmental research (in particular in the priority areas of research and technological development), the Slovenian Research Agency, which is our main funding body for scientific research, is relatively limited by the contractual obligations already assumed in previous tenders. In fact, until 2008 a large part of the Agency's[1] budget is fixed and restricted by five-year contracts for research programmes. In the selection of research programmes particular account was taken of the criterion of scientific excellence. In the future the socio-economic relevance will also be considered in line with the NRDP. While in the past participation in research programmes had only been possible for public research institutes of national importance, the new five-year financing period 2004-2008 introduced concessions allowing the participation of other public institutes and

[1] 37% of the entire budget and 67% of all expenditure on R&D in the Agency's budget until 2008.

enterprises. The aim of the NRDP to reduce the share of research programmes and increase project financing (target ratio 40:60), will only be taken into account in the new round of programme financing at the beginning of 2008.

Project financing allows the new tenders to be adjusted to the NRDP's objectives more rapidly as the existing funds are released every year. In 2005, the financing of the Slovenian Research Agency saw the introduction of 'thematic projects': the themes being put up for tender correspond to the NRDP priority areas and are defined in more specific terms by a priority task force comprising the heads of R&D at successful Slovenian enterprises. Due to a minimum share of non-allocated funds for research projects in 2005, the thematic projects account for only 1% of the entire amount available to the Slovenian Research Agency for research. But they represent a new quality as all newly-financed basic projects were directed at research themes aligned with the corporate sector. In 2006 two public tenders for target research programmes were carried out: 'Knowledge for Security and Peace 2006-2010' (12.6 MEUR until 2008) and 'Slovenian competitiveness 2006-2013' (10.9 MEUR until 2008); in 2007 a new tender was completed for 'Knowledge for Security and Peace 2006-2010' (6.9 MEUR until 2009). The target research programmes thus combine Slovenia's scientific, defence and economic potentials.

In 2006 a significant progress has been made in the functioning of the national system of innovations, notably by increasing the efficiency of the Slovenian Technology Agency (TIA). The responsibility for most public tender calls for technological R&D projects that were previously within the remit of the competent ministry (Ministry of Higher Education, Science, and Technology – MHES) has been transferred to the TIA. The Agency and the Ministry are jointly preparing public calls and relevant documentation. The TIA also publishes an annual public call for R&D projects of the Ministry of Defence. Further, a proposal for a public call for research projects financed by the Ministry of the Economy and planned to be implemented by the TIA is being prepared.

The current financial perspective provides for a gradual increase in the funds obtained from structural funds for R&D, which are planned to reach 0.20% of GDP by 2009. The planned amount of public expenditure on R&D relative to GDP (funds earmarked for this purpose in the national budget plus EU funds) is progressively increasing until 2009.[2] Given the expenditure earmarked for 2009 and the current

[2] The levels from 2006 onwards include approximately 0.1% of funds from the EU.

pace of growth, the target public expenditure on R&D (1% of GDP) will be achieved somewhat later than planned.

4. PRIVATE INVESTMENT IN R&D

While still below EU average, business sector investment in R&D in Slovenia, has experienced a steady growth for the last decade. If in 1996 the share of business sector in expenditure on R&D (BERD/GDP) was 0.68 %, it reached 0.97% in 2004 (**Statistical Office of the Rep. of Slovenia**, 2006). Business expenditure now accounts for more than 60% of the total.

The business sector R&D investment is much more sector specific than the public research. There is still a predominant role of manufacturing (86.4% of total BERD) and within manufacturing a rather narrow list of business sectors, which play major role. In particular, the chemicals - specifically pharmaceuticals stand out since this sector alone accounts for 32.9% of total business R&D expenditures). Another concentration of business R&D can be found in machinery and equipment (37.5%), especially machinery (non-classified) and electronic and electrical equipment. The share of services in R&D expenditures is 11% and hardly reflects otherwise important role of the sector in national economy with over 62% of value added (Statistical Office of Rep. of Slovenia, Rapid reports No. 310, 2005).

In terms of main R&D spenders, the two large pharmaceutical companies, Krka and Lek are in the lead. Other firms, known for relatively high R&D investment come from electrical and electronic equipment. Since 2000, several small firms have achieved an impressive growth thanks to their investment in R&D and innovation and become highly successful in their niche.

Measures promoting small and medium-sized enterprises through equity and debt financing (loans, guarantees, donations) are implemented by the Slovenian Enterprise Fund (SEF) which provides financial instruments, taking into account the trends arising from the macroeconomic environment and market needs.

According to data from the European Patent Office, Slovenian applicants filed 91 European patent applications at the EPO in 2006 (45.5 per million inhabitants). This was the highest number of patent applications per million inhabitants among the new member states. Slovenia was also at the top among the new member states according to the total number of patent applications per million inhabitants (international, European, and national) filed in 2005 (185 applications per million inhabitants).

In Slovenia, a network of technology platforms, within which the sharing of information and good practices is well established, functions as an instrument of linking the corporate sector with the research sphere. It operates within the remit of the Chamber of Commerce and Industry with the support of the Ministry of Higher Education, Science, and Technology. Technology platforms are an EU development policy mechanism for meeting challenges and determining the strategic advantages and opportunities of technology sectors. All key players from the corporate sector to institutes, universities, public institutions, and the state participate in the platforms.

In the area of knowledge transfer to the private sector, the Young Researchers Programme has significantly contributed to lowering the average age of researchers in the country. Over the past three years, this example of good practice has been applied to the training of young researchers in the private sector for the private sector, which has been brought even closer to the needs of companies and upgraded by the obligation of young researchers to undergo training abroad. A complementary measure, which is already being carried out by the Ministry of the Economy, aims to enhance the mobility of experts. It promotes the hiring of both domestic and foreign experts in the private sector, particularly in small and medium-sized enterprises. Further measures aimed at creating closer links between universities and the business sector are also provided for in the already adopted Scholarship Act and the new draft Resolution on the National Higher Education Programme 2007-2010.

Tax relief for corporate investment in R&D has been recently introduced as part of the tax reform (by way of the Corporate Income Tax and the Decree concerning Regional Tax Incentive for R&D). The amended Corporate Income Tax introduced tax relief for corporate investment in research and development[3], providing businesses with the possibility to claim a reduction of their taxable base in the amount of 20% of the sum they invested in R&D[4] in a given tax period; the amount of tax relief cannot exceed the taxable base. This relief has been upgraded by a regional component, the so-called regional relief, which was successfully notified to the European Commission in August 2007. It will take a while before the effects of the implementation of tax relief on corporate investment in R&D become measurable. We expect that the tax relief on R&D investment, which is currently the only existing tax relief for businesses, will stimulate new R&D activities in the private sector.

[3] Since 1 January 2005, tax relief can also be claimed for investment in research equipment and for the salaries of newly hired doctors of science in the first year of their employment.

[4] Investment eligible for tax relief includes investment in internal R&D activities and the purchase of R&D services provided by other entities, including affiliated enterprises, or by other public or private research institutions.

Further, a new law on venture capital companies, which will provide the necessary legal basis for venture capital funds and public-private partnerships in the area of equity finance, is in the process of adoption. The Employment Related Industrial Property Rights Act, which was amended at the end of 2006, governs also inventions developed in public higher education institutions and public research institutes.

5. INVESTING IN HUMAN RESOURCES

One of the essential goals in this area derives from the NRDP aiming to strengthen human resources in R&D and increase their humanistic orientation by educating young people in the spirit of free and open creativity, curiosity and awareness of the importance of personal knowledge, and by encouraging equal opportunities for women and men in science and research. As well the urgent needs to stimulate an increased share of R&D personnel in the economy, to encourage the international and interdisciplinary mobility of researchers and to attract the potential of Slovenians living on the other side of the national borders and around the world has been recognized.

The Young Researchers Programme has significantly contributed to lowering the average age of researchers in the country. The Slovenian Research Agency provides financing for around 1200 young researchers every year, representing around 850 to 900 FTEs. Between 200 and 250 new young researchers complete the training programme every year, with the same number of new young researchers being included in the programme.

As already mentioned, a complementary measure of the Ministry of the Economy, aims to enhance the mobility of experts. It is intended to promote the recruiting of domestic and foreign experts in the corporate sector, particularly in small and medium-sized enterprises.

The reform of higher education was launched in 2005. It mainly comprises measures relating to increasing the quality of studies, facilitating the employment of graduates, and changing higher education funding. The ratio of students to teaching staff has improved slightly but is still fairly high in comparison with other EU countries. Seven new autonomous higher education institutions were established in 2005 and 2006. All this should result in more human resources with better knowledge that could then be transferred to research institutions or directly to private sector.

6. MAIN CHALLENGES FOR RESEARCH POLICY IN SLOVENIA

While a new set of documents in the area of R&D policy (National Research and Development Programme) and development policy (Slovenian Development Strategy) give ground to assume a more favourable attitude in government circles as to the R&D and innovation policy, they also open a set of challenges, stemming from the past experience:

- **Implementation of the new policy documents**, particularly in view of the fact that the past record was seriously deficient in this area. Several policy documents in the past have set similar objectives, but the specific measures were either underfinanced or not addressing the policy priorities adequately.
- **Achievement of sufficient coordination of instruments and measures** among different ministries and other support institutions to enable smooth functioning of the National R&D and Innovation System. This coordination is especially important with the current organizational scheme where the science and technology issues are within the Ministry of Higher Education, Science and Technology, while the Ministry of Economy is in charge of entrepreneurship, including segments of innovation policy (support to technology parks, for example). Along with the two Ministries, two public Agencies are involved in the financing of R&D at the operational level: Research Agency and Technology Agency. In addition, the Government's office for growth is to coordinate the implementation of the Slovenian Development Strategy and the National Lisbon reform programme. All these different levels call for a clear R&D governance scheme.
- Development of **closer cooperation between public R&D institutions, Universities and business sector** within set priorities, applying available and new planned support measures. A specific problem in this area is raising the absorption capability of the business sector, especially SMEs, for R&D results.
- **Adjusting budgetary resources to support the declared priorities** in sufficient amount. Slovenia declared its intention to raise R&D investment to 3% of GDP. This would call for substantial annual increase in public financing.

France

Valérie Pécresse

Minister of Higher Education and Research

For a Science at the Service of Society

Valérie Pécresse

In full agreement with the objectives set out at the Council of Europe meeting in Lisbon, France is preparing to embark on a major effort aimed at its research sector, in order to usher a new dynamic of discovery and innovation into the country.

Indeed, research needs to be an absolute priority for the country: it is on research that our future depends, for without it, there will be no sustainable growth.
It is common knowledge that we are entering the knowledge society, meaning a society in which the dissemination of knowledge will be the primary driver for innovation and, thereby, employment.

Yet that growth also needs to be sustainable: and there too, it is research and the work produced by our scientists that will determine our ability to come up with a new form of progress, one that is in keeping with the major ecological, social and human equilibriums in our world. In the face of the challenges impressed upon us at the start of this new century, our greatest asset, yet again, will be our intelligence, our ability to understand, be imaginative and invent.

The French government has thus chosen to make research the political priority for the 2007-2012 presidential term and, therefore, to invest massively in the future.

The President of the French Republic has made very clear commitments on this point: over a five-year period, the Nation will dedicate an additional EUR 9 billion to its higher education and research.

As early as this year, their budget will be up by more than EUR 1.8 billion. This increase, amounting to nearly 8%, is unparalleled in our country's recent history, and testifies to our shared determination to make knowledge the driver for growth and social promotion.

Over the five years to come, this effort is set to continue, so as to bring about in-depth and sustainable change in the landscape of higher education and research in our country.

My vision is built on four pillars: empowered, autonomous universities; institutions conducting an excellence-focused scientific policy; dynamic project-based research; and more active private research. These four pillars, which will be able to benefit from the expertise of the newly-created Agency for the Assessment of Research and Higher Education, are complementary.

1. PILLAR I: EMPOWERED AND AUTONOMOUS UNIVERSITIES

There can be no overall research strategy without universities that are on par with the most prestigious, successful universities.

For universities are indeed the setting where a very large part of French research takes place: to give it full rein, an overhaul of the university system was needed, in order to bestow a new future upon it.

As soon as the new government was appointed to office last May, I put my every effort into this task, proposing to the Parliament and the nation as a whole that we build a new university system, with autonomy as its foundation.

It is indeed a revamping and a rebirth, for with this law, France's universities will at last have the freedom necessary to quickly hire the best professor-researchers in all fields.

They will also be able to adjust their teaching and research loads to accommodate those who wish to dedicate themselves more to research, or to enable those who wish to teach more to do so. The most dynamic and most inventive young researchers will thus be able to progress more quickly in their research, just as the most seasoned teachers will be able to spend even more time alongside their students. In other words, we will be able to offer all of the people who bring French universities to life the freedom they need to fully blossom and make the most out of their undisputable personal and scientific qualities.

With this law, France has chosen to offer its universities the flexibility, responsiveness and, to be frank, the freedom they needed to fulfil the responsibilities that are now theirs, at a time when, everywhere, establishments are striving to attract the best students and the best professor-researchers.

As a result, in the future, French higher education and research establishments will have the resources and the freedom necessary to aim for excellence in their every undertaking.

However, instituting the autonomy of universities does not mean making them into monads, in every way isolated from other institutions and other establishments in the higher education and research system.

Quite to the contrary, I believe that autonomous universities, being intent on developing their own strengths, are first and foremost universities that complement one another, just as they complement the *Grandes Ecoles* and research bodies. In fact, it is in their differences that they will find their shared strength.

One of France's greatest assets lies in the highly-diverse academic landscape it offers, making it possible for all students and researchers to find an environment suited to their needs and plans.

The autonomy granted to universities, thus, cannot be dissociated from the alliances that, in the future, will bring our establishments together, in particular in research and higher education clusters (PRESs).

The PRESs will make it possible to organise and structure educational offerings that are consistent across a given region and within a given territory. They will also provide the international visibility that diplomas need: by creating empowered multi-disciplinary doctoral schools, the establishments united through the PRESs will build up the qualities they need to shine in international rankings, such as the recent Shanghai Rankings.

Lastly, by enabling them to pool their research promotion structures, the PRESs will be a major tool for disseminating innovation, without which there is no growth.

With autonomous universities working together in the PRESs, France will have all of the cards in hand to distinguish itself in the global intelligence battle now raging.

Lastly, the Autonomy Act will also make it possible to bring French universities closer together with the business world, thanks to partnerships with university foundations.

For it is essential that an incentive-creating tax policy enables public or private bodies to invest massively in developing our shared intelligence and, thereby, to contribute to raising our children's level of education and helping our research system take off.

This objective must, in the future, mobilise French society as a whole, which has everything to gain from a future built on progress in knowledge and understanding.

2. PILLAR II: INSTITUTIONS CONDUCTING A EXCELLENCE-ORIENTED SCIENTIFIC POLICY

The French research landscape stands out for the existence of high-quality research bodies dedicated to specific areas or disciplines. I wish to consolidate those bodies and enable them to make greater strides toward excellence.

To achieve this, we will first need to continue our contractualisation effort: signing a contract between the State and a research organisation means clearly setting out the expectations of the public authorities where research is concerned; it also means giving visibility about the resources which the State will make available to the said bodies so that they can meet those expectations.

Secondly, a real culture of assessment must be instituted, for it is on the basis of multi-disciplinary, transparent and international peer review that research must be carried out. Therein lies the purpose of the Agency for the Assessment of Research and Higher Education (AERES), which issued its first opinions in 2007. The opinions were based not only on published scientific articles, but also on teaching, the extent to which the research findings were put to use, or contributions to the development of scientific culture.

Lastly, and this is stating the obvious, French research will not be able to continue developing if the scientific environment remains unattractive. It is thus necessary to raise the condition of researchers as a whole.

The first step is to transform the environment in which teachers, researchers and students work.

This is why I wish to launch, as quickly as possible, a far-reaching "Campus Plan" across France, so that the academic community is at last able to enjoy teaching and research facilities worth their salt. Indeed, there will be no revival of French universities unless the campus system as a whole is overhauled in-depth.

With large-scale real estate projects, such as the Scientipôle in Saclay, we will also build the new research centres that our country needs, in order to give cutting-edge research the home it deserves.

Bringing teaching and research facilities up to 21st-century standards also means creating natural access points for the information and communications technologies that contribute to disseminating and making knowledge accessible from anywhere. The objective is simple: that 100% of France's campuses be equipped with wireless broadband access to the Internet, in Wi-Fi or Wi-Max.

With universities that are revamped and brought up to 21st-century standards, we will attract more young talent, provided that we are capable of offering them real prospects for the future and real careers.

In my view, this requires, first and foremost, full recognition for doctoral degrees, which must be linked to full-fledged job experience and considered as such by recruiters, whether in the corporate world or in civil service.

It takes only a glance at other countries to see that young PhD-holders there are courted by employers, whereas in France, the degree hardly stirs a reaction, except when it scares the recruiter off entirely: we must convince our enterprises that they stand only to gain from hiring young PhD-holders.

This is why I have decided not to stop at raising the grant endowment for doctoral research from the start of academic year 2008-2009, which will bring the increase to 16% over a two-year period, or EUR 2000, plus supervisory responsibilities. In addition, I have chosen to extend the doctoral consulting system, tested in Bordeaux, to the entire country, so that two communities – researchers and the corporate world – too often far-removed from one another, can meet and get to know each other.

The consulting doctoral programmes will make it possible for enterprises to turn to young researchers, in order to benefit from their expertise, entrust them with scientific and technological watch assignments, or receive training for their own staff.

The doctoral students will be able to continue their research in their own laboratory, all the while being paid for short-term assignments, invoiced by the universities to the enterprises, local authorities or associations.

In other words, the culture of scientific expertise will be able to spread throughout all of society. Enterprises and researchers have everything to gain from this, as do doctoral students, as they will find new opportunities in the business world.

Likewise, the Industrial Agreements on Training through Research (CIFRE), which bring together a young scientist, a laboratory and an enterprise with a direct interest in their work, have become even more attractive for all of the parties involved: the minimum pay for the CIFRE doctoral students has been raised by 16% and the subsidy for companies has increased to the same extent.

With both the CIFRE agreements and the thesis supervision system, which has just been exonerated from tax, we are in possession of excellent tools to help enterprises, in particular SMEs, incorporate innovation and become familiar with the laboratory community. This is essential if we are to create the growth of the future, but also if we are to motivate young researchers.

Beyond the thesis level, broad-ranging discussion of the place of post-doctoral students in France must now begin.

For the time being, the contracts offered to young researchers to continue their work are often too short, poorly-paid and poorly-connected with the rest of their career, hence the decision on the part of a number of our young talents to go abroad.

I wish to put an end to this situation, verging on the absurd, in which a brilliant student takes his education all the way to the doctoral level in France, but is then is forced to leave our country for lack of future prospects, moreover, just when his career as a researcher starts to take off.

This is particularly important, considering that, in the years to come, 25% of the researchers at the National Institute for Health and Medical Research (INSERM) and 18% of those from the National Centre of Scientific Research (CNRS) will be leaving on retirement. Thus, there is no greater priority than to attract young talent to research, not only to preserve, but even to develop our country's scientific potential.

3. PILLAR III: PROJECT-BASED FINANCING, TO TAKE UP THE CHALLENGES OF OUR TIMES, THANKS TO PUBLIC-STEERED RESEARCH EFFORTS.

Of this, I am convinced: that, in scientific progress, lie the responses to the great problems of our times. Whether in sustainable development, the energies of the future, or new public health policies, we will need to be able to draw upon constant scientific and technological research efforts to build the future.

Already today, new knowledge and new technologies are profoundly changing our everyday lives and the way we behave: the considerable part that information and communications technologies already play is obvious, but this refers also to nanotechnologies, which may well trigger revolutions of magnitude yet unfathomable to us.

In order to ensure that France is up to the challenge of innovation, real leadership and real research strategies are needed. This will first require developing project financing: in France, it accounts for only 12% of our research, as compared to 50% in the other countries. This is inadequate and, as early as 2008, the budget of the French National Research Agency, the primary steering agency for project financing, will increase by 16%, reaching EUR 955 million.

With this, the effort launched by the 2006 Planning Law for Research will be consolidated. France will continue to develop excellence research, largely focused on the major challenges of our time.

One point deserves to be emphasised, however, in order to do away with the ambiguity that sometimes muddles up the meaning and purposes of this form of steering, which is new to France. Developing project financing does not mean giving priority to applied research, over fundamental research. Quite to the contrary, it means, first and foremost, putting emphasis on more innovative research, whether through specific calls for tenders, experimental projects dedicated to pure science, or even projects by young researchers, intended to enable the brightest young scientists to initiate innovative projects under the best possible conditions and, thereby, to create the science of the future.

Project-based research is, above all, a guarantee of scientific excellence – well-guided, well-funded science, and thus, science that looks to the future.

4. PRIORITY IV: TO STIMULATE PRIVATE RESEARCH IN ORDER TO SPREAD THE CULTURE OF INNOVATION THROUGHOUT THE BUSINESS COMMUNITY AND TO MAKE IT THE DRIVER FOR GROWTH OF A NEW KIND

This is the objective sought through the recently-revamped the Research Tax Credit system (CIR), which is, simply speaking, the most effective tool we have in our country for encouraging investment in research. For every 1 euro invested via the CIR, 2.41 euros in additional financing are generated. This means that it is more effective than subsidies.

In addition, the CIR brings benefits to both fundamental research and applied research: as Albert FERT, the winner of the Nobel Prize in Physics, recently reminded us, there is no airtight boundary between private research and fundamental research. His career itself is proof of this, as he was the co-founder of a research unit shared by CNRS and Thales.

By channelling nearly EUR 1.3 billion to the CIR System in 2008, France is endowing itself with the means needed to stimulate its research in a sustainable manner, by adopting a three-pronged strategy:

› an anti-offshoring strategy for research laboratories, including those run by major corporations. For experience shows that, when a company's research structures leave a country, its other structures are soon to follow.
› an aggressive strategy to attract foreign laboratories inside our border. Likewise, their arrival will be a first step toward their setting up operations in France, as some of the most innovative companies around.
› a dynamic strategy for disseminating innovation to SMEs: for they are the ones that will benefit the most from the tax breaks, which can amount to 50% of their research expenses during the first year.

This general innovation strategy is all the more necessary as our country lags behind where private research is concerned: private research accounts for only 1.2% of GDP, whereas in Germany, for instance, it amounts to 1.7% of GDP. With the CIR system, France will be able to make up for lost time, but giving all enterprises – and, in particular, SMEs – incentive to invest massively in research.

This is the pre-requisite – and an absolute one – for France and Europe to be able to build their futures on a culture of innovation shared by all of the companies in our countries.

We will all benefit from these investments, first and foremost our scientists, in that the recruitment of young doctoral students will fall within the scope of expense covered by the CIR system.

On none of these objectives does France intend to act alone. Building a society of knowledge and understanding, one that will enable new progress thanks to sustainable growth, built on the dissemination of innovation, is a long-haul undertaking, the very magnitude of which requires that the European Union's Member States pool their efforts.

Consequently, France is deeply committed to the principles that guided the elaboration of the Lisbon Strategy and intends to contribute, throughout Second Half 2008, during which our country will preside the Union, to substantial progress in this area.

It will place particular value on supporting and bringing forward the initiatives that will enable it to illustrate, unmistakeably, the benefits that science can bring to our societies.

In France's view, scientific progress is the best guarantee that our cultures and people will progress in the future also. The challenges that we must take up together are tremendous: whether the ecological imperative of sustainable development, protecting biodiversity or fulfilling the new needs that greater life expectancy entails, we will not be able to come up with new ways of overcoming these challenges, unless fundamental and applied research can made considerable headway.

The peoples of the European Union must thus return to the trusting stance they have always taken with regard to their scholars: without that trust, no progress will be possible, for instead, our future will be dictated by fear and preconceptions.

And that trust – France is confident of this – will not be able to return entirely unless efforts are made along two lines: first, in explaining, so that Europe's citizens can better understand the nature of recent scientific advances and studies in progress, hence making it possible to dispel the latent suspicions that surround them too often today; and second, in opening up, for science has nothing to hide from civil society and can easily prove it, by giving a voice to the representatives of stakeholder associations, on the boards of scientific institutions.

It is this same thinking – the desire to explain and be open – that gave rise to the "Grenelle Meetings on the Environment" in France, a first-ever consultation process involving all of the organisations with a stake in environmental issues, as well as representatives from every economic sector, scientific experts and the State. This exercise in shared intelligence made it possible to reach a broad consensus regarding the concrete actions that will make it possible to deal with the ecological state of emergency in our country.

The importance of restoring scientific expertise in the public eye, by guaranteeing its independence and credibility, will be one of the major objectives brought forth throughout the French presidency: it will be vital if the European Union wishes, as it stated in Lisbon, to build its future on the unshakeable foundation of knowledge and understanding.

As for France, it is ready to set forth wholeheartedly on this path, with the help and support of its European friends and neighbours.

The Future of Science & Technology in Europe

Czech Republic

Dana Kutchtova

Minister of Education, Youth and Sports

Public and private investment into research and development and human resources for research and development

Dana Kutchtova

PUBLIC INVESTMENT INTO RESEARCH AND DEVELOPMENT

What are the most important measures of research and development policies and programmes established in Member States in support of development and boosting investment into research? What are their main objectives?

The Lisbon Strategy has set a target of increasing investment into research to 3 % of GDP by 2010, including 1% from public resources and 2% from non-public resources. This ambitious target gradually proved to be a generally "impracticable wish", despite the fact that some Member States (typically, e.g. Sweden or Finland) were able to accomplish this target, even ahead of the set time limit – year 2010. Nonetheless, even the Czech Republic deems it appropriate to stick to this ambitious target.

The Barcelona target of increasing expenditure on research and development to 3 % of GDP proved to be an ambitious wish only, not an attainable target. Boosting expenditure on research and development is one of necessary conditions for achieving the Lisbon targets. For this reason, the Czech Republic seeks to increase steadily expenditure on research and development and to persuade the general public to view increased expenditure on research and development as a step in the right direction.

State budget expenditure on research and development in the period 2005-2010

YEAR	2005	2006	2007	2008	2009	2010
State expenditure on research and development (CZK '000)	16 457 905	18 178 683	21 496 551	22 996 206	24 835 902	26 882 775
Share of GDP (%)	0,55	0,57	0,62	0,62	0,62	0,62
EU resources (since 2007)			3 570 379	11 721 125	13 722 348	16 689 233
Total expenditure on research and development since 2007 (CZK '000, Czech Republic+EU)			25 066 930	34 717 331	38 558 250	43 512 008
Total share of GDP (%)			0,73	0,93	0,96	1,00

Source: The Research and Development Council

Starting from 2007, the table presents also expenditure on operational programmes (three complementary programmes have been drawn up in the research and development area for the period 2007 - 2013: the Enterprise and Innovations Operational Programme, the Research and Development for Innovations Operational Programme and the Education for Competitiveness Operational Programme). This includes expenditure intended for covering the Czech Republic's participation in the operational programme projects and EU funds.

Year-on-year increase in state budget expenditure on research and development

YEARS	2006/2005	2007/2006	2008/2007	2009/2008	2010/2009
Year-on-year increase in absolute terms (CZK billion)	1,7	3,3	1,5	1,8	2,0
Year-on-year increase (%)	110,46	118,25	106,98	108,00	108,00

Source: The Research and Development Council

The increased public expenditure on research and development will be primarily geared towards the participation of Czech researchers in EU Framework Research Programmes, operational programmes and the basic directions laid down in the Main Long-term Guidelines for Research. Hence, the Main Long-term Guidelines for Research concentrate both financial and human resources into a limited number of research directions which are of key importance for the country's economy and competitiveness (in compliance with the National Research and Development Policy).

In order to improve the control over the funds expended, the Research and Development Council prepared in collaboration with the Ministry of Education, Youth and Sports in 2005 the detailed Methodology for evaluation of research and development and its results which is based on the principles of an objective and transparent evaluation of the results achieved. On the basis of the results of the evaluation performed in 2005 and experience gained, the Methodology is updated every year. The aim of specification of the Methodology carried out every year is to prepare the basis for the Research and Development Council for making changes to the allocation of the R&D funds and to provide a comprehensive set of information on the efficiency of the use of the state R&D funds. The Czech Republic intends to get as close as possible to the international evaluation of research and development, as performed, for instance in OECD or EU countries.

Research and development does not exist separately or independently in the economic and social environment. Investment into research and development, in particular the public one, is closely related to the whole environment including e.g. education, from the primary level to the life-long learning, via secondary and tertiary (higher/university) education. Therefore, the environment is affected even by such activities, as, for instance, the Bologna Process.

PRIVATE INVESTMENT INTO RESEARCH AND DEVELOPMENT

What are the most important barriers to private investment into research?
What are the most important measures of each Member State in support of private investment into research?

The low return on private investment into research and significant risks associated with such investment are the most important barriers to private investment into research. In connection with the Barcelona target to invest 3 % of GDP into research and development, the contribution of private investors is significant, namely 2 %. Indirect tools supporting investment into research need to be improved as a necessary prerequisite for boosting incentives for private investors to invest into research. Generally, investment into research is considered to be very risky, in particular from the viewpoint of short-term return on such investment. The well-known history of economic success of a number of research or scientific discoveries does not contribute to overcoming this problem of a risky investment, either – in this context, let us give an example of e.g. the discovery of transistor shortly after World War II which resulted in an enormous return on a relatively risky investment into research.

Although expenditure on research and development from private resources tends to rise, it falls far short of the 2% Barcelona target.

YEAR	2004	2005	2006
Private expenditure on research and development (as a percentage of GDP)	0,67	0,77	0,89

Source: The Czech Statistical Office

The Czech Republic sought to boost rise in the private investment into research by the amendment to the Income Tax Act. The amendment to the Income Tax Act of 1 January 2005 allows to reduce the income tax base by a deductible item amounting to 100 % of own expenditure invested into research and development projects (without the state support). The first evaluation of this indirect support tool was published by the Ministry of Finance in June 2007.

A relatively low interest in this tax incentive can be explained by the fact that a number of the projects have been started already prior to 2005 and received grant support from the state. The data for 2006 are not yet known, since corporate income tax returns can be filed through tax consultants by mid-next year. On the basis of the more detailed evaluation of this indirect form of support,
the extension of the existing scope of the tax relief to research and development assignments ordered by companies from universities or research organizations is being considered for the future. However, the Czech Republic must assess precisely which indirect R&D support tools it will use, while at the same time account needs to be taken of the indicators reducing the government deficit.

HUMAN RESOURCES FOR RESEARCH AND DEVELOPMENT

What progress has been achieved by the Member State on implementation of research and development policies of the Lisbon Agenda, specifically with regard to public and private investment into research and development and human resources?

In 2006 the Czech Republic has achieved significant progress as regards the share of expenditure on research and development which according to the most recent preliminary data accounts for 1.6 %, including about 0.8 % of private investment. Apart from these macroeconomic data, it should be noted that research and development is among priorities of the current Government and in the course of modifications of the state budget (with respect to its appropriate structure) research and development will be the least affected by any budget constraints.

Is there any need to redefine or specify policy objectives in the area of research and development in connection with the Lisbon Agenda?

The Czech Republic does not deem it necessary to change these objectives, but in particular to fulfill them and to create the necessary conditions for meeting them. As regards methods, we consider especially the mutual learning method, the open coordination method as a very important policy tool that should be used more extensively. Insights gained from success or failure is of key importance, too. Research and development is included among operational programmes of the Structural Funds and we hope that this way will also make a significant contribution to the support for research and development. Boosting research and development at universities continues to be one of the priorities.

In view of sufficient sustainable level of qualified researchers in Europe, how could we attract more young people to study natural science and technology subjects and make scientific career more attractive? How could we increase the participation of women in scientific efforts?

Low interest in study and career in the area of natural science and technology is one of the long-term problems that apparently affect the society as a whole. Answers to this question by qualified sociologists, whose studies in this field should be supported, are not available.

The statistics show that numbers of students who apply for study of natural science and technology subjects in the Czech Republic remain more or less unchanged. The acceptance percentage rate of applicants for study of natural science and technology subjects in the total number of applicants ranges from 34% to 39%. The success rate of applicants is high – for technology subjects in the academic year 2006/07 it was 90%. In natural science disciplines their success rate is at the average level and in the academic year 2005/06 it was 69% (average success rate of 70%). Numbers of admitted applicants to universities for natural science and technology subjects have slightly risen in absolute terms, but their share in the total number of admitted applicants has declined. In the academic year 2005/06 a total of 34.3 thousand applicants for study of natural science and technology subjects were accepted which accounts for 43% of all admitted applicants. In the academic year 2006/07 36.8 thousand applicants were successful which accounts for 41% of all admitted applicants.

Support for young researchers and increasing the number of students in scientific disciplines is necessary and desirable for the Czech Republic. The Czech Republic has introduced several tools aimed at boosting the popularity of science and research among young generations. A prepared **Institute for Applied Sciences** – a joint institution of the Czech University of Technology and the Academy of Sciences of the Czech Republic in Prague is one of such tools. A professional contact organization **Science and Media** has been established in the Czech Republic with the financial support from the Ministry of Education, Youth and Sports. Its aim is to popularize research and development in Czech society – with a view to cultivating the environment for human resources development (activities associated with the promotion of science at secondary schools, the project **Czech Small Heads** (**České hlavičky**) focused on support for talented youth, in particular in technical subjects and promoting interest of young people in study of natural science and technology subjects and in scientific career).

The project **Czech Head** (**Česká hlava**) supporting professionals engaged in science and technology was announced in March 2002. It consists of a set of interrelated activities whose objective is to popularize science and enhance social prestige of professionals engaged in science and technology as the main parties contributing to the country's economic prosperity. The whole process culminates every year in the awards ceremony in the course of which the Czech Head national awards are given to outstanding personalities in science and technology.

The event **"Science in the Streets"**, which was held in June 2007 in Prague and Pilsen, is an integral part of the project. It seeks to attract interested parties into the world of state-of-the art technologies, present them with the results of research work and thereby contribute to the popularization of research and development in the Czech Republic.

The Czech Republic has also successfully participated in the second year of the project **"Researchers in Europe"** financed by the European Commission which is named in the Czech Republic **"The European Researchers' Night"**. This event is organized traditionally for several years already across the whole of Europe simultaneously in several dozens of towns/cities of EU Member States and endeavours to boost interest in and the general public's awareness of researchers, research and scientific career.

How could we increase the participation of women in scientific efforts?

With a view to promoting participation of women in science, the Ministry of Education, Youth and Sports supports financially **The Czech National Contact Centre for Women in Science** (**Národní kontaktní centrum - ženy a věda**). The aim of the project is to establish an information, communication and support centre for the issues of the status of women in research and development in the Czech Republic.

The Czech Republic should adopt measures conducive to the elimination of unequal treatment of women arising from their parental role and the unequal sharing of responsibilities between men and women and support higher share of women in decision-making positions in research structures, namely both in the university sector and within the Academy of Sciences of the Czech Republic and other bodies and committees of Czech science and research.

Furthermore, in 2006 the Ministry announced a pilot development programme in support of promoting interest of talented youth in study of natural science and technology subjects which met with an enormous response and continues as part of centralized development projects also in 2007.

A number of activities at a national level focus on young researchers and support of their mobility. This is inter alia the cross-sectional programme **"Human Resources"**, as part of the National Research Programme II (programmes Sabbatical, Clutch and Rudolf II scholarship). The Academy of Sciences of the Czech Republic makes a significant contribution to the support of young researchers. The **Junior Programme** supports start-up projects, but also the construction of dormitories and flats for young researchers. In order to enhance the qualifications of newly qualified researchers, the Academy of Sciences of the Czech Republic organizes the courses on the essentials of research work. The **Otto Wichterle Award** is intended for extraordinarily talented young researchers. The Academy of Sciences of the Czech Republic give this award every year to about 20-25 selected excellent young researchers (up to the age of 35). The Czech Science Foundation (Grantová agentura České republiky) supports young researchers by doctoral and post-doctoral grant projects.

What measures have been taken by each Member State to prevent brain drain and on the contrary support brain gain?

The problem of brain drain – the so-called external brain drain – was not such a serious problem for the Czech Republic, at least not until gradual opening of the labour markets after the Czech Republic's accession of the EU. It might be associated with the fact that the Czech Republic as a whole faces the problem of mobility. Consequently, the so-called internal brain drain, i.e. the outflow of researchers into out of science jobs more rewarding both in terms of salary and the social status, is much more important. As regards attracting of researchers, it has been already noted that in particular two problems need to be addressed: enhance attractiveness – e.g. focus on high quality laboratory equipment – and cultivate and boost attractiveness of the scientific environment and the environment of society as a whole.

The Czech Republic attaches enormous importance to the issues of human resources in research and development (not only in this specific area). Nevertheless, even the Czech Republic wrestles with global problems affecting Europe as a whole which are associated with human resources issues in research and development: ageing of the scientific community, poor financial and moral – social – reward. EU activities related to the so-called European Researcher's Charter and the Code of Conduct for the Recruitment of Researchers could help to address these problems. The Czech Republic has created the conditions necessary for the European Researcher's Charter and the Code of Conduct for the Recruitment of Researchers to be accepted (signed) by research institutions. Nevertheless, so far the Charter and the Code of Conduct have been signed and the moral commitment accepted only by the Academy of Sciences of the Czech Republic.

The Czech Republic welcomes re-opening of the debate on the European Research Area (ERA), evaluation of seven years of its existence and the proposed inspiring topics for the revitalization and acceleration of its functioning. The Ministry of Education, Youth and Sports published this document on its website together with the discussion panel furthermore the document is also discussed by the Research and Development Council. We consider that priority areas of interest have been chosen appropriately by the Presidency and it will be primarily up to the Member States as to how they apply recommendations from the prepared Action Plan.

Research and development, in particular the ERA and the human resources are not in a "vacuum". Consequently, the care for the human resources development needs to be linked to higher (university) education, in particular the Bologna Process. Europe, the ERA, education, including the Bologna Process create an environment that needs to be developed and cultivated which is precisely what the Czech Republic is trying to do.

Mobility must not be an end in itself, but rather a means to gaining and exchange of experience. The problems associated with experts' **exit mobility** (i.e. travelling abroad) are as follows: strong ties to the Czech Republic, the way of life, the language barrier which fails to be overcome, complicated administrative transactions and red tape. It is not important whether experts travel abroad often or not, if their work meets with a positive response there. A particular sort of research also has its specific features (Czech specifics).

Experts'**entry mobility** (i.e. arrival to the Czech Republic) is associated with legislative problems, insufficient awareness of Czech research abroad, below average financial reward for Czech scientists and researchers. The similar level of financial reward for Czech scientists and researchers is a necessary prerequisite for improving the conditions for the return of young Czech scientists from abroad. Also, sufficient information on the Czech Republic and its research is not available abroad.

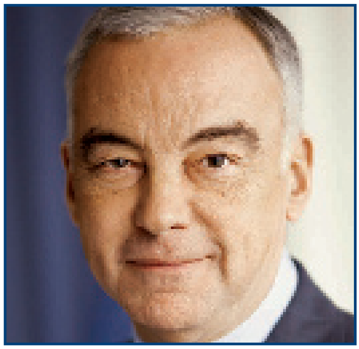
The **Czech Mobility Centre** (Centrum mobility) has been established in the Czech Republic. The Centre is a member of the European Network of Mobility Centres ERA–MORE and offers assistance to researchers and their families in connection with their travel abroad or on the contrary arrival of foreign researchers to the Czech Republic. The Czech Republic ranks among those countries in which interest in mobility, in particular the long-term one, is still insufficient. The most frequent barriers that obstruct mobility in the Czech Republic are as follows:

- problem of issuing visa to scientists and related problems with the work permit and residence visa (in particular for non-EU countries),
- long time limits for granting work permits and issuing the residence visa,
- insufficient flexibility of the system,
- big differences between salaries in the Czech Republic and other countries (that's why scientists mostly arrive from the third countries and not from EU Member States),
- language barriers in communication with the authorities
- ambiguity of taxation on EU projects and grants.

The Czech Republic has already transposed **Directive 2005/71/EC** on specific procedure for admitting third-country nationals for the purposes of scientific research (the so-called “Scientific Visa Directive”) into national law. This Directive regulates the mobility of third-country researchers. When transposing the Directive into Czech law a simple and “non-discriminatory” method has been chosen. The effective wording of the Act on Support for Research and Development (Act No. 130/2002 Coll.), which provides for that institutions which perform research under the law, such as e.g. public research institutions and universities, can apply for entry in the Register of authorized institutions without any need to produce evidence of other facts, has been used for transposition purposes. Other institutions have a number of equal opportunities how to produce evidence of the fact that they are performing research – e.g. receive institutional financing, take advantage of the option to reduce their income tax base and suchlike.

The support for young researchers and for increasing the number of students is no doubt necessary and desirable and for the Czech Republic this issue is even more important than for other EU Member States. The issue of human resources/young generation needs to be regarded as being crucial in the forthcoming decade, in particular in the so-called “science and engineering” disciplines. It is hard to find high quality human resources and it is not clear, how to address this issue (The Charter, the Code of Conduct, status of women, etc., are typical European solutions which, however, are rather of intellectual nature). The use of scientific capacities of migrants from non-EU countries, in particular Eastern Europe, is a viable solution. Securing well-equipped workplaces/laboratories that will become attractive already for secondary school leavers is another solution available. However, unfortunately, favourable legislative framework, safety at work etc. have not been put in place for this area.

Sweden



Lars Leijonborg

Minister for Higher Education and Research

Lars Leijonborg

A Nobel Prize to Sweden? Overview of Research and development in Sweden

Sweden is known as the country of the Nobel Prize, the legacy of the scientist and innovator Alfred Nobel. This reminds us that Sweden for a long time has been a country of great scientists. Carl Linnaeus, often called the father of taxonomy, Anders Celsius, the creator of the Celsius temperature scale and Svante Arrhenius, who was the first to describe the impact of carbon dioxide on the greenhouse effect 111 years ago, are historic examples.

The aim of the Swedish government is that Sweden should remain a leading research nation. Swedish researchers should not only select the Nobel Laureates but reach the excellence necessary to be awarded the Nobel Prize.

In this era of globalization it is necessary for countries that want to be advanced welfare states to be at the cutting edge of knowledge. The goal for the Swedish government is that Sweden must be a knowledge-based nation of absolute world class. When competition from the surrounding world is increasing, knowledge is the paramount way to compete. Swedish R&D policies have been successful for a long time but must be much better for the future.

Research however has a greater purpose than to provide commercially successful products and material wealth. The search for knowledge is an indispensable part of human culture. Curiosity leads us forward. Investments in research are investments in our future well-being.

PUBLIC INVESTMENT IN R&D

Sweden is among those nations that allocate most resources for R&D in the world, some 4 % (only Israel invests more). The major part of these investments is made by industry, about 3 % of GDP. In 2001 the investments peaked at 4,3 % followed by a decrease to about 3,9 % in 2005. Since 2005 both public and business investments have again increased and are presently at about 4,0 % of GDP.

A large proportion of Swedish industry are producing high-tech products, or use high-tech production, making large investments in R&D a necessity for continued economical growth and competitiveness. The Swedish government is therefore giving high priority to research and has at least since the 1960's kept the public investments in R&D to about 1 % of GDP. The ambition is to keep this level also in the future.

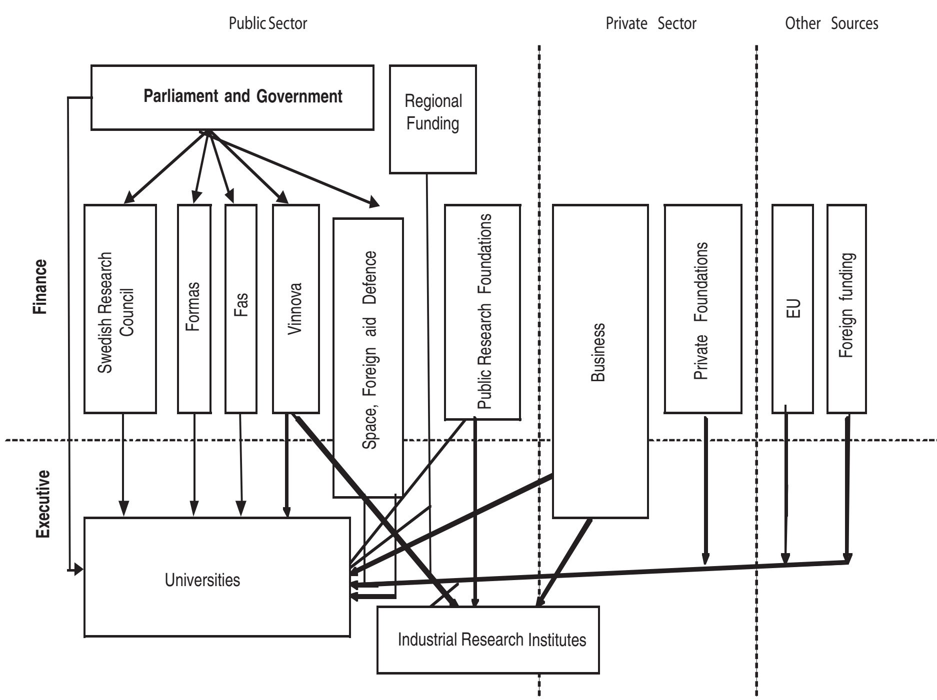
In 2007 the government allocation of funding for R&D together with funding from a number of public research foundations amounts to 2,90 billion Euro (26,427 Mdkr, 1 Euro=9,1 SEK), some 0,88 % of GDP. Last time the public investments, including funding from the public research foundations reached 1 %, was in 2004. Due to the present high economical growth the fraction of public funding for R&D has decreased, but the total funding has continued to increase. The ambition is to again reach the goal of 1 % by 2010.

The government R&D investments are generally in a continuous increase, although some years the increase cannot keep pace with the growth in GDP. Besides yearly budgets that sometimes includes increases also for R&D, our government introduces a research bill to parliament every four years with an outline of the R&D priorities for the coming years and the budgetary need to fulfil the priorities. The last research bill was in 2005 giving an outline for the years 2005-2008. Our new government has in addition to this in the budget for 2007 also given an increase of the direct funding to universities during 2007-2009. In total, the R&D funding increases with more than 300 million Euro during 2005-2009. Besides this, the present government has decided to exclude R&D investments from sales tax which will correspond to an increased funding with some 40 million Euro. The next research bill is planned for 2008 giving an outline of the plans for 2009-2012.

The Swedish universities and colleges are funded from several sources. The government is giving some 45 % of its total funding by direct grants. The allocation of these is made by size of the university, the volume of research and also by quality. Besides the direct grants, the government is also funding research by indirect funding by three research councils: The Swedish Research Council, Formas, and FAS as well as an organization for funding of business related research, Vinnova. The total funding from these sources amounts to about 35 %. The research councils allocate funds according to quality assessment.

The Swedish Research Council, being the largest with a yearly budget 2008 of 395 million Euro (3,59 Mdkr) funds fundamental research in all areas. The research councils for environment and agriculture, Formas (79,1 million Euro (720,565 Mnkr)) and for social sciences, FAS (37,3 million Euro, 340 Mnkr) besides quality also assess the societal need for knowledge in there respective areas. Vinnova funds business related R&D with 192 million Euro annually (1,747 Mdkr). Besides these government agencies there are also a number of research foundations formed with public funds are expected to awarding some 187 million Euro in 2008 (1,70 Mdkr). The Swedish universities are also receiving funding from a number of private foundations, international sources and from businesses amounting to some 20 % of their budget.

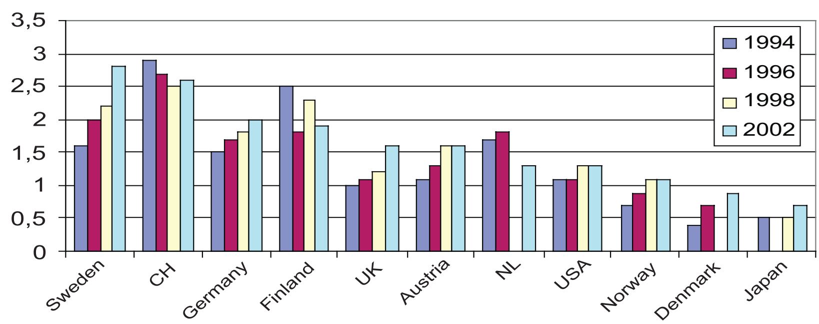
Besides universities, publicly funded research is also performed at industrial research institutes. These are performing R&D in collaboration with industry, or funded by industry. Space related research is performed at universities and in industry funded by government, and by business. The defence sector accounts for some 20 % of all publicly funded R&D. Their research is performed at the Swedish Defence Research Agency and in the defence industry.



The large public investments in R&D are reflected in graduates and a high production of scientific publications. Swedish articles are also cited more frequently than papers from most countries

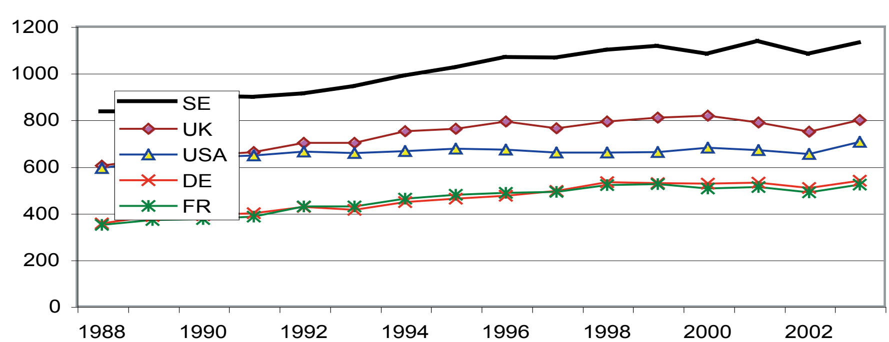
Between 1991 and 2001 the number of PhD graduates from Swedish universities more than doubled. The number of students has continued to increase to up until 2005 followed by a slight decrease. The goal of the new government is to increase the quality of education through continued increased funding for higher education without necessarily increasing the number of students.

Fraction (%) of population cohorts graduating with PhD



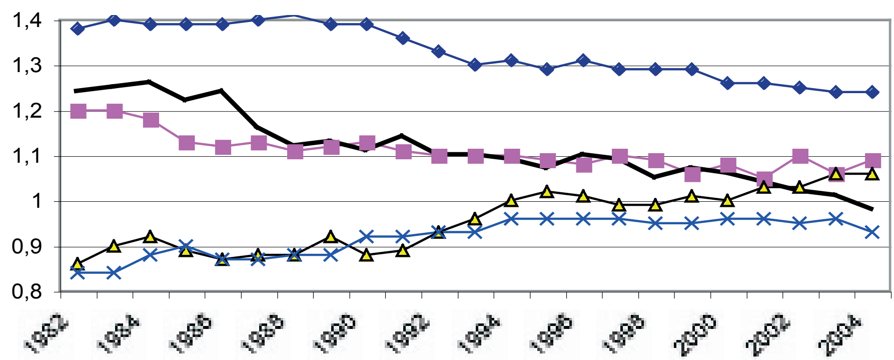
The high level of research funding is reflected also in the number of publications which are among the largest in the world, measured per capita. Switzerland and Sweden are the two nations with highest number of publications counted per million population. Israel (not shown) has a slightly lower amount of papers followed by Finland and Denmark.

Number of publications [million inhabitants]



Regarding international visibility, measured as number of citations per capita, Swedish research belongs to the ten most prominent in the world calculated according to citation per paper. But the trend is negative. 20 years ago Sweden was among the 3-4 most cited nations.

Citation per article [average citation for field]



Since 2004 the government investment in R&D has increased by 15 percent. In 2008 the government will present to Parliament a plan including priorities and funding for the next four years. The intention is to continue to increase funding. It is the Swedish government's hope and conviction that this additional funding, together with a stronger focus on high quality education will strengthen Sweden's position as one of the first research nations.

As was indicated before, the Swedish government is spending about 2,71 billion Euro (24,7 Mdkr,) on R&D amounting to 0,82 percent of GDP. In addition the public research foundations are awarding some 190 million Euro (1,727 Mdkr) for research. Total public investment thus amounts to 2,9 billion Euro or 0,88 percent of GDP.

PRIVATE INVESTMENT IN RESEARCH AND DEVELOPMENT

Sweden is a relatively small country, very dependent on exports, and with a high degree of knowledge intensive products and services. The Lisbon target for private investment in research and development has since long been reached. The figure for total research and development investment during 2006 is just below 4 percent, of which around 75 % is invested by industry.

The major part of the business research and development investments today is performed by Swedish-based large multinational companies within the fields of pharmaceuticals, automotive, industrial machinery and telecommunications. Some 20 large companies represent more than 60% of the total business research and development investments, whereas a multitude of small and medium sized enterprises represent less than 10 %.

Even though the Lisbon goals already have been reached, it is important for Sweden to continue to strengthen the foundation for increased industrial competitiveness during the ongoing globalization process. For many companies, and especially for large multinationals not focused on specific natural resources in Sweden, it is possible to choose to conduct and finance research and development in other countries. In analyzing the large private investments in research and development it is therefore necessary to study important what factors are behind the companies' choice to pick Sweden as platform for research and development activities.

Research has to be of highest quality and relevant to the needs of industry. Sweden's ambition to strive for high quality in research, together with it's high investments in public research and development, have shown to be fundamental for the decisions of companies to continue to invest in Sweden.

Another important factor is to enable industry to recruit competent researchers for their research and development facilities, i.e. human resources. With Sweden's high general level of education, high research competence and comparably low salary costs for well educated staff, private industry has good chances to recruit attractive personnel.

A third factor is the interaction between academic research and industry in order to increase knowledge transfer and relevance of research. Efforts have been made to provide good research and innovation environments for the actors to interact. During recent years it has been government policy to stimulate the establishment of strong research and innovation environments together with industry, through private-public partnerships. In establishing strong centers in user driven research, Vinnova, the Swedish Agency for Innovation Systems, is active in several initiatives. From the mid nineties, around 25 Competence centers were established at universities together with industry, which were of great value to industry but now have come to an end. In 2006 a new generation of 15 competence centers, so called Vinn Excellence Centers, were established and will run for a period of 10 years, in which industry contributes with one third of funding. Jointly with the Swedish Research Council, Vinnova has also launched four Berzelii Centers, with part funding from industry, and which will also run for 10 years. Together with the Foundation for Strategic Research and the Competence Foundation, eight Institute Excellence Centers at research institutes have been launched during 2006. These will run for six years with 50% of the funding coming from industry.

In recent years, the former government initiated research and development programmes in six industrial sectors of great importance to Swedish exports, and Vinnova is now involved in the execution of these programmes. In close dialogue with industry, the research areas for these programmes are identified, and industry contributes with 50% of the funding. An important element of these programmes is the connection to the technology platforms being developed at the European level, which has been very much a request by the industries involved.

Research and development in small and medium sized companies is conducted at a more modest level. Until recently there were no specific measures addressing R&D in these companies. In 2006, however, a special programme, ”Research for growth”, was launched to invite small and medium sized enterprises to carry out research projects, in particular in cooperation with universities and research institutes. The major part of the programme requires co-funding from the company. The programme has become very popular and attracted a lot of interest and grant applications. Early stage evaluation has indicated that the programme is successful and of importance for the competitiveness of small and medium sized enterprises.

The research institute sector in Sweden is small compared to several other countries. This sector has been rather scattered with a multitude of small institutes, but recently the government decided to restructure and strengthen this sector. One of the reasons for the restructuring is to better utilize the institutes for enhanced knowledge transfer in the innovation system. Apart from the specific technological competence with relevance to the industries and their customer base, the institutes also represent an important link between universities and industry, supporting new technology in reaching the market. The strengthening of the institutes is anticipated to benefit both small and medium sized enterprises and large companies.

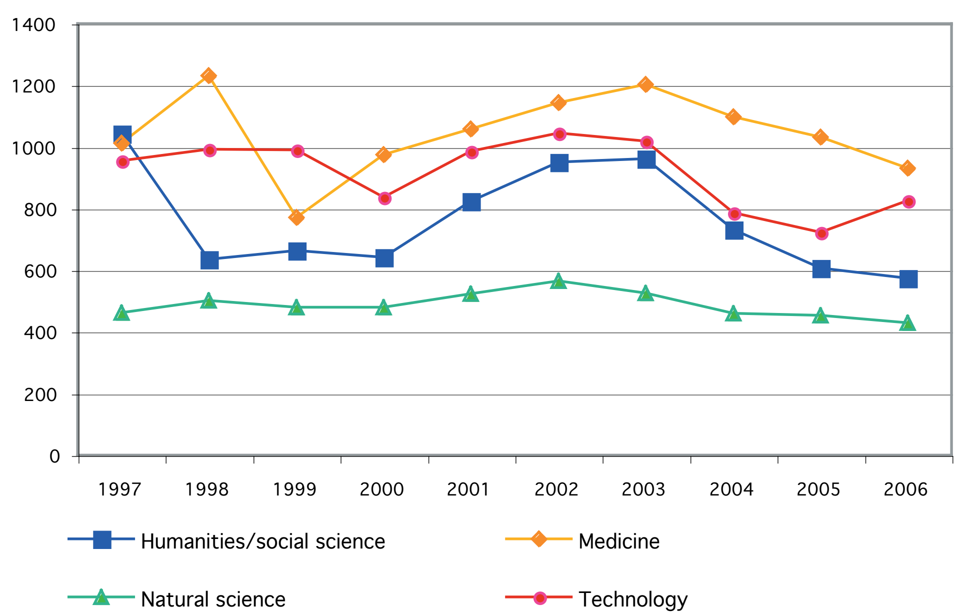
It can be concluded that there is a need for a strong coupling between private and public investments in research and development to further strengthen the foundation for knowledge based industry in Sweden.

HUMAN RESOURCES

Human resources is one of the driving forces in a knowledge based economy. The educational system equips people with different kinds of knowledge and skills in describing the human resources available for research in the areas of S&T it might be useful to look at the input side.

Since 1996 the number of postgraduate students has increased from 17 000 to 20 000 in 2003 and then decreased to 18 000 in 2006. The number of new postgraduate students shows a 25 % decrease since 2003 except for natural sciences. This decrease, however, has not yet impacted the number of doctoral degrees, which was 2 700 in 2006. That corresponds to about 3 % of an age cohort. Over the last decade the humanities and social sciences have decreased their roles and medicine has become the largest research area in terms of doctoral degrees, from 35 % to 28 % and from 22 % to 30 % respectively.

The number of graduates 2005 in S&T were 1 100 together with a small group of about 25 doctorates from industrial institutes.



The PhDs are found in universities, institutes, agencies, hospitals and in different companies. Of those graduating in 2003 about 50 % went to one of the first three categories and about 30 % to the private sector. It is likely that a vast majority of the PhDs who choose the private sector are within S&T.

Private sector

Over the last eight years the number of people involved in research and development on the labor market has increased by approx. 30 % to 65 000. Among the 65 000 we find 5 000 PhDs.

Universities

There are 42 000 full time equivalent in 2006. The gender balance overall is within 40-60 interval except for assistant professors (37 % women) and professors (17 % women, but 26 % of newly appointed). In the S&T area fewer individuals are women.

In different categories we find 4000 professors (1600 S&T of which 84% has a PhD), 915 research assistants (450 S&T of which 84% has a PhD), 6300 senior lecturers (2100 S&T of which 81% has a PhD) 6100 junior lecturers (1400 S&T of which 5% has a PhD), 4000 "researchers"(1 200 S&T).

Industrial institutes

There are 1800 employees and among them 23 % with a PhD in 2005. Most of them work within S&T.

Mobility

The mobility of researchers between academia and industry is low, except in medicine. The flow goes from academia to industry like in most countries, but there is a small growing flow of visiting professors from industry to academia, mainly within S&T.

Sweden has a well-functioning system for visiting scholars and researchers, and in general the inflow is larger than the outflow.

The Future of Science & Technology in Europe

Spain

Mercedes Cabrera Calvo-Sotelo

Minister of Education and Science

Mercedes Cabrera Calvo-Sotelo

Science and Technology Policy in Spain: an investment in the European Research Area

Spain has undergone extraordinary economic and social change over the last few decades. The growth rate of the Spanish GDP has exceeded the average of that of the EU and the vitality of our economy has allowed us to advance towards real convergence with the EU-25. While the Spanish GDP per head was 87.6% of the EU- 25 average in 1990, today it is 98.4%. One hundred per cent convergence in 2010 is the main objective of the 2005-2010 Spanish National Reform Programme.

However, this process was founded mainly on a rising employment rate and a modest increase in productivity. Therefore, the Government has focused on measures aimed at triggering productivity growth and competitiveness. We are aware that only by promoting a growth model based on productivity increases and on a more competitive productive system will we benefit from the new world economic order by means of increasing social cohesion and higher living standards.

With this in mind, the Spanish Government has designed measures to correct structural weaknesses detected in the Spanish economy, such as the technological gap with the EU-15, which is hampering the productive system. Spanish lags behind in R+D and this affects all areas of the National Innovation System. It is therefore important to better organise the Science-Technology-Enterprise System.

The new 2008-2011 National Plan for R+D provides for actions to achieve these objectives as well as to face the challenge of having the mature R+D system Spain needs; an R+D system in line with the level of economic and social development we have attained in recent years. Key factors to attain such a goal are human capital, research, development and innovation.

THE LISBON CHALLENGE: SPAIN PICKS UP THE GAUNTLET

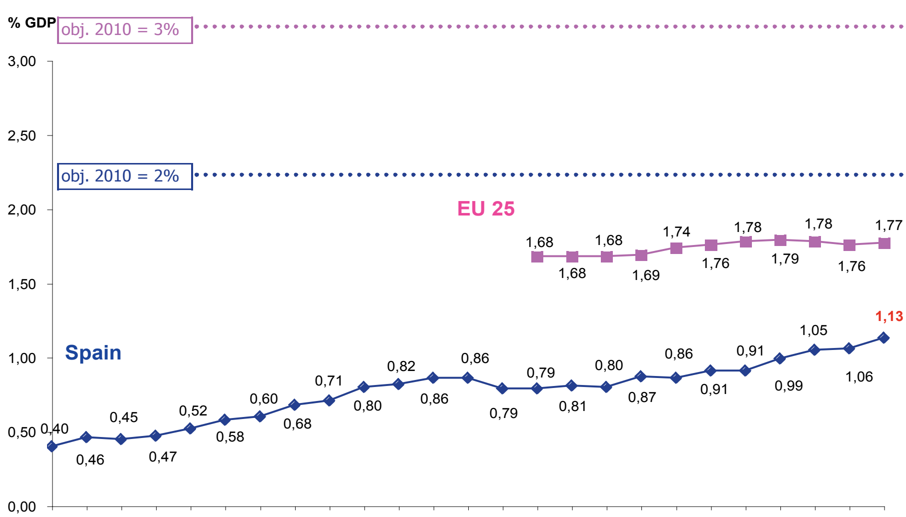
Spain has fully addressed the challenge of the Lisbon Agenda and has made an unprecedented effort in the last four years -- both in budgetary terms and as regards the development of national policies -- to boost Spanish competitiveness.

The positive results of that effort are now becoming noticeable. The consolidated figures for 2005, which show a 14% growth of investment in R+D,[1] clearly demonstrate this.

The figures also confirm that Spain has reinforced the tendency to achieve the Lisbon objectives; sustaining an annual average growth rate of 4.8% in R+D investment intensity since 2000, with a clear acceleration from 2004 to 2005.

The Spanish goal for 2010 is to achieve investment intensity in R+D of 2% of the GDP. Although this figure may seem modest compared to the Lisbon objective of 3%, it is important to take the Spanish gap in R+D figures into account. The country started out from an extraordinarily precarious situation of below 1% in 2000. At the same time, Spain has led economic growth in Europe, which means that the budgetary and investment efforts made are, in absolute terms, far greater than these percentages reflect.

(Gross Expenditure on R&D/GDP)x100: Total



In terms of Human Resources, the number of researchers has been growing at a rate of 9% per year since 2002, well above the European annual average growth of 1.3%.

[1] Although the growth of private investment was considerable (12.9%), it was lower than that of public investment, which explains the recent drop in the weight of the private sector in total R+D funding.

Thirty-seven percent of Spanish researchers are women. This is higher than the European average of 28%, although the figure still falls below desirable levels. For that reason, the Spanish Government has designed a policy to promote the participation of women in scientific and technological research as well as science management.

Beyond the purely statistical aspects, the efforts made by the Spanish Government have consolidated the science-technology-enterprise system by:

› improving its organisation,
› enhancing the transfer of technology and knowledge,
› strengthening the science and technology infrastructures,
› ameliorating the co-ordination with the strategies of the Autonomous Communities strategies that have wide responsibilities in the field of Research and Innovation, and
› strengthening the international presence of the R+D system.

These are aspects of maximum importance in qualitative terms for the Government of Spain as they represent solid foundations that will foster future development and growth.

The main challenge remains in boosting private R+D investment. Spain is in the group of countries that are "catching-up". In total, private R+D investment in 2005 accounted for 46.36% of the Gross Expenditure on Research and Development. An increase in private R+D efforts requires a substantial commitment from industry and public actions to trigger private investment. Hence, the new National Plan for R+D foresees that, in 2011, the private sector will finance 55% of the Gross Expenditure of Research and Development.

LISBON RENEWED: ASSESSING THE IMPACT

The Lisbon Agenda established a spending objective (input) for R+D. Time and experience prove that even if such a goal is essential to align efforts it is necessary to take into account the characteristics of each country when planning and implementing the strategies and actions.

Although this target is still a useful benchmark for Europe and Member States, we must also look for objectives, in terms of results or impact (output), that regional, national and European R+D policies should achieve, since the Member States fail to know the real impact of European policies on their own systems.

It is important not only to establish goals in terms of impact, but also to elaborate the instruments to assess them. In this respect, Spain considers that the CREST initiative for policy mix reviews in Member States is significant, as it provides for a valuable source of experience. Furthermore, Spain, along with other countries, is willing to put initiatives into practice to determine the impact of the Framework Programme, which in the long term, will help to adapt the design of future actions at European and national levels.

MOBILISING PRIVATE INVESTMENT.
HAVE SMES BEEN GIVEN THE PROPER ATTENTION?

SMEs make up 99% of all enterprises in Europe. They account for the majority of new jobs created, are responsible for much of the innovation that leads to new, higher value products and services and make an important contribution to achieving the European Union's goal of more growth and more and better jobs. Therefore, the value of SMEs to an economically competitive Europe is enormous. However, policies promoting R+D in industry are concentrated in large business enterprises, particularly the European ones. As the experience of Joint Technology Initiatives shows, even their aim is to contribute to the growth of the proportion of private investment in R+D in line with the Barcelona objective.

While Europe has managed to design a good instrument to foster individual high quality frontier research (ERC), a symmetrical mechanism has not as yet been considered for SMEs. Community support programmes, such as CRAFT, based on the paradigm of the collaborative project, benefit in many instances, science and technology projects developed by research centres that include SMEs, but which are not always projects by and for SMEs. Lastly, the objectives of SMEs global participation in the EU Framework Programmes do not account for a real commitment translated into effective measures to foster their participation.

SMEs are interested in investing in R+D insomuch as this investment bears business opportunities in relatively shorter time periods and with smaller investments than those required in large-scale industry. Hence, it is necessary to offer SMEs opportunities such as rapid and widespread access to technological or scientific capabilities that exist throughout Europe, since they can help to find solutions through simple bilateral agreements.

In short, SMEs need to have access to a real European research market in order to use and to offer advanced R+D services wherever they may be located.

LOOKING AHEAD: THE ERA INSIDE

The European Research Area exists insofar that this concept of "area" is also put into practice inside the Member States themselves, who should shoulder their degree of responsibility in this endeavour. Thus, the ERA requires Member States to strengthen their own National Research Areas. This means eliminating internal barriers to mobility, creating closed compartments for funding R+D and the effective opening up of the programmes to third party participation, with the appropriate safeguards that ensure that the benefits of this opening-up deliver proper returns (regarding economics, knowledge and welfare) in the local systems.

Consequently, there is still room for a series of new actions, framed midway between the big multinational projects (Framework Program, Article 169, ERA-Nets, EUREKA and COST) and the purely national or regional programmes: the latter would be programmes funded by national or regional budgets, but open reciprocally to third-party participation. Actions in support of SMEs, and in areas of basic research, are a breeding ground for initiatives of this kind.

The building of the ERA has only just begun. Let us not waive the responsibility that we, as Member States, have in its consolidation and expansion. The Commission's role should continue to be that of a driving force that encourages progress towards a more open approach and greater integration, but should not replace the initiative of Member States to develop areas inside their territories that are increasingly more open and inter-connected with their setting.

The real European Research Area begins with our policies, our plans and programmes, our attitudes -- with us.

Broad political consent among national and regional governments on the importance of R+D for the economic and social development has led to the definition of an action package to progress on Human Resources for S&T, Private Investment in R+D and Public Funding of S&T in Spain. This package includes the INGENIO 2010 initiative and the National Strategy of Science and Technology (ENCYT). The former is enclosed in the 2005-2010 National Reform Programme which is developed in line with the Lisbon Agenda, the later is built on successes and strategic adjustments with respect to the previous programmes and establishes both, the objectives and indicators for the S&T system for 2015, and the strategy to develop the National R+D Plans 2008-2011 and 2012-2015.

Therefore, this year the new 2008-2011 National R+D Plan has been elaborated and approved based on both the ENCYT and the recent experience of the INGENIO 2010 initiative. This Plan includes all the R+D measures and actions and aligns the strategies of all agents of the S&T system and will encourage the qualitative change that the S&T system needs. Moreover, since we are aware that society must acknowledge the importance and positive effects of science for their welfare, the Government has declared 2007 the "Year of Science" with the aim of bringing science, technology and society all together.

HUMAN RESOURCES FOR S&T

Human capital is a key aspect to have a solid S&T system, hence, in the current National R+D plan (2004-2007), as well as in the upcoming 2008-2011 plan, measures to strength the human resource base of R+D have been implemented and continue being important.

The main focus of the measures in the area of human resources is concentrated on:

1. Raising *public awareness* on the importance of S&T for social and economic development.
In the frame of the Year of Science 2007, various public events are being organised. Fares, exhibitions, open house days at universities and public research institutions, round tables etc. intend to trigger interest and to inform society of the role of S&T in a knowledge based economy.

2. Attracting *young people* to study science and technology.
New curricula for school pupils designed for a systematic "get in touch" with S&T in order to enhance the attractiveness of this kind of studies and careers and raise, in the long term, the number of researchers and personnel of the national S&T system.

3. Support *education and training* of human resources in S&T.
The new National R+D Plan foresees actions to increase the quantity and quality of educational (formal and competitive) offers and lifelong learning activities at all levels for research personnel (researchers, technicians, knowledge transfer managers etc.).

4. Support for *mobility* of researchers.
Implementation of measures that aim to increase the mobility of Spanish researchers to participate in research activities in third countries, as well as to lure foreign human

research capacities to settle in Spain. Moreover, trans-sectorial mobility schemes are planned to enhance the flow of researchers and technical personnel among public research institutes and private enterprises.

5. Improve *career development*.
   Attractive career development schemes are essential in order to have a sound human resources basis for the national R+D system and to keep researchers on their career path. It is equally important to enable flexible and less bureaucratic schemes for hiring research staff in universities and public research institutes.
6. Avoid *brain drain* and stimulate *brain circulation*.
   Besides focussing on the single researcher and his/her career development, steps are taken to improve the overall research conditions by investing in R+D infrastructures, strengthen international co-operation, promote top research teams, support academy-industry linkages etc.

The measures implemented in order to increase and support human resources in S&T are integrated in programmes such as:

› *Torres Quevedo Programme*: supports trans-sectorial mobility of R+D staff between university and industry. The aims of the programme are to support and motivate quality hiring in both public and private centres, providing incentives to private firms for hiring PhDs and technology management experts for R+D and innovation activities.
› *Ramon y Cajal Programme*: The main feature of this programme is the recruitment of postdoctoral researchers by R+D centres on five-year contracts. The programme, which develops the action lines of the National Programme for the Promotion of Human Resources, aims to enlarge the research capabilities of R+D groups and institutions in both the public and private sector by recruiting qualified researchers. At the same time, the selection of applicants will be based on a process that ensures the highest standards, in objective terms, of scientific quality and merit of the researchers selected.
› Other significant characteristics include the joint responsibility shared by R+D institutions and government, the co-funding of the programme by the parties involved, and the search for mechanisms whereby high-quality researchers can be incorporated into the science and technology system.

- Juan de la Cierva Programme: This programme aims to promote the recruitment of postdoctoral researchers by R+D centres on three-year contracts. This programme, as well as the above-mentioned, attempts to enlarge the research capabilities of R+D groups and institutions.
  The objective of this new programme is to hire young postdoctoral researchers. It is directed, in particular, at researchers who have recently been awarded their PhD and is designed to enable them to join research teams and continue developing their research skills.
  These R+D centres must, therefore, have research teams benefiting from funding for a project in the framework of the National R+D Plan or the European Union's Framework Programme.
- Programme *I3 (Incentive, Incorporation and Intensification of Research Activity)*: created in 2005, provides incentives for the creation of stable positions within the Spanish S&T system for both Spanish and foreign teachers-researchers with outstanding research careers and support for the finest researchers by reducing their teaching workload
  Two instruments are used for this: incorporation of incentives through subsidies per stabilised researcher at professor or chair level incorporated from abroad; or co-funding research intensification aiding more intensive dedication from highly productive researchers.
- *FPI* Programme (Training for R+D personnel): the main feature of this programme is the scientific training of those graduates who are willing to do a Doctoral Thesis in any area of knowledge. Thus, this Programme offers possibilities of training in R+D projects framed within the National R+D Plan.
- *Severo Ochoa Programme*: offers grants for hiring top international researchers.

Concerning the number of women working in the S&T system, there is high potential for ameliorating the figures. Therefore, the Ministry of Education and Science has established the Unit of Women and Science adherent to the Secretary General for Science Policy. The main objectives of this unit are:

- Raise the level of involvement of women dedicated to S&T into the R+D system.
- Develop gender specific statistics showing the contribution of female scientists in education, science and technological activities.

- Make use of studies analysing the progress and the obstacles for female academics and scientists in their professional life.
- Reach the average EU-15 level of numbers of female academics and scientists working in high management- and executive positions of universities and other research/technology centres
- Co-ordinate the implementation of measures with other institutions (private, personnel offices etc.) to raise the number of women in R+D areas
- Foster favourable working conditions for female academics and scientists
- Make the research career attractive for young people

The international comparison of the number of employees in the S&T system shows that Spain is still lagging behind with eight R+D personnel per 1000 active work force to the EU-25 level of 9.7 R+D personnel/1000 active work force.

With respect to R+D personnel active in the private sector, Spain is ahead of other Southern and Eastern European countries (Greece, Portugal, Hungary, etc.) with 32.4% of R+D employees in the private sector but still has potential to increase towards EU-15 (52.4% R+D staff employed in the private sector). This rise in the number of private R+D researchers is essential to achieve our goals in terms of private sector participation in total R+D investment.

Despite the efforts undertaken by regional and national governments, major problems persist with respect to:

- Career perceptions for researchers: difficult, long career, low salaries and less attractive environment than in other areas and/or countries.
- Training: difficult transition from the higher-education system to industry.
- Education in schools: science teaching is highly abstract and theoretical, teachers lack training for more interactive and applied science curricula.
- Science in society: little awareness on the part of the public for the importance of science in a progressing and knowledge-based economy.
- Women in science: female scientists remain underrepresented at all levels of scientific careers.

PUBLIC FUNDING OF S&T

R+D is a key priority of the current Spanish Government, consequently, a substantial increase of public funding for R+D is part of the strategy to reach the Lisbon goals.

From 2004 to 2005 (latest data available), public funding has increased 21.8% (see Table 1 for a trend analysis from 1990-2007). The Spanish Government plans to sustain this positive trend.

In 2005, the Spanish Government launched the INGENIO 2010 initiative, whose aim is to boost the resources committed to R+D and innovation, and to set up new programmes – or redefine existing ones- in order to meet the main challenges of the Spanish S&T system. The increase in public funding has been mainly allocated to three major lines of action, namely:

› CENIT Programme, *(National Strategic Technological Research Consortiums)*, to stimulate R+D and Innovation collaboration among companies, universities, public research bodies and centres, scientific and technological parks and technological centres, supports public-private partnership in R+D performing large industry-oriented projects and is divided into the following activities:

  • CENIT Projects that co-finance major public-private research activities. These projects will focus on increasing the scientific-technological capabilities of Spanish companies within a framework of sustainable development. The subject-matter of these projects refers to: Biomedicine and Health Sciences; Food Technologies, Information and Communication Technologies, Production and Design Technologies, Environment, Sustainable Development and Renewable Energies, New materials and Nanotechnology, Sustainable and aerospace mobility, and Security.

  • Fund of Funds to invest in private venture capital funds, which in turn will invest in technology companies in the infant and start-up phases.

  • Torres Quevedo programme mentioned above.

› CONSOLIDER: aims to strengthen leader scientific groups in key R+D areas, reinforcing critical mass and excellence. It includes the following actions:

  • CONSOLIDER Projects that offer long-term large scale financing for excellent research groups and networks

  • CIBER Projects that promote high quality research in Biomedicine and Health Sciences in the National Health Care system and the R+D system, with the development and enhancement of Network Research Structures.

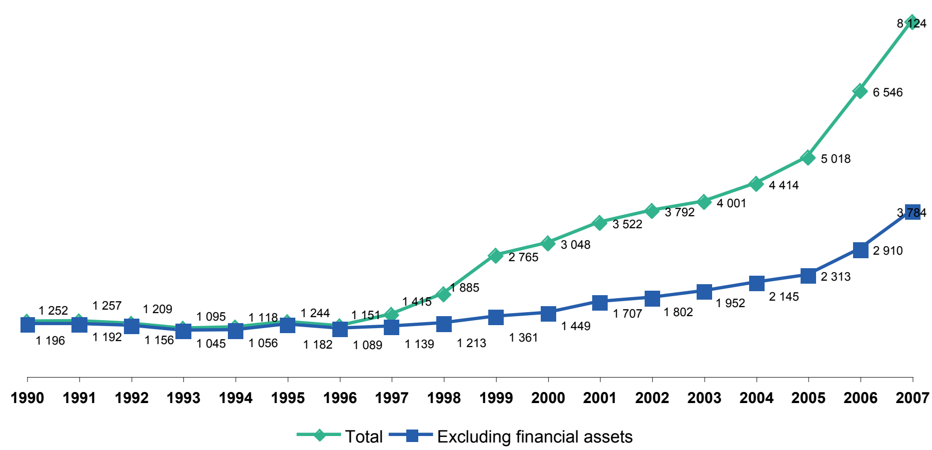
  • I3 Programme mentioned above

• The Strategic Scientific and Technological Infrastructures Fund, that ensures the availability and renewal of scientific and technological equipment and facilities for research and the promotion of scientific and technological parks linked to Universities and public research bodies, and singular strategic projects.

› AVANZ@ Plan: supports measures to spread the knowledge and information society in order to converge with Europe in the main information society indicators.

› Other initiatives to boost private innovation (NEOTEC, aiming to promote the creation of New Technology Based Firms), tractor programmes, scientific installations, etc.

Table 1 › **Rise in Spanish public expenditures on R+D (Million€)**



(Grey graph: Total; Blue graph: without loans)

The current 2004-2007 National R+D plan and the new 2008-2011 National R+D Plan, foresee substantial increases in the Gross expenditure on R+D to 2% in 2010, supporting public-private partnerships, boosting innovation performance of the private sector, strengthening internationalisation of the R+D system and focusing on a few key priorities of Spanish R+D: Information and Communication Technologies, Biotechnology, Nanotechnology, Health and Energy and Climate Change.

Together with the INGENGIO 2010 programme, the new National R+D Strategy forms the basis of the new 2008-2011 National R+D Plan. Rather than focusing on thematic areas, the new National R+D Plan targets towards reaching strategic objectives through operative national programmes.

The main strategic objectives aim to position Spain in the forefront of new knowledge, to increase and support human resources in R+D, to improve business sector competitiveness in R+D, to integrate national and regional R+D efforts, to foster social welfare and sustainable development, to further integrate the Spanish R+D into ERA and international activities and to create a favourable environment for R+D and innovation in Spain.

It foresees an increase of the gross expenditure in R+D to 2% of the GDP (out of which: 55% will be financed by the private sector) in 2010 and 2.5% in 2015 (see Table 2).

Table 2 › **Main objectives of the New National R+D Strategy for 2015**

INDICATORS	2005	2015
1. Total expenditure for R+D (public + private) as percentage of GDP	1.13	2.50
2. Total private sector expenditure executed on R+D (in % of overall R+D expenditure)	53.80	65.00
3. Total financing of R+D by private sector (in % of overall R+D expenditure)	46.30	60.00
4. Expenditure in innovation as percentage of GDP	1.49	4.00

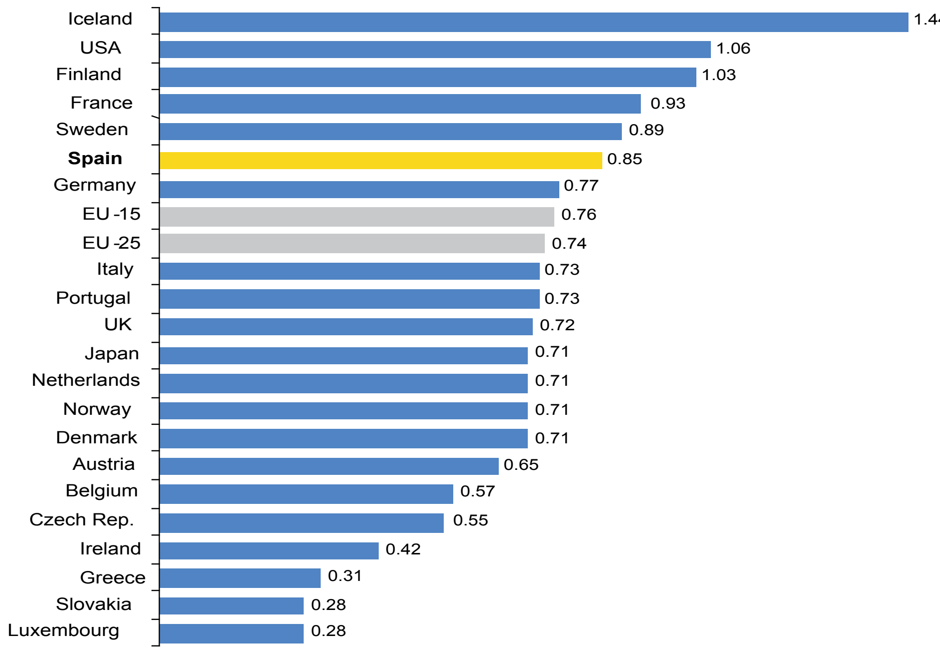
In order to attain these goals, new programmes will be developed in the 2008-2011 National R+D Plan while, at the same time, the former are being reorganised to simplify the participation of all agents in the Plan. Some of the new programmes are:

- SEVERO OCHOA: grants for hiring top international researchers.
- A programme to provide long-term block funding for excellent research centres.
- Simplified measures: creation of a single electronic gateway for easier participation in the Plan.
- Improved co-operation among the central and regional governments in order to reduce fragmentation and to enable the financing of challenging initiatives as the Large S&T Infrastructure roadmap.

Moreover, the new National R+D Plan foresees an annual increase of 16% of the Public investment in R+D over the 2008-2011 period.

If we look at the EU level, we see that Spain is currently in the group of the "catching up" countries (Table 3). Spanish public investment in R+D topped the average EU-15 level (0.76% of Gross expenditure in R+D) with 0.85% of GDP in 2005.

Table 3 › **Public R+D investment as percentage of GDP, 2005. International comparison**



The new National R+D Plan lays the ground-works for substantial advancement of the Spanish S&T system with respect to the Lisbon goals. However, specific problems remain:

› A pending necessity for further co-ordination at both inter-ministerial level (Ministries in charge of R+D and Innovation policies) and territorial level (National level and the Autonomous Communities) to avoid excessive fragmentation of the policy-making system.

› Prioritisation is a key issue, as the Spanish S&T system is “bottom-up” and inclusive, reflecting the interests of all the R+D performers, but lacking a focus on overall strategic needs and priorities.

› A persistent need for a better formulation of the policy mix with stronger integration of the various agents and influential factors of the Spanish R+D system (public, private).

PRIVATE INVESTMENT IN R+D

Private investment is a key factor for building a knowledge-based society and strengthening the third pillar of the knowledge triangle -- education-research-innovation. In the context of the current and the forthcoming National R+D plan, new programmes have been introduced marking a complete policy framework to encourage research, development and entrepreneurial innovation activities.

Again, the INGENIO 2010 and the new 2008-2011 National R+D Plan offer instruments for the promotion of industrial and private sector participation in boosting investment in S&T in Spain.

In 2005, 46.3% of Spanish R+D investment came from the private sector. The objective is to reach 60% in 2015.

In this context, programmes like NEOTEC, which supports the creation of new innovative enterprises ("seed financing"), or PROFIT, which fosters public-private partnerships or the CENIT Programme, by which risky, big industrial research projects are realised supporting public-private collaboration.

The new National R+D Plan foresees two programmes oriented towards the increase of industry participation: exploiting knowledge and technology transfer as well as a national programme for public-private co-operation.

Finally, the Centre for the Development of Industrial Technology (CDTI) of the Ministry of Industry, Tourism and Trade is highly active in the support for Spanish enterprises with means for financing innovation activities.

For the next years, the objectives are as follows:

› Reach 55% of private R+D investment in 2010
› Employ 1300 PhDs annually in the private sector from 2010 onwards
› Increase the number of spin offs from public R+D institutions to 130 in 2010

Spain lags behind other developed economies with respect to the S&T figures, this gap is bigger in what concerns private R+D investment (46.3% of Spanish GDP vs. 54.4% EU-25 average in 2005) thus, as mentioned above, encouraging the private sector to invest in R+D represents the main challenge for the Spanish S&T system.

The current situation in private investment is negatively influenced by the fact that the business sector lacks the awareness that innovation is the engine of economic growth and competitiveness. In addition, stimuli targeted specifically towards the increase of business R+D investment need to be exploited and implemented more effectively.

In conclusion, the Spanish Government is providing a package of programmes, measures, actions to create a sound Science-Technology-Enterprise system that will be essential to the sustainable growth and development of our nation. These measures are enclosed in the new 2008 -- 2011 National R+D Plan that has been elaborated and approved based on both the National Strategy of Science and Technology and the recent experience of the INGENIO 2010.

The Future of Science & Technology in Europe

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Recent initiatives in favour of research and development in Belgium

ABSTRACT

Belgium has a strong basis of higher education and related research. As in many European countries, innovative measures are needed to keep this asset in face of the international competition, and to improve the transfer of knowledge from academia to industry and services. This text, which is by no means an exhaustive catalogue of measures, presents some recent initiatives.

INTRODUCTION

Belgium is a Federal State, with competences shared by different levels of government. Aside from the federal government, Belgium is divided in three Regions : Brussels-Capital, Flanders and Wallonia, and three linguistic Communities : French, Flemish, and a small German one. All seven entities have their own parliament and government, however in practice the Flemish Region and Community have merged their institutions. Belgium counts about ten millions inhabitants.

All entities have competences in research. The federal government is in charge of specific programmes (related to space and the federal competences) and federal institutions. The communities are mostly in charge of basic research, and the regions of applied industrial research.

The Eurostat data made available in 2007 indicate that in 2005, the research and development investment of Belgium equalled 1,86 % of the Gross Domestic Product, to be compared with the 3 % Barcelona objective. The public and private contributions equalled 0,60 and 1,26 % respectively. This places Belgium close to the EU average.

However, since 2004-2005, research and development have moved up on the agenda of each of the Belgian entities, in a way not yet reflected by the 2005 statistics, so it is expected that these percentages will increase progressively over the coming years.

In fact, research has become both a top priority and a transversal subject for the various governments, leading to a variety of measures in favour of R&D.

In 2004, a 3 % High-level Group was created, including research actors from universities, public and private research institutes and companies. It made a number of suggestions in 2005 to improve the Belgian research landscape, which were taken up by the relevant authorities. More recently, Belgium participated in the Policy Mix Peer Review initiated by the European Commission, leading to a further list of recommendations expressed by international experts, mainly aimed at improving the governance of the innovation system.

Some of the actions recently taken are now described.

TAX MEASURES IN FAVOUR OF RESEARCH

Labour cost is particularly high in Belgium. To foster research and attract innovative companies, the federal government decided to decrease the wage cost of researchers by tax deduction. Companies and research institutions transmit only part of the withholding tax on researchers' wages to the treasury (this is at the time the salary is paid). For the individual researcher, it is assumed the tax has been paid so it makes no difference to her or him. Companies and research institutions make a saving which can be used to develop further research. The advantage of this formula is that the tax deduction is immediately known, allowing companies or institutions to take it into account in their strategy for the immediate future. A slight disadvantage is that if this tax deduction is used to fund more research, it does not appear as an increase of the research budget of the companies or institutions. In fact they can hire more researchers for the same budget, but that cannot be taken into account as an increase of the research budget for the Barcelona target, or in other international benchmarks. Maybe an adaptation of the Frascati rules could allow including this kind of investment in the research statistics.

Following this formula, the following measures have been progressively applied :

› universities are allowed a 65 % reduction in the withholding taxes of researchers, whether at doctoral or post-doctoral level,

- registered non-profit research institutions are granted a 50 % reduction,
- researchers in the private sector are allowed a 50 % reduction if they are involved in a collaboration with a public research institute,
- a 50 % reduction is granted for the research staff of "young innovative companies", i.e. companies less than ten years old investing at least 15 % in research,
- finally, in all companies, researchers with a master or Ph.D. in appropriate domains give rise to a 25 % reduction.

The effect of these recent measures was immediate on the public research institutions, which could hire more researchers, but they are not yet evaluated on the attraction they yield for private investors.

Other measures include a support to basic research paid out of the social security budget (31 million €), and the possibility for companies to deduct from their taxable income 80 % of those resulting from patents.

RESEARCHERS IN UNIVERSITIES AND FUNDS FOR SCIENTIFIC RESEARCH

A large proportion of publicly funded basic research goes through the universities and the French and Flemish Funds for Scientific Research, which receive their funding from the Communities.

Both have substantially increased their support for research, thereby increasing the volume of human resources at all levels : doctoral, post-doctoral and tenured. All these positions are accessible to researchers of all nationalities. In particular, the French Fund for Scientific Research has a staff of 400 tenured researchers working in universities.

The Flemish government has launched three specific programmes to foster its research strength.

The Odysseus programme (sixty million € over five years) aims at attracting to Flemish universities expatriate or foreign researchers, by offering them both their salary and a substantial budget to start their own research group.

The Methusalem programme provides long-term structural funding to top researchers at Flemish universities. Grants are awarded for renewable seven-year research programmes, and may reach two million € per year. The philosophy behind this programme is to offer stable long term funding for excellent teams, in a period where university teams have to rely more and more on a succession of two or four year long contracts, making long term planning difficult. The annual budget will reach twenty million € in 2009.

The Hercule Foundation, with an annual grant of 15 million € starting in 2007, will set up structural competitive funding for research infrastructure. The agency will operate in close partnership with the Fund for Scientific Research Flanders and the governmental agency for innovation IWT.

RESEARCH AND COMPETITIVE ECONOMY

Various measures or plans have been put into action in order to develop research in relation with economic development. Most regional policies have the same main objective, which is to develop science-industry linkages through a wide variety of programmes that foster public-private partnerships, clusters, etc.

All universities have developed a technology transfer unit to help university researchers identify potential economic applications and organise the rather complex process of developing a commercial product from a scientific discovery. Flanders has recently doubled the budget of these units.

The **Brussels-Capital Region** has launched a Regional Plan for Innovation (2007-2013) stressing the importance of close collaboration between the public and private sector. In particular :

› the region helps its companies to fund their R&D activities through joint public-private funding schemes, meaning that public funding up to 75 % is made available for research projects of participating industries,
› a strategic auditing project aims to assist SME's in their strategic innovation, by advising them on the market launch of innovative project. This scheme is government funded and executed by an industry association,
› an action in favour of the development of spin-off companies aims at creating new, innovative companies.

The Brussels region has analysed its strengths in terms of scientific excellence, strategic targets and industrial capacities and has decided to concentrate its action in three priority themes : the life sciences, the ICT sector and the environmental sector.

Various tools are used to promote the creation of these centres of excellence, involving the different stakeholders in the process. Universities are also encouraged to take part with monetary incentives, and co-operation between private companies and universities is strongly encouraged. This transfer of technology is therefore promoted through a strategy of clustering and the setting up of joint research centres, with the help of appointed advisors.

The **Walloon Region** has launched the Priority Action Plan for the Future of Wallonia 2006-2009, currently nicknamed the "Marshall plan for Wallonia".

It is an integrated plan, involving all ministries in order to achieve global results. It is the result of the analysis of strong points in Wallonia, made with the help of external experts. The plan has a budget of one billion €, of which 270 millions devoted to R&D.

Among the actions is the creation of five poles of competitiveness, again chosen after analysis by external experts. They are Bio-sciences, Agro-industry, Mechanical engineering, Transport and logistics, Aeronautic and space industry.

The creation of these poles (with in particular a research budget of 120 millions) triggered an unprecedented collaboration between all the universities and the companies. To give but an example, all universities got together and appointed collectively one person in charge of each theme.

The activities in these poles of competitiveness cover all aspects from research and development to industrial realisation and training of the necessary workforce.

Other aspects of the research actions of the Marshall plan concern the creation of well-funded excellence programmes for top research teams (25 million € per programme over five years, half funded by the Marshall plan), help to the creation of spin-off companies, support to the training of new scientists by funding of Ph.D. fellowships in industrial and agricultural domains, and the creation of an Agency of technical stimulation, whose aim is to co-ordinate the action of the different stakeholders of the transfer of scientific discoveries to innovative products.

One of the aims of this plan, coupled with the tax incentives, is to create a very favourable environment for research based private companies to invest in Wallonia.

Another action of the Walloon region are the so-called FIRST programmes, by which the region provides two years of salary or contribution to the salary of young researchers working in universities on a project specifically concerning an industrial company, or planning to create a spin-off, or working in an industry in collaboration with a university. The aims of this programme are to raise the research potential of universities, favour transfers of technology, and encourage industries to raise their innovation potential by the hiring of young researchers, after the two years period.

Concerning the **Flemish region**, it appears that 10 % of all research expenditures are generated by collaborative partnership between industry and academia (as compared to the 6,9 % EU average). Encouraged by this result, the government has launched a series of new initiatives.

In 2004, the Industrial Research Fund was established in the universities.
It is distributed among universities on the basis of performance driven parameters, such as the number of spin-off created, the number of patents applications, the volume of industrial contracts, etc. The annual budget will reach 16 million € by 2008.

A pilot funding scheme (the so-called Baekeland programme) will be launched in 2008, setting up jointly public/private funded four years fellowships for Ph.D. students. This will further enhance intersectorial mobility between academia and industry.

Hungary

János Kóka

Minister of Economy and Transport

István Hiller

Minister of Education and Culture

János Kóka
István Hiller

Science, Technology and Innovation Trens in Hungary

1. ANALYSIS

The domestic R&D financing frame is disproportional; the corporate share is low

At national level Hungary spent HUF 238 billion on R&D activities in 2006, which constitutes 1.00% of GDP (Figure 1.).

› Business expenditure: 43.3%; HUF 103.0 billion = EUR 412 million
› Governmental expenditure: 44.8%; HUF 106.5 billion = EUR 426 million
› Other domestic sources: 0.6%; HUF 1.5 billion = EUR 6 million
› Foreign sources: 11.3% HUF 26.9 billion = EUR 107.6 million

Within R&D expenditure the corporate share was 29.7% in 2002, 30.7% in 2003, 37,1% in 2004 and 39.4% in 2005, thus the trend is favourable.

Hungary's Summary Innovation Index is 58% of that of the EU average

According to comparative EU data Hungary's summary innovation index (SII) [1] was 0.26 in 2006, some 58% of the EU-25 average. With this, Hungary stood in 20th place out of the EU 25. This is in line with Hungary's current relative level of development but in the mid-term it must be taken into account that most EU countries treat R&D&I as a key priority, thus even maintaining the current position will also require significant endeavours.

[1] The Summary Innovation Index summarizes the results of five indicator groups consisting of 26 indicators in total. The input indicator groups: indicators showing the driving force of innovation, the producing of knowledge, as well as innovativeness and company readiness. Two output indicator groups: indicators related to economic utilisation and intellectual property. (European Innovation Scoreboard, 2006).

Corporate R&D expenditure is low

According to Central Statistical Office (CSO) data 1027 companies were involved in R&D activities in 2006. 75-80% of domestic corporate R&D expenditure comes from firms with foreign majority ownership, from which 38 operated research & development units in Hungary in 2006.

Non-corporate R&D

Non-corporate research and development activity is being carried out at universities and research institutes of the Hungarian Academy of Sciences.

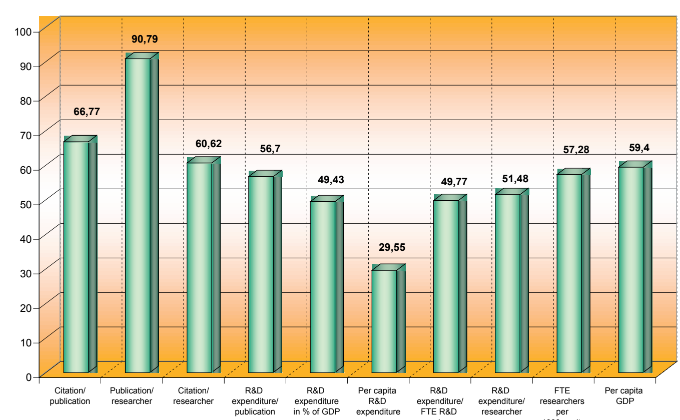
Few researchers

R&D human resources are insufficient: the number of researchers per 1000 employees is 3.9 persons in Hungary, while the EU-15 average is 6.1. The number of researchers (FTE) is 17 547, out of which 6 248 are employed in the business sector, 6073 at universities and 5 226 in research and development institutes and other research institutes. The Hungarian Academy of Sciences employs (FTE) 2 935 researchers in total.

Higher education has faced a dynamic growth in recent years, the number of enrolled university students grew by 300% in 15 years. Several universities in Hungary offer high quality training programmes in international comparison proved by the high number of foreign students enrolled.

The international comparison of the number of publications per country shows the efficiency of domestic basic research (see graph 1); in several scientific fields, the number of citations is above average.

Graph 1 › **Performance indicators of Hungarian science, and data on the economic and research potentials in percentage of the average of the EU states**



The recognition of domestic researchers is indicated by the fact that a young Hungarian researcher won the European Young Investigator Award in both in 2005 and 2006, and a Hungarian group of researchers received the Descartes Award in 2006.

The number of fresh graduates in the engineering and natural sciences is low

The predominant part of corporate R&D activity is concentrated in engineering areas; however, the low number of fresh graduates in the engineering and natural sciences is hindering development (Figure 2.). In the above-30 age group their proportion per 1000 persons doesn't even reach half of the EU average, and only Cyprus, Malta and Luxembourg are behind Hungary. There is also a significant shortage shown in terms of technicians and skilled workers with competitive knowledge.

Research activity has disintegrated, no critical mass

A predominant part of domestic research is carried out in international cooperation integrated in the European Research Area. This to a certain extent compensates for the fact that the domestic infrastructure has outdated and cutting-edge research in many cases can only be carried out with foreign infrastructure, but as a result of this in many fields the critical mass of research groups essential for efficient work was not established. Above all it is physical capital that is missing of the conditions necessary for the concentration of research.

In the area of foreign patents, especially European and US high-tech patents, Hungary remains far behind the EU average (Figure 3.). The number of publications per a million people is half of the EU-15 average; the number of publications per one researcher however is approaching the EU average.

Figure 1 › **Hungarian R&D expenditure as a proportion of GDP (%) (CSO)**

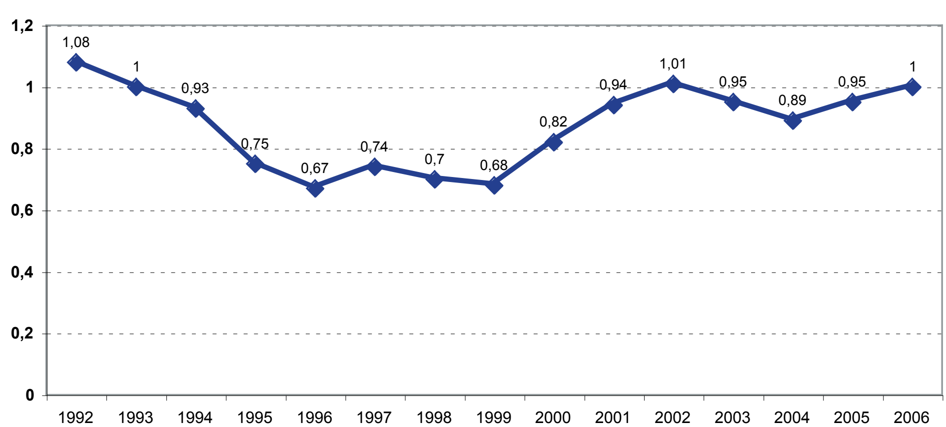
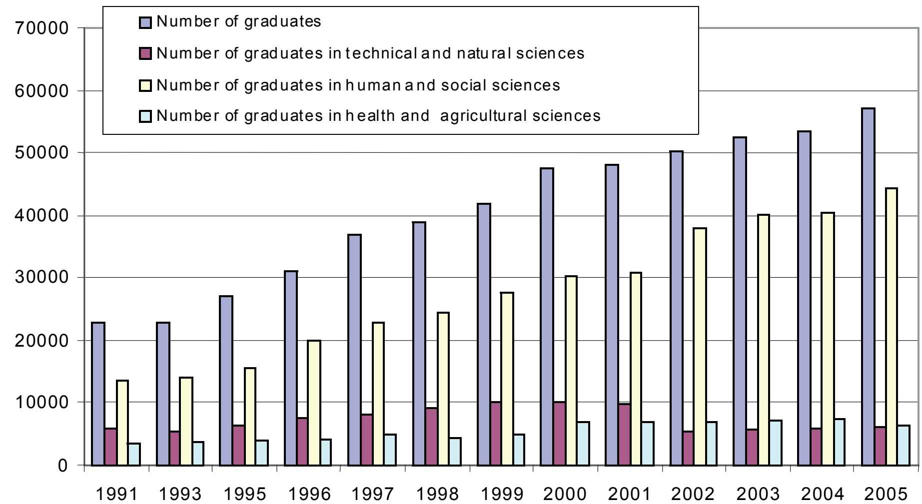


Figure 2 › **Acquired higher-education certificates**



Low IPR activity

In international standards, the IPR activity of the Hungarian firms and research units is low. According to the data of the EU Innovation Scoreboard 2006, the number of EPO patent applications per 1 million inhabitants is 18.9 (13.8% of the EU average), the number of USPTO patents is 5.3 (10.4% of the EU average), the number of community trademark applications is 18.8 (18.7% of the EU average), and the number of EU design protection applications was 15.2 (13.7% of the EU average). The number of national patent applications per 1 million inhabitants was 92.4 in 2006, the number of trademark applications was 423.7, and the number of design protection applications was 73. However, according to the Gambardella-Giuri-Mariani report[2] comparing 8 EU member countries, Hungary is #1 in the ratio of utilised patents, and the patents offered for utilisation (20.1% and 27.8%, respectively).

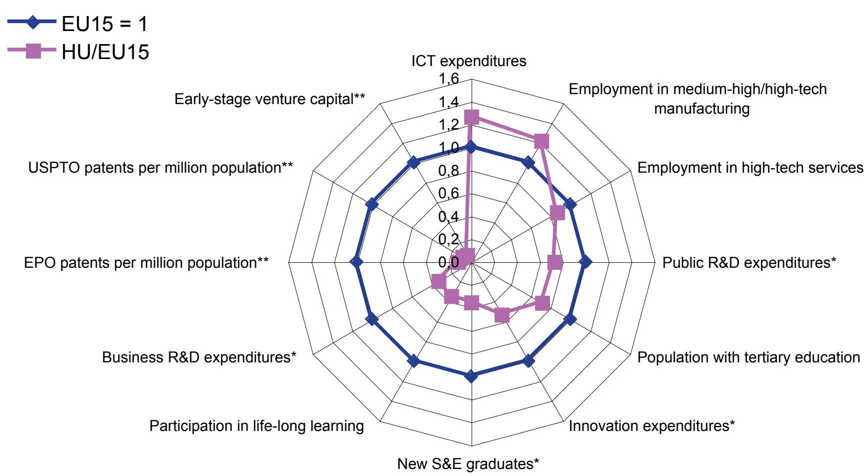
An open view of the market and the economy is missing

The knowledge flow between the research and economic sectors is not adequate. Economic perspectives do not appear in the management work of public research institutes, neither in the selection of research themes or the evaluation of researchers. In some instances rigid, authoritarian structures impede dynamic development; a large

[2] Study on evaluating the knowledge economy what are patents actually worth? The value of patents for today's economy and society. Final Report. 23 July 2006. p.16.

part of public sector research institutes require reform. There is hardly any swapping of experts between the public and the private sector research institutes, but mobility of researchers between the different institutions and thematic areas is not sufficient either. Between 2000 and 2004 the average total of job changes per researcher was 0.11. Incentives and support for the return of young researchers from abroad hasn't been solved either.

Figure 3 › **Innovation indices in Hungary compared to EU-15 (2005)**



Notes: *: Year 2004
**: Year 2003

Source: European Innovation Scoreboard 2006

Shortcomings in the innovation system damage competitiveness

Innovation activity in the domestic SME sector falls short of that experienced in more developed economies. There are few spin-off companies. Technological incubation serving the strengthening of innovative SMEs is underdeveloped. Institutional and network structures (innovation centres, technology transfer centres, technology incubators) that connect research & development institutes with companies are lacking or are weakly developed. There are no efficient mechanisms for directing capital to innovative businesses; capital market tools supporting innovation are undeveloped.

There is a significant difference between the research and innovation capacities of the domestic regions

The North-Western quarter of the country has been successful in attracting working capital, and due to imported technologies its innovation situation is good, however as a result of the weakness in R&D capacities there is little innovation built on in-house research. Budapest and the larger university towns in the eastern part of the country with low innovation capacity have significant research centres, however these institutes – with the exception of Budapest – have recently started to become real innovation centres of the regions. Indicators show a 2/3 central Hungary concentration of regional division of R&D resources (Table 1.).

Table 1 › **Regional division of R&D resources (2005, 2006)**

AREA	NUMBER OF R&D UNITS (2005)	NUMBER OF R&D UNITS (2006)	CALCULATED NUMBER OF R&D STAFF (FTE) (2005)	CALCULATED NUMBER OF R&D STAFF (FTE) (2006)	R&D EXPENDITURE (HUF MILLION) % (2005)	R&D EXPENDITURE (HUF MILLION) % (2006)
1. Central-Hungary	1 204	1 339	14 740 (63.4%)	16 273 (62,7%)	138 790 (66.8%)	163 076 (68,5%)
2. Central-Transdanubia	161	185	1 158 (5.0%)	1 429 (5,5%)	9 673 (4.7%)	11 337 (4,8%)
3. West-Transdanubia	188	210	966 (4.2%)	1 268 (4,9%)	6 737 (3.2%)	9 431 (4,0%)
4. South-Transdanubia	206	235	1 342 (5.8%)	1 628 (6,3%)	6 459 (3.1%)	6 926 (2,9%)
5. North-Hungary	141	172	961 (4.1%)	1 152 (4,4%)	5 890 (2.8%)	7 363 (3,1%)
6. North-Great Plain	300	310	1 946 (8.4%)	2 018 (7,7%)	17 913 (8.6%)	18 114 (7,6%)
7. South-Great Plain	316	336	2 126 (8.2%)	2 203 (8,5%)	14 658 (7.1%)	16 941 (7,1%)
Not classifiable by area					7 644 (3.7%)	4 765 (2,0%)
Hungary total	**2 516**	**2787**	**23 239** (100%)	**25 971** (100%)	**207 764** (100%)	**237 953** (100%)

Sector analyses, corporate R&D expenditure by sector

In terms of resources and abilities influencing R&D and innovation activities the sectors show a very different picture. The manufacturing industry supplies more than a third of the return from sales. The share of other production sectors is below 8%. Manufacturing companies supply more than 70% (73%) of corporate R&D expenditure. The construction, food industry, energy supply, postal services and communications sectors' economic role in the area of R&D expenditure lags far behind their role in manufacturing. The diffusion of innovation was the most dynamic in the service sector. The industrial parks - a successful organisation in the development of the SME sector - offer growing quality services for the companies settled within the industrial park. About 30 out of the 200 industrial parks are able to provide high level innovation services.

R&D expenditure in the manufacturing industry

Within the manufacturing industry, besides pharmaceuticals production, dynamically growing R&D expenditure can be measured in the communications equipment production, and the public road-vehicle production industries is in line with their significance, and R&D expenditure is also considerable in the area of electrical goods production.

Development potential

The pharmaceutical, environmental protection, biotechnology and information technology industries have significant R&D expenditure (capacity), dynamically developing sectors, and development opportunities in an international context. Small and medium-sized enterprises (SMEs), and from a human resources perspective, the vehicle production (vehicle steering- and sensor technology) and the food industry have development potential. Development of the public-roads vehicle production and telecommunications equipment production sectors is encouraging.

2. GOVERNMENT PROGRAMMES AND MEASURES

Governmental coordination

In the present coordination of S&T and R&D&I governance, the Minister of Education and Culture is responsible for the coordination of science related and the Minister of Economy and Transport is responsible for the R&D&I related governmental tasks. The Hungarian Academy of Sciences is a non-governmental organisation but, as the community of scientists by law, it has an essential role in the coordination.

The harmonious development of the R&D&I sector can be ensured by their dynamic cooperation.
The governance of this sphere is lead by the Science and Technology Policy Collegium, a cabinet of the government. The president of the Collegium is the prime minister, and the vice presidents are the minister of education and culture, the minister of economy and transport and the president of the Academy of Sciences.

Innovation act

The act CXXXIV of 2004 on research, development and technological innovation was approved by Parliament on 20 December 2004, and became effective as of 1 January 2005. This is the country's first innovation act which comprehensively defines, and through numerous measures, promotes research and development, technological innovation, and the economic and societal exploitation of the results thereof.
One of the act's most important measures is that it alleviates the limitations on enterprise establishment of public sector research institutes.

STI strategy

The national medium-term science, technology and innovation strategy for 2007-2013 has been introduced by Government Decree 1023/2007. (Apr.5). The STI strategy is based on the recognition that Hungarian economy and society should choose another development path. Its goal is that Hungary should be a country where the engine of the economy is innovation, and the firms are able to be present at the global markets with competitive products and services in some years. If Hungarian products contain the highest possible added value in the global market, the Hungarian economy and society can realise growing incomes. The strategy sets goals concerning the research and co-ordination institutions, the human resources, the positive societal environment, the corporate innovation that utilises research results, the intermediary organisations at national and regional level, the international co-operation, and, finally, the financial and legal environment that promotes all the factors mentioned above.

STI action plan

The national medium-term science, technology and innovation action plan for 2007-2010 (STI action plan, Government Decree 1066/2007 [Aug.29]) defines the detailed tasks based on the STI strategy, containing deadlines, responsible organisations and the financial sources. The tasks can be categorised in three groups: organisation tasks, programmes with public financing, and tasks forming the legal environment to improve the conditions of science, technology and innovation.

New programs for the widening of R&D activities in the business sphere
Central innovation initiatives based on a wide-ranging cooperation, promoting networking and integration, have recently appeared. These are regional university knowledge centres, cooperative research centres, key sector programs, large international programs, and regional innovation agencies.

R&D Programmes based exclusively on domestic financial funds
OTKA (National Scientific Research Fund) calls promote basic research, where the decisions on the projects are based on professional quality, upon the judgement of the research community. Its yearly budget is about HUF 6 billion (EUR 24 Million).

The calls of KTIA (Research and Technology Innovation Fund) promote principally applied research, experimental development, and innovation activities beyond R&D. Such calls serve the co-operation of companies and research institutions, the young innovative companies, the mobility and international co-operation of researchers, and the strengthening of regional innovation capacities. These calls are highly oriented to economic utilisation and technology transfer. In most innovation calls IPR costs are also accountable. The separated Fund, having a yearly budget of about HUF 47 billion (EUR 188 Million), has two main sources: a tax-like corporate innovation contribution, and the central budget. The Fund is managed by the National Office for Research and Technology (NKTH).

R&D Programmes with EU co-funding
In 2004, when Hungary joined the EU, co-financed R&D and innovation programmes have been launched in the frame of ECOP (Economic Competitiveness Operational Programme). Utilising these experiences, the new ECOP programmes starts in 2007. These measures promote the corporate oriented thematic research, the new regional science and technology parks, innovation process from prototype to market, cluster building, corporate researcher job creation, and the growth potential of innovative

micro enterprises. The yearly budget is about HUF 40 billion (EUR 160 Million). The co-ordination of all EU co-financed programmes is the task of NFU (National Development Agency).

Intellectual Property Rights programmes (IPR programmes)

Due to the high costs of foreign IP protection and the generally low financial capacity of domestic SMEs, the Hungarian government has been promoting the foreign patent application and starting of the economic utilisation by a programme since 2003. This programme provides SMEs, individuals, research and education institutions up to 90% of the IP protection costs. From 2007 on, the programme is financed from the KTIA (see above).

Indirect R&D incentives

In recent years the Hungarian tax system has developed much in terms of R&D incentives. According to the OECD comparative examination, by 2005 Hungary was in the leading pack in terms of R&D incentives and applied tax-allowances. Significant tensions can be seen however in the area of labour force loads. Knowledge-based firms (for example, software industry, content industry, research intensive activities) characteristically create added value through intellectual work demanding high levels of skills, thus within their costs the proportion of wages is large. Contributions on wages however hit those companies the most (companies selling not material products, but intellectual content and performance), which from an innovation point of view, should most of all have incentives.

IPR tax incentive

Since 1 January 2005, small and medium size enterprises, and individual entrepreneurs up to 250 employees may decrease their income by the cost of acquiring and maintaining for domestic patenting, utility models, industrial designs, and plant variety protection in their accounting.

Increasing IPR awareness

Recognising the weak innovation and IPR activity of most Hungarian enterprises, the Hungarian Patent Office launched the VIVACE programme (Programme for

Strengthening the Entrepreneurial IP Competitiveness) in 2003. The VIVACE programme is the only one among the new EU member states joining the EU in 2004 that has been chosen into the 15 best practice IP protection programmes.
The programme aims at increasing IPR awareness and activity of SMEs. In the frame of the programme, a national IP information network has been organised, including IP info-points in 21 cities organised by the trade and industrial chambers, IP info-points in 3 cities organised by the Hungarian Association of Engineering Associations, and so-called PATLIB centres in 4 regional university knowledge centres.

IPR Charta and the in-house IPR management regulations

The EU initiative prepared by the German Presidency, confirmed by the Competitiveness Council on 25 June 2007 as a Council Conclusion, gives a proposal on the elaboration and acceptance of a charter for the management of intellectual property from public research institutions and universities. Hungary supports the acceptance of the Charta, furthermore, according to the Innovation Act (see above) introduced the compulsory in-house IP management regulations for all public research institutions in 2004. Public institutions missing these regulations are not allowed to apply to any public grant. The Hungarian Patent Office, in co-operation with the National Office for Research and Technology, worked out and published a methodology manual for the research institutions. However, the preparation of the individual in-house regulations remains the exclusive responsibility of the institutions.

Bilateral international R&D cooperation

The Hungarian Republic is involved in bilateral intergovernmental cooperation with 32 countries. These are coordinated by the National Office for Research and Technology. Presently there are over 600 mobility projects running. In 2006, 260 new projects were started. Non-governmental bilateral co-operations are managed by the Hungarian Academy of Sciences and higher educational institutions. International Science & Technology relations were enhanced by large-scale R&D cooperation projects. Several projects were established within the framework of large-scale R&D cooperation such as the new biotechnology centre at Szeged with French cooperation, the nanotechnology centre at Miskolc with Russian cooperation, and an “ambient intelligence” project at Budapest with German cooperation.

Science & Technology attaché network

The National Office for Research and Technology in cooperation with the Ministry of Foreign Affairs operates the Science & Technology attaché network with 11 delegations (in Berlin, Brussels, Helsinki, London, Moscow, Paris, Beijing, Rome, Tel-Aviv, Tokyo, Washington).

Multilateral international R&D cooperation

The Hungarian Republic participates in the following multilateral co-operations in the field of R&D: OECD Science & Technology Policy Committee, COST, EUREKA, NATO RTO, CERN, ICSTI, ESRF, ESA. The participation in several new cooperation schemes is under preparation such as XFEL in Germany or hosting the European Technology Institute (ETI) and potentially the European Spallation Source (ESS) (introduced in the following paragraph). Hungary finds it important to be integrated in the European Research Area, and be actively involved in the debate on the redefinition of tasks.

European Spallation Source

The European Spallation Source (ESS) is one of the largest R&D installations in the EU presently. The tender for choosing the potential location has been successfully completed in Hungary in the summer of 2007. The financial model of the investment is managed by a group of international experts.

European Institute of Technology

The aim of the foundation of the European Institute of Technology is to support European competitiveness by means of establishing a European network of education, research and innovation. Hungary has applied to the European Commission in 2005 for hosting the governing board and administrative body of ETI. Hungary also advocates the participation in Knowledge & Innovation Communities.

Hungarian participation in the EU RTD Framework Programmes

The 6. Framework Programme (FP6) started in 2002, before the accession of Hungary to the EU. Among the countries joining the EU since 2004, Poland is the only country having higher success indicators. A weakness is, however, that the number of projects with Hungarian co-ordination is low: out of 850 projects with Hungarian participation, only 95 had Hungarian co-ordinator. The share of participating companies is less than 10%.

A new consortium building programme will help reducing these problems, providing support for the preparation of projects, and, in case of success, for the preparation for the contracting with the European Commission.

To promote the work of the applicants and the supporting programme committee system (PC/NCP), a new Brussels Liaison Office will soon be established. The office provides R&D and technology innovation services, and up-to-date information for the applicants. Furthermore, a domestic office network will be established, providing business related consulting service for the applicants.

The National Office for Research and Technology (NKTH) considers the ex-post evaluation of the FP6 an important strategic task. This evaluation, due to the continuity of FP6 and FP7, may give valuable input for the policy and strategy making, as well as for the elaboration of incentives for more intense corporate participation in the Framework Programmes.

The Future of Science & Technology in Europe

Poland

Barbara Kudrycka

Minister of Science and Higher Education

Barbara Kudrycka

Poland – towards a knowledge-based economy

1. GUIDELINES OF SCIENTIFIC POLICY

“The National Development Strategy 2007-2015” presents a vision of Poland in 2015 as a country of high living standards as well as a strong and competitive economy capable of creating new jobs. According to the Strategy, Poland will develop a knowledge-based economy that makes broad use of information and communication technologies (ICT) in all fields, including social services accessible to every citizen. Poland will promote the development of intellectual capital, with respect to both people and organisations. Polish economy in 2015 should be strong and internationally competitive, characterised by high and stable economic growth, innovativeness, efficient industry, a well-developed service sector and modernised agriculture.

In order to make this vision come true, the science sector – which is one of the pillars of a knowledge-based economy – needs to be strengthened. Scientific progress and educational function of knowledge are essential in the context of building a knowledge society prepared to live in an increasingly ICT-dependent world. Therefore, the most important task for Polish science in the coming years will be to contribute significantly to bridging the development gap between Poland and the developed countries and to improving the quality of life of its citizens.

“The strategy for the development of science in Poland till 2015” is a key document that formulates the objectives and priorities of state policy regarding the R&D sector. The document defines the underlying goal of the policy, i.e. enhancing the quality of Polish science, and states the following specific goals that derive from it:

› strengthened co-operation between science and industry,
› improved quality and quantity of R&D staff,

› improved effectiveness of R&D institutions,
› enhanced R&D infrastructure.

These objectives will be achieved in accordance with the principles of sustainable development of the country.

2. ORGANISATION OF R&D

In 2006, the Polish Government commenced the next stage in the reform of the system of science and R&D funding, driven by the intention to separate the creation of science policy from its implementation (i.e., evaluating project proposals and disbursing funds on R&D).

As the first major measure, the National Centre for Research and Development has been established. The Centre is a state legal entity that implements scientific and innovation policies by carrying out strategic research programmes and development activities defined by the minister of science. Other tasks of the Centre are as follows:

› support for the transfer of results of research and development activities to the economy,
› support for the development of scientific staff, in particular for the participation of young researchers in scientific programmes,
• carrying out international programmes for the mobility of researchers.

In the next phase, the Agency for Frontier Research will be established, which will fund basic research. The choice of research topics will be left to scientists themselves, and the Agency will use peer-review procedures in arriving at decisions regarding the funding of specific projects.

The establishment of the two executive agencies will also contribute to streamlining and depoliticizing the process of distributing public funds for R&D. The competence to decide on grants for individual projects will be transferred from the ministerial level to the level of the executive agencies supervised by the minister of science.

In the reformed system, the minister will be supported in conducting research policy by the National Council for Science. It will be a consultative and advisory body of the minister, composed of representatives of the scientific and business communities, non-profit organisations as well as central and local administration.

3. FUNDING R&D

To ensure an efficient execution of state scientific policy a continuous improvement of public funding for science system is essential. An important step in the reform process was the 2007 amendment of the act on the principles of financing science, which modernised the system of science funding in Poland and introduced organisational and legal arrangements aimed at placing greater emphasis on conducting applied research and development work as well as on elaborating a proactive policy of the state in the area of science, technological development and innovation.

Institutional subsidies[1] will be scaled down and the resources thus freed up will support research relevant to entrepreneurs. The share of funds granted on a competitive basis will increase substantially, and the form of these subsidies will be very flexible. Considerable simplification of the current funding system is planned: the number of funding schemes will decrease and they will now be determined mainly by the project's objectives. Last but not least, strategic research programmes will become one of the most important forms of funding R&D. The system outlined above will help to strike a balance between the autonomy of research that is indispensable to scientists and the economic needs of the country.

In April 2007, the Council of Ministers adopted realistic projections of increasing expenditure on R&D in Poland from 2007 till 2015. The basic indicators in this respect are presented in the table below.

Total expenditure on R&D (GERD) and its components (in millions PLN), and their share of GDP in the years 2007-2015; the current exchange rate: 1 EUR = 3.75 PLN.

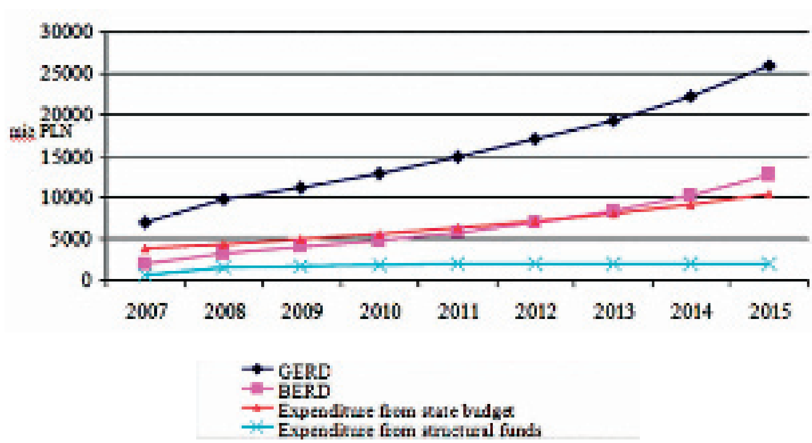
	2007	2008	2009	2010	2011	2012	2013	2014	2015
GERD	6 960	9 795	11 232	12 933	14 875	17 043	19 352	22 301	25 929
BERD	2 030	3 320	3 990	4 820	5 820	7 020	8 410	10 290	12 710
Expenditure from state budget	3 849	4 396	4 970	5 619	6 351	7 175	8 102	9 153	10 343
Expenditure from Structural Funds	592	1 539	1 676	1 835	1 971	2 039	1 948	1 948	1 948
BERD share in GERD	29%	34%	35%	37%	39%	41%	43%	46%	49%
Share of structural funds in GERD	8%	16%	15%	14%	13%	12%	10%	9%	8%
GERD share in GDP	0.62%	0.81%	0.86%	0.92%	0.98%	1.04%	1.09%	1.17%	1.26%

[1] Subsidies provided to research institutions to cover their regular, day-to-day activities.

The national budget resources, which are expected to rise 2.5 times by 2015 compared to the expenditure in 2007, will be of crucial importance to the overall spending increase for R&D as the so-called leverage effect is expected to induce the private sector to increase its R&D expenditure so that its share in the overall spending rises by 20% annually. The estimated annual expenditure for science in the state budget will increase by about 10% in real terms in 2007-2015.

A second vital source of increased expenditure on R&D will be EU structural funds, which should also considerably stimulate entrepreneurs to invest in R&D.

The graph below shows the most important components of the total expenditure for R&D. The GERD components not mentioned above include non-structural funds from abroad (e.g., EU framework programmes), revenue acquired by institutes of the Polish Academy of Sciences or by Applied Research Units.



The financing instrument in the form of grants commissioned by the minister for science is currently the most widely used by entrepreneurs in Poland, although since 2006 companies have been able to take advantage also of other instruments supporting innovative activities. The most important of them is a technology loan. It helps to fund investments where new technology, either purchased or developed by the company involved, is used. The loan may also be used to launch the production or modernisation of goods based on the new technology. An entrepreneur who will prove the sale of the goods or services based on this investment may apply to have up to 50% of the loan remitted.

Another instrument encouraging companies to invest in R&D is an option to obtain the status of an R&D Centre (RDC). It entitles a company to apply for a tax exemption, and – more importantly – enables it to set up an innovation fund out of a monthly deduction of up to 20% of revenue in a given month. The RDC may spend the fund's resources on R&D.

A number of useful amendments in the tax law have been introduced as well, whereby an entrepreneur can deduct from the taxable income up to 50% of the price of new technology purchased. Moreover, the possibility to include expenditure on development activities in revenue costs – regardless of the outcome of those activities – has been confirmed by the amendments. A considerable change is also the introduction of a 22% VAT on R&D services, which is expected to facilitate co-operation between entities selling R&D services and other companies. As a result, the entities undertaking research with a view to selling the research results can deduct the VAT for materials and services purchased, thus decreasing their operating costs.

4. DEVELOPING SCIENTIFIC STAFF

It is important to undertake activities that may make the European labour market in the area of science more friendly for the researchers working here. As regards Poland, many difficulties and challenges have been identified that impede the development of scientific staff. These include limited funds from the budget, differences in the quality of teaching offered by higher education institutions, an archaic model of young researchers' careers, insufficient alignment of teaching areas with market needs and a low level of collaboration between universities and the business sector.

The Ministry of Science and Higher Education is currently implementing, or about to implement, several programmes aimed at supporting the mobility of researchers (both international and between science and the economy), professional advancement of young doctors, and utilising the potential of scientists returning to Poland.

The following programmes aiding the development of scientific staff in the R&D sector will be implemented in 2007:

1. support for innovative R&D projects by encouraging the participation of under- and postgraduate students in research teams carrying out the most interesting projects; one of the programme's forms will be assistance offered to the best PhD theses that constitute an R&D framework preceding the industrial application of new technologies;

2. programme of international doctoral studies to allow young scientists to participate in strong international research teams. This goal will be achieved by means of linking PhD studies in Poland with those abroad; the R&D activities of the PhD students involved will be co-funded;
3. research projects carried out by students, PhD students and young doctors participating in the best Polish research teams (TEAM Programme); the goal of the programme is to encourage young scientists to participate in the work of the best Polish teams and laboratories; the best research teams will be able to hire young researchers and students and fund their projects. It is expected that the programme will not only play a role in career development of young scientists but also add to the interest of students in undertaking research activities;
4. programme "Support for the international mobility of researchers" allows Polish researchers to participate in projects conducted in foreign research centres. It covers living and other daily expenses of a programme participant while abroad in the period from one to three years. The programme obliges the participant to continue working in the mother institution for at least two years on returning to Poland;
5. programme "WELCOME" aimed at attracting excellent foreign researchers, as well as outstanding Polish scientists working abroad, to conduct research in Poland. The programme will fund projects in priority areas (termed Bio, Info, Techno) carried out under the direction of those scientists in Polish research centres. It is expected that the programme will strengthen the human capital of Polish science as well as contribute to better transfer of knowledge and skills;
6. third edition of the POL-POSTDOC programme, under which funding will be provided for research projects prepared and carried out by doctors, preferably project managers younger than 35.

One of the biggest challenges for Polish science is to increase the number of graduates of mathematics, engineering and natural sciences and to boost the mobility of students and academic staff. Therefore, Poland actively pursues the goals of the "Education and Training 2010" Programme, which contributes toward the Lisbon Strategy priorities.

Numerous possibilities of supporting mobility and encouraging young people to take up studies in exact sciences stem from structural funds. These funds will enable universities to expand and supplement their educational offer with elements related to the needs of the labour market and a knowledge-based economy. These activities include efforts to increase the number of mathematics, physics and engineering studies graduates (e.g., by commissioning educational services in the area of exact sciences), support for the launching of new study areas and curricula particularly important for the economy, society and the labour market, as well as organising training useful for conducting research and teaching work in leading foreign and domestic centres, both academic and scientific.

The shortage of scientific staff in Poland has given rise to many programmes providing incentives to embark on a scientific career. These include:

› scholarships from structural funds for PhD students, covering also their industrial internships,
› new scholarship programmes conducted by the Foundation for Polish Science, such as the "Innovator Programme" for PhD students and young doctors, whose aim is to support innovativeness by popularising market mechanisms and business practices among researchers, as well as to provide consultative and financial assistance in preparing innovative projects early on in the commercialisation process.

Moreover, scientific institutions carry out their own initiatives in this regard which fit in the overall strategy of supporting the mobility of researchers.

The Future of Science & Technology in Europe

Denmark

Helge Sander

Minister for Science, Technology and Innovation

Helge Sander

Main lines in Danish research and Innovation Policy

Since it came into office in 2001, the Government has focused on the development of the knowledge society in Denmark. Increased investment in research and innovation has been a key element in the efforts to promote renewal, growth and welfare.

The Government platform has singled out science and innovation as top priorities. Denmark is to become one of the world's most inventive and high-tech societies and to get better at translating new knowledge and new ideas into production and new jobs.

A significant step in this development was taken in 2006 when the Government launched a national Globalisation Strategy with new goals and a total of 350 specific initiatives in the fields of education, research, entrepreneurship and innovation. The strategy is to contribute to Denmark becoming a leading growth, knowledge and entrepreneurial society, and it involves comprehensive reforms in education and research as well as substantial improvements of the framework conditions for growth and renewal throughout the whole of society.

The Government, supported by a large majority in Parliament, has allocated a pool of EUR 2.8 billion to research and development over the next six years for the implementation of the national Globalisation Strategy. The funds are to be used for a broad range of initiatives.

The initiatives in the Globalisation Strategy have been discussed in the Globalisation Council, which is composed of members from trade unions, business organisations, private enterprises, study programmes and research. The Prime Minister chaired the Globalisation Council and the Minister for Science, Technology and Innovation and other government ministers participated.

The following general research and development goals have been prioritised:

› Public research allocations are to be increased so as to amount to 1 per cent of GNP from and including 2010, including funds to improve the interaction between businesses and public knowledge institutions.
› Privately financed research is to be increased so that total research amounts to 3 per cent of GNP in 2010.
› The universities are to educate more highly qualified researchers and have greater freedom to attract talented researchers.

1. PUBLIC INVESTMENT IN RESEARCH AND DEVELOPMENT

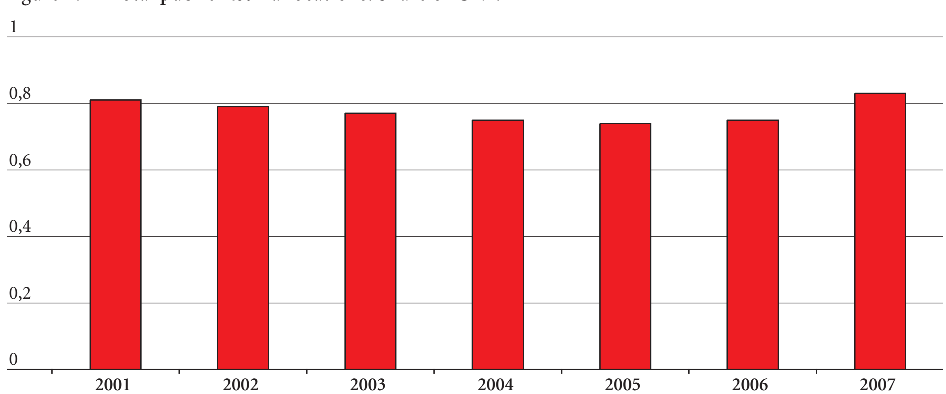
It is the objective of the Government to increase public allocations to research and development in Denmark so that the allocations comprise 1 per cent of the gross national product (GNP) from and including 2010.

The Government's goal for the increased allocation is to ensure that Danish research is world class.

› Public research is to be innovative and its quality should measure up against the best research environments in the world.
› Public research is to be relevant and underpin a high level of prosperity and welfare.

In recent years the development in government allocations to public research and development has been increasingly positive and in 2007 is anticipated to comprise a sum corresponding to approx. 0.8 per cent of GNP. Cf. figure 1.1.

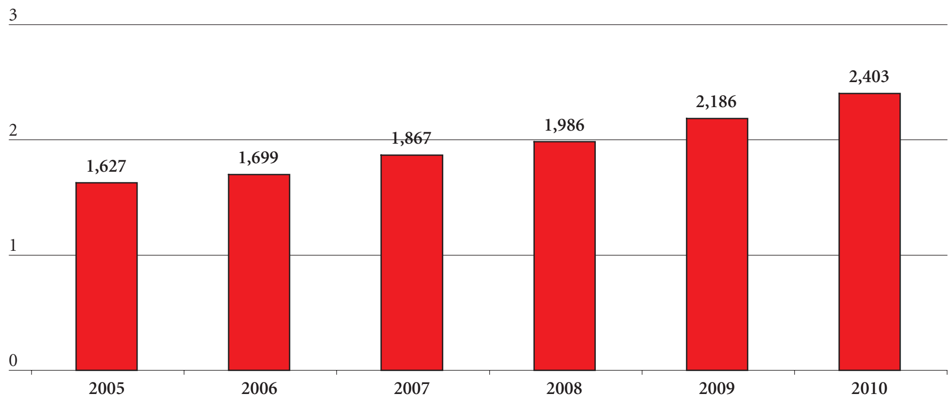
Figure 1.1 › **Total public R&D allocations. Share of GNP.**



Source: Ministry of Finance.

Concretely, the Danish Government has entered a long-term political agreement with a broad political majority that ensures an increase in the public research budget from EUR 1.7 in 2006 to EUR 2.4 in 2010. Funds are to be earmarked to maintain the 1 per cent target in 2011 and 2012. Figure 1.2 shows the development in the public allocations for research and development between 2005 and 2010.

Figure 1.2 › **Public R&D development allocations 2005-2010. EUR billion.**



Source: State research budget 2007 and public research budget 2006. GNP: Ministry of Finance, Economic Survey, August 2006.

In 2010 there will be an increase of almost 50 per cent in the public research budget relative to the 2005 level.

Universities and research institutions

Modern institutions in the field of research delivering research of the highest standard are the precondition for the greatly intensified investments in research producing the desired return. The Government would like to see autonomous universities with an independent responsibility for making their contribution to the development of the knowledge society.

The Danish universities have undergone several reforms since 2001. In 2003 the universities became autonomous institutions through separate legislation. The form of management was altered from being a management elected from among the university staff to being an institution under the leadership of a board as the highest authority. The boards have an external majority and an external chairman. The board appoints the vice-chancellor and the upper levels of the day-to-day management.

Relations between the individual university and the Ministry must be based on mutual dialogue and openness. The board establishes the guidelines for the organisation of the university, long-term planning and development. The board enters a development contract with the Ministry of Science, Technology and Innovation which sets the objectives for the university's strategic development.

The purpose of the Danish universities has been subject of a debate. This led to the Government in 2006 and 2007 implementing a process whereby universities were merged, and where government research institutes were merged with universities. The result was that 25 universities and research institutions joined together to form eight universities and three government research institutes.

It is the assessment that this has created the necessary organisational framework for further dynamics in the development of the individual institutions and the planned expansion of the Danish research sector as a whole.

The binary grant system

The binary Danish research financing system with, respectively, basic funding for research institutions and research funds that are distributed in competition is to be continued with increased funding from the Globalization Pool, as and increased share of the funds are distributed by competitive bidding. In the case of the funds that are competed for, larger sums are set aside for both basic and strategic research.

New pools

One special area of focus is building enhanced research capacity, the need for which is created by the rising level of activity. These efforts mainly consist of increased grants for more PhD scholarships and funds for investment in research infrastructure.

The Government has set up two new pools to which the universities, as an innovation, can apply for funds in competition with one another. The one is the *Infrastructure Pool* with a total of EUR 80.5 million to finance investments in large-scale, crosscutting research infrastructure in Denmark and abroad. The Infrastructure Pool is intended to improve access by Danish researchers to the most recent and most advanced equipment, instruments, databases etc. within promising fields of research. The utilisation of these funds is to be coordinated with the EU programme for investments in infrastructure.

University management can apply to a second pool, UNIK *(University Research Investment Capital)* of an annual EUR 32 million for large, long-term ventures. Funds can be granted to both basic and applied research within all scholarly disciplines and across disciplinary lines. The funds are intended to help the universities to mature and develop new, academically important areas.

International collaboration

Research in Denmark comprises only approx. 1 per cent of total world research. The Government finds it important that we gain increased access to the new knowledge that is created in the rest of the world. Danish researchers collaborating with top researchers in other countries is the best way to ensure this.

Research collaboration within the EU plays a key role in this context. The Government has worked for the research allocations on the EU's 2007-2013 budget being considerably increased with a view to furthering the European and Danish competitiveness.

National funds have been allocated to strengthen and stimulate Danish researchers to make greater use of the possibilities for research collaboration within Europe.

In addition, a better framework must be created for bilateral collaboration between Danish and foreign research environments, not least with countries outside of the EU. In this connection the Government has entered bilateral agreements with selected countries, and *centres of innovation have been established in Silicon Valley and Shanghai*. A third centre is to be opened in Munich in January 2008. The centres of innovation are intended to create contacts between Danish researchers and companies and leading international research, innovation and business environments.

Danish National Advanced Technology Foundation

In 2004 the Government established the Danish National Advanced Technology Foundation whose general objective is to enhance growth and strengthen employment by supporting strategic and advanced technological priorities and support Denmark's development as a high-tech society. The Foundation awarded EUR 28 million to projects in 2006 and has EUR 37 million at its disposal in 2007. The annual budget of the Foundation is expected to increase gradually.

Strategic programmes

Funds have been set aside for new/existing *strategic programmes* within a series of thematically defined research fields. The strategic research is to contribute to Denmark developing new research competences with a significant societal potential. Funds have been set aside for the following programmes for the 2007-2010 period:

- Renewable energy, environment and transport
- Food, health and environment
- The field of education
- Consumer-driven innovation
- Nanotechnology, biotechnology and ICT
- Cultural understanding

Within the prioritised areas, strategic research projects can be both basic and more application oriented research. Some of the funds are to be used to finance PhD programmes implemented in connection with the projects.

Strategic planning

With a view to *identifying and prioritising coming focus areas for strategic research*, an initiative has been taken to conduct an overall mapping of the research needs prompted by social and business development and which the Danish research institutions have the capacity to fulfil. Every fourth year this mapping is to result in a catalogue of important themes for future strategic research. The catalogue can function as a basis for decision-making regarding political prioritisation of the important focus areas. The mapping will be conducted for the first time in 2008.

Measuring quality

The Government has decided to establish a *quality barometer for Danish research*, where the quality of Danish research in relation to other countries can be followed and measured. The barometer is to be based on internationally recognised indicators such as citation frequency and publication activity.

Moreover, a *bibliometric quality indicator* to identify and measure Danish research publication across the institutions is to be established. The objective of the indicator is to strengthen the quality of Danish research and to support behaviour that promotes publishing in the most renowned peer-reviewed channels of publication. One target is to make use of university research publications when distributing basic funds from and including 2010.

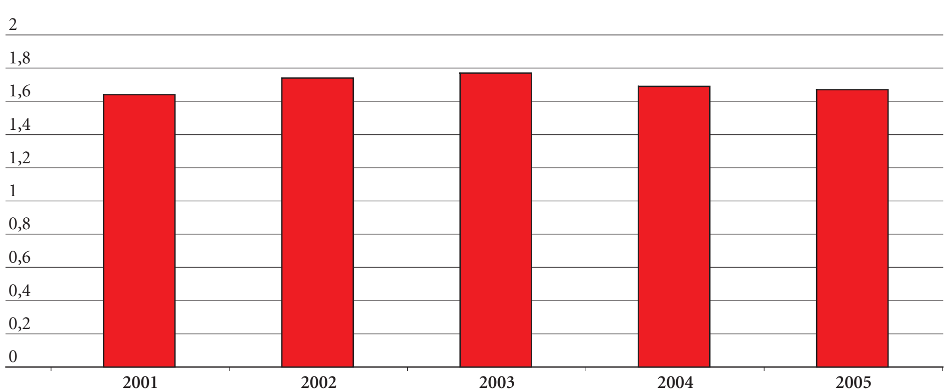
2. Private investment in research and development

It is the aim of the Government that Denmark should continue to be one of the countries in the world where private enterprises conduct most R&D. The private sector is to use a minimum of 2 per cent of GNP on research and development in 2010.

The Danish innovation policy is to support and further research and development in trade and industry, and contribute to a higher degree of utilisation of public research in Denmark by trade and industry and the public sector, for example through increased commercialisation of research results and cooperation on research.

According to OECD reports, the business sector in Denmark invested a sum corresponding to 1.67 per cent of GNP in research and development in 2005, thus placing Denmark quite high in an international context. Cf. figure 2.1.

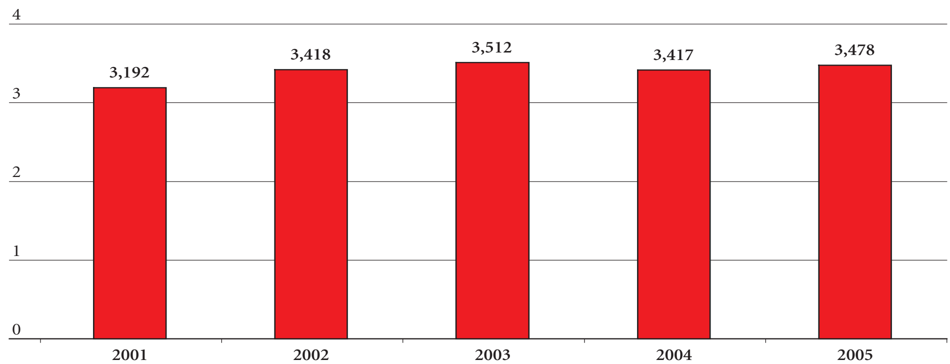
Figure 2.1 › **Private investment in R&D. Share of GNP.**



Source: OECD, Main Science and Technology Indicators and the Danish Centre for Studies in Research and Research Policy.

In 2005 the Danish business sector spent EUR 3.5 billion on own research and development, which is an increase of about 2 per cent in relation to 2004.

Figure 2.2 › **Private investment in R&D 2005-2010. EUR billion**



Source: The Danish Centre for Studies in Research and Research Policy.

The Globalisation Strategy contains a great number of initiatives designed to create a better framework for private sector research, development and innovation

New instruments

The Government's globalisation efforts have given rise to the establishment of instruments designed to provide research institutions with the possibility of bringing several new inventions to market, stimulating the purchase of knowledge and technological assistance by small and medium-sized enterprises, and creating more interaction between research and business.

With effect from 2008, a scheme is to be established whereby small and medium-sized enterprises receive *a price reduction the first time they purchase knowledge* from a knowledge institution, for example a university, a research institution or a technological service institution. The enterprises must themselves finance at least half of the costs to ensure relevance and commitment.

Small and medium-sized enterprises entering an agreement about a *co-financed research project* with one or several universities or research institutions can have their contribution doubled up. The state grant goes to the research institution and a ceiling of EUR 0.2 million per project is to be set. For a grant to be obtained, there must be a cooperation agreement between the enterprise and the knowledge institution that includes an agreement about publication of results and about ownership of any immaterial rights.

The task of the Danish *Advanced Technology Group* (GTS) is to promote the development and utilisation of the newest technological, management and market knowledge in Danish enterprises. GTS thus plays an important role in the dissemination of knowledge from public research and education institutions to the business sector. The GTS system has been made more flexible and open to competition by new actors having gained a better possibility of participating in the bidding to perform technological service.

A *matchmaking scheme* is to be established. The matchmakers who are appointed are to find and unify the best researchers and business people and initiate cooperation projects between enterprises and research institutions.

It is only in recent years that Danish universities have built up *professional units for technology transfer* to assist researchers in their work with patents and licenses. The university mergers in 2006 and 2007 have led to the creation of a number of units with the volume and capacity to enter into professional interaction on research and development with the business community. Strong environments are a necessary precondition for cooperation at the highest international level.

In order to encourage further positive development in the area, a pool has been earmarked for *the maturing and documentation of promising inventions* (proof of concept) at public research institutions.

3. HUMAN RESOURCES

The Globalisation Strategy states that the Danish universities should be able to measure up against the best in the world. This is to be ensured inter alia by the universities developing and refining attractive academic environments to continue to make it possible to attract and retain highly qualified manpower.

The total research staff of the universities has expanded considerably in recent years, with an increase of 31 per cent between 1996 and 2006. This rise has taken place in particular among assistant professors, postdocs and professors.

During the past decade, the universities have typically appointed 500-600 researchers a year, and in the last three years universities have employed a total of 1,803 researchers. Women researchers were appointed to 30 per cent of the positions advertised during the period, thus increasing the total share of women researchers from 24 per cent in 2003 to 26 per cent in 2006.

The quality of the education programmes

The goal of the above-mentioned *university mergers* has been to create better conditions for the Danish universities to offer high quality research training.

In April 2007 an independent *accreditation institution* for higher education was established. The accreditation institution is to evaluate the quality of Danish higher education programmes in accordance with international standards. The objective is to strengthen Danish universities in the competition to attract talented students and in cooperation with universities abroad.

PhD programmes

The significant increase in public research funds creates the need to train more researchers. PhDs also constitute an important resource for trade and industry. The objective is, therefore, to *double the number of PhD programmes commenced in 2010 in relation to 2003*.

In 2006 an international panel concluded that in general Danish PhD training is top quality, and that the potential and capacity exist for a radical increase in PhD intake. In consequence, PhD training programmes are now to take place at graduate schools with academic environments of an appropriate size.

The development of recent years has already shown an increased intake of PhD students. Between 2002 and 2006 there was a 37 per cent rise in annual PhD intake from 1100 to 1507.

Table 3.1 › **Annual PhD intake, 2002-2006. Number of persons**

YEAR	2002	2003	2004	2005	2006
Number	1100	1260	1295	1403	1507

Source: The Danish Centre for Studies in Research and Research Policy.

Funds are earmarked for the universities to gradually increase their intake by means of growth in the universities' basic funding. Simultaneously, further funds have been set aside for the Business PhD Scheme. In all, the number of PhD scholarships and Business PhDs is to be increased so that approx. 2400 PhD students are to be admitted in 2010. This increase will take place in particular in the areas of natural science, technical science, IT and health science. This will represent an increase of more than 60 per cent in relation to the 2006 level.

The Elite-Forsk initiative

Since 2005 the Government has focused on cultivating talents and the élite of Danish research. The initiative is to draw the attention to the results of excellent researchers as well as to single out researchers as role models with a view to recruiting more young students for a research carrier. In 2007 prizes for more than EUR 10 million was allocated.

Recruitment of researchers

It is the aim of the Danish Government that the universities of the country should have greater freedom to attract talented researchers and that they should train more, highly qualified researchers.

In the coming years, the universities will be faced with a considerable generational change. In order to safeguard long-term build up of capacity, as well as the funding for more PhD scholarships, funds have also been earmarked that are to be directed into *postdoc jobs.*

In terms of the most recent job structure, which lays down the academic level and basic content of academic positions at the universities, appointment at assistant professor level can be time-fixed up to four years or can be without a fixed term. Time-fixed lecturers can be transferred to security of tenure as agreed with the university, i.e. without the position being advertised if the lecturer has been assessed as being academically qualified during the period. This creates *a greater possibility for the university to offer tenure to the lecturers* they wish to retain. This can function as an instrument to remove uncertainty in the terms of employment and thus contribute positively to the recruitment possibilities of the universities.

An open salary system (”New Salary”), where the salary is based on qualifications and functions, provides the possibility of allocating bonuses over and above the centrally laid down basic salary. The possibilities have been gradually developed so that today the university sets bonuses for the individual employee, and it is therefore the university that establishes the total individual salary. The ”New Salary” provides the possibility of utilising *the pay as a strategic management tool* and for recruiting and retaining talented researchers and teachers.

There is work in progress to formulate an agreement on a *super professor scheme.* The aim is to provide the universities with the possibility of attracting the best national and international capacities with their own budget and managerial responsibility.

The 2003 reform of university management paved the way for university managements to make a greater contribution to creating *a well functioning research and work environment*.

Efforts are also being made to attract foreign researchers by means of a *tax scheme for researchers.* The scheme gives foreign researchers (and other key workers) the possibility of choosing 25 per cent gross taxation for up to 3 years. Danish researchers who have not been taxed in Denmark for a three-year period can also use the scheme.

The Ministry of Science, Technology and Innovation is financing the website www.workindenmark.dk in order to make it easier for foreign knowledge workers to obtain information about moving to, working and living in Denmark.

Cyprus

Michael Sarris

Minister of Finance

Michael Sarris

Science and Technology Policy in Cyprus

In the various assessments of the Cypriot economy by international rating institutions it is consistently stated that it is a healthy, robust and flexible economy, characterised by high rates of growth, a high standard of living and a high level of employment. An economy which has undergone, in recent years, remarkable structural reforms, mainly due to the liberalisation process of most of the sectors of economic activity and the emergence of intensive competition after joining the European Union. The adjustment period was minimal and the economy managed to absorb effectively the shocks experienced during the pre-accession period.

The strategic objective of Cyprus, as adopted by the Government, is to develop into a regional centre of provision of high-quality services, especially in the areas of education, health, research and innovation. This clear vision is consistent with the European development strategy, known to all as the Lisbon Strategy.

The Government is optimistic that this objective can be attained by exploiting the country's comparative advantages. We are confident that we possess the capacity and the features needed to play a leading role in Eastern Mediterranean. The issue is to take up the opportunities offered and to develop our full potential having in mind that international competition is creating pressure for improvements in efficiency, quality and productivity. The triangle research, education and innovation has been recently placed and kept at the heart of our policy agenda, as we appreciate their importance as a driver for a competitive economy.

THE GOVERNMENT POLICY – CURRENT SITUATION AND TARGETS

Consistent with the national strategic objective, the President of the Republic announced, during the Spring European Council 2006, that Cyprus has set a target to increase its R&D spending to 1% of GDP in the year 2010 (from 0,41% in 2005). Despite the fact that the current spending is among the lowest in EU-25, the signs are encouraging as the average annual rate of growth of R&D expenditure was of the order of 18% during the 5-year-period 2001-2005; one of the highest rates exhibited in the EU.

Regarding the breakdown of research activities by sector, it has been observed that in 2005, the higher education institutions accounted for 38,9%, the government sector for 31,8%, the enterprises for 22% and the private non-profit institutions for 7,2% of total R&D expenditure. These are features of the relatively less innovative economies, where private businesses are reluctant to get involved and undertake research activities, as they are not willing to take up the high risk entailed. This also explains the very weak links between academia, research institutions and the enterprises, as well as the limited utilisation and commercialisation of research results.

The intention of the Government is to build on the country's strengths and to address the relative weaknesses. The high percentage of tertiary level education (it is 36% above the EU average), as well as the high ratios with regard to the Science and Engineering graduates are elements that cannot be ignored. Meanwhile, the limited research capacity of the country, with the main constraining factors being the insufficient physical research infrastructure and the limited human capital, should not be understated.

Taking into consideration the challenges posed, the Government has selected various policy priorities, which constitute the basis for the achievement of the country's very ambitious targets. These include the strengthening of the scientific base (upgrade of existing and building of new research infrastructures), the enhancement of human resources, the encouragement of private sector participation in research activities,

and the promotion of regional and international scientific cooperation.

A significant structural reform that has been recently adopted by the Council of Ministers is the integration of the research, technology and innovation system of the country. It aims at the upgrading of the existing organisational structures through the establishment of a National Council, of a Scientific Council and the integration of the activities of the Research Promotion Foundation (RPF) and the Cyprus Institute of Technology. The RPF's main activities are the administration of both the National and the E.U. Framework Programmes for Research and Technological Development, the operation of the Mobility Centre for Researchers, and the preparation and implementation of bilateral agreements between Cyprus and other countries in the fields of Science & Research. On the other hand, the Cyprus Institute of Technology is mainly responsible for the operation of the Innovation Relay Centre.

1. Public Investment in R&D in Cyprus

The Framework Programme of the Research Promotion Foundation is considered the most important instrument for the implementation of the national research strategy. It covers the period 2007-2010, and involves a significantly higher budget than previous Programmes (initial estimates are of the order of €100mln compared to €17mln of the 2006 Programme and €20mln of the 2003-2005 Programme). Approximately 75% of the budget of the Framework Programme 2007-2010 is planned to be funded from the EU Structural Funds.

The design of the Framework Programme 2007-2010 is currently at its final stage and includes the following main pillars:

a. Development of Multithematic Research,
b. Development of Human Research Potential,
c. Development of Industrial Research and Innovation,
d. Strengthening of Research Infrastructure and
e. Expansion of International Cooperation.

It is important to indicate that the selection of proposals to be financed is done on a competitive basis, with scientific excellence being the main criterion.

With regard to the EU 7th Framework Programme (FP7), it is the government's aim to continue the successful performance achieved in previous FPs. Cyprus' records have been remarkable in both the 5th and the 6th Framework Programmes, where more than €45mln have been utilised in total in both Programmes. It is interesting to note that most of the successful projects gained financing under previous Framework Programmes are in the area of Information and Communication Technologies (ICT), which proved to be the leading research field in Cyprus. In particular, ICT projects absorbed 70% and 50% of the funds raised from the 5th and the 6th FP respectively.

The Research Promotion Foundation (RPF) encourages and promotes the participation of Cypriot researchers and institutions in the 7th Framework Programme on a continuous basis, through the establishment of a particularly effective National Contact Points Network, as well as through information seminars and brokerage events.

A second instrument for the enhancement of the research sector is the establishment of new research institutions, academic institutions, and the creation of innovation poles. Heavy investments have been undertaken in this area during the last couple of years, with the establishment of a second state university in Cyprus (the Cyprus University of Technology) and the creation of new institutions. The most promising ones are the Cyprus Institute for Environment and Public Health, which was established in collaboration with the University of Harvard, and the Cyprus Institute, which collaborates with the MIT. The Cyprus Institute's first research centre has already been created and concentrates on the scientific fields of Energy, Environment and Water. Also, it is worthwhile mentioning that three private colleges were upgraded into private universities in September 2007, a development that is expected to increase substantially the research activity.

Additional public spending has been channelled to facilitate all forms of innovation, knowing that the country is also underperforming on innovation diffusion. Appreciating the importance of innovation in enhancing the growth potential of the economy, particular emphasis was placed on the creation of Business Incubators, where the most popular scientific fields/subjects of interest are: Biomedical Engineering, Biotechnology, Electronics, Fluid Dynamics, Telecommunications, and Information and Communication Technologies (ICT).

In addition, the Government decided the establishment of a Technology Park, which will host research centres, high-tech enterprises, business incubators, and academic institutions, thus improving the links between academia, research institutions and enterprises.

2. Private Investment in R&D in Cyprus

The poor involvement and investment of industry in R&D activities is one of the main restraining factors for the development of the research sector. Indicatively, it is mentioned that the contribution of industry to total R&D expenditure was only 18% on average during the five-year period 2001-2005, which is well below the target of 67% set in Barcelona in 2002.

Having full consideration of the latter, the Government promotes a series of measures towards the encouragement of industry participation in research activities. The most important ones are the funding programmes included in the Framework

Programme of the RPF called "Research for Enterprises", "EUREKA Cyprus", and "Follow-up Projects". The first programme aimed at encouraging the cooperation of enterprises with local research organisations, the second one targeted the cooperation of local enterprises with foreign research organisations, and the last one aimed at promoting the utilisation and commercialisation of the results of completed research projects. The first positive signs of improvement were observed during the announcement of these programmes in 2006, as 42 projects were funded with a total budget of €5,64mln, compared with 34 projects with a budget of €3,45mln in 2004, and 9 projects with a budget of €0,48mln in 2003.

Furthermore, it is important to mention that the substantial increase of the budget of the RPF Framework Programme for Research, Technological Development and Innovation 2007-2010, will further enhance industry's participation in R&D activities, as the contribution of the public and private sector in these programmes is set to be 60% and 40% respectively.

Last but not least, the Government is considering the implementation of fiscal (mainly tax) incentives for encouraging the participation of enterprises in research activities. These provide for tax allowances for the income of foreign researchers while first employed in Cyprus, and tax allowances for the income of private research organisations secured from national research programmes.

3. Human Resources and R&D in Cyprus

As in all small countries, human scientific capital is limited. According to available statistics, and despite the satisfactory 14% increase between 2004 and 2005, the number of full time researchers was only 1,157 persons. However, it seems difficult to maintain such a high growth in the future, as the pool of national researchers is limited. Consequently, the Government concentrates its efforts in two main directions, which are the development of young researchers and the attraction of foreign researchers.

With regard to the development of young researchers, the measures underway include initiatives for promoting research culture within the educational system. Specifically, there are two research competitions programmes in the RPF Framework Programme addressed to pupils in the age of 6-18 and to undergraduate students. Furthermore, there is a programme for the Support of Young Researchers, which includes actions for the entry, improvement and mobility of new researchers.

Concerning the attraction of foreign researchers, two additional programmes are offered by the RPF, namely "Philoxenia" (means hospitality in Greek) and "Research Cooperation with Distinguished Overseas Scientists". The former refers to the employment of foreign researchers in research institutions in Cyprus for a short period of time, whilst the scope of the second is the transfer of knowledge and experience of internationally distinguished scientists, through their participation in research activities conducted for the benefit of Cypriot research organizations.

Moreover, a Mobility Centre has been operating in Cyprus since September 2005, with its main activities being the publication of promotional materials, the provision of assistance to researchers and the organisation of various research events.

CONCLUDING REMARKS

At the bottom of the EU Member States ladder, in terms of GDP spending for R&D, Cyprus is making particular efforts to climb up. Even though the Government has undertaken significant measures, it is a real fact that attaining the ambitious target of 1% by the year 2010 is a challenging task.

Despite the willingness and devotion of the Government to support and further enhance research activities, the upgrading of the research sector is not easy; it requires careful planning, consistent and dedicated efforts, and the collaboration and commitment of all stakeholders: the Government, the academia, the research community and the enterprises.

The achievement of the targets set at EU levels is even more difficult in service driven economies like Cyprus, where the nature of activities make it more difficult to engage in high quality research, particularly when 99% of enterprises are SMEs. As a consequence, their innovative and competitive potential is restricted.

Irrespective of these, we remain positive that with the creation of the National Scientific Council and the integration of the activities of the Research Promotion Foundation and the Cyprus Institute of Technology, the new organisational structures will introduce new dynamism and bring forward successful results. Our vision is to create the necessary conditions, so that expenditure in R&D in Cyprus is used as efficiently as possible, with a target of engaging in high quality research with visible results. Undoubtedly, this will have a positive impact on the national economy and on the European competitiveness in the long run.

Ireland

Micheál Martin

Minister for Enterprise, Trade and Employment

Science and Technology Policy in Ireland: “Investing in Knowledge and its Application”

Micheál Martin

FOREWARD

The renewed focus on the Lisbon agenda and the emphasis placed on strengthening the European Research Area coincides with the implementation of the most comprehensive plan for investment in science, technology and innovation that has ever taken place in Ireland. A key element of our *Strategy for Science, Technology and Innovation (SSTI) 2006-2013* relates to Ireland’s interaction with the rest of Europe and the rest of the world.

Our Strategy provides us with a distinct opportunity to achieve convergence, coherence and complementarity in our national innovation system and to ensure maximum economic and social benefits are derived from the Government’s commitment of €8.2 billion to this area under our National Development Plan.

The Strategy gives breadth and depth to a vision for a knowledge economy and society in Ireland backed by real investments by departments and agencies, with clear targets and clear outcomes to be achieved.

As the challenge of cost competitiveness must be met by higher value added output across the economy we will continue to invest in Ireland’s science base as one important cornerstone underpinning our future place in the world. A strong science base matched by a paradigm shift in the capacity of our enterprise sector to create knowledge, to innovate, and to exploit new knowledge across global markets marks out Ireland’s future strategic direction.

There is a high degree of complementarity between Ireland’s objectives in science, technology and innovation and wider European objectives in this area. We fully subscribe to the development of a European Research Area and to the objective of raising EU research efforts to 3% of EU GDP, two thirds to come from industry.

I believe our success in meeting the challenge of global competition will depend on our ability to cooperate and share experiences and knowledge for our mutual benefit. This and well-being is the very basis upon which the concept of the European Research Area is built. However positive development, there remains a need to tackle the fragmentation of research policies and activities across Europe and to avoid the unnecessary duplication of our research efforts. The world of knowledge does not respect national borders. Today's Activities at a European level, including trans-national collaborative research, funding of frontier research and support for researcher mobility, will contribute directly to the achievement of national targets as set out in our strategy. Similarly, I am confident that the activity stimulated in Ireland through our investment in science, technology and innovation and the initiatives we are designing can contribute to the wider goal of strengthening the European research system.

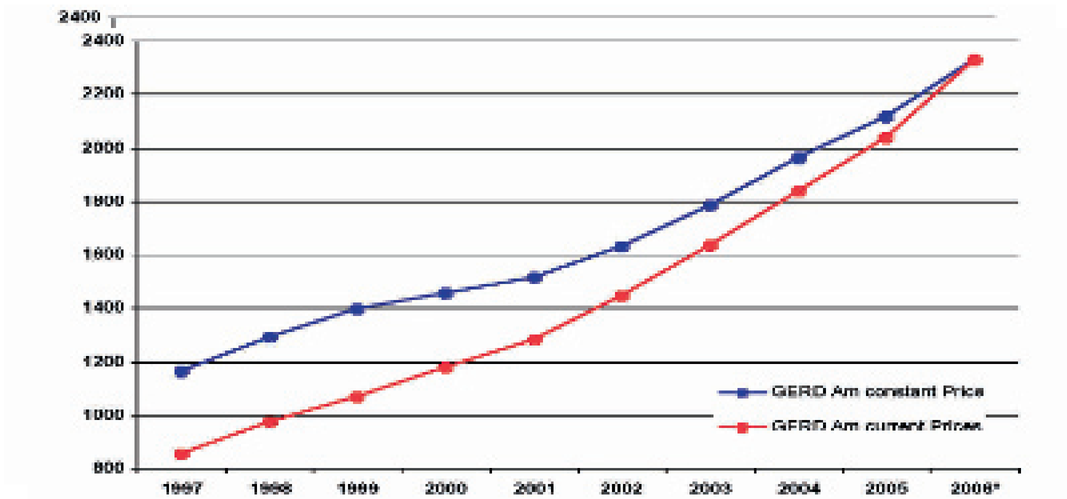
The challenges now lie very much in the implementation of our Strategy and are being achieved through the policy initiatives and implementation structure outlined below.

The following Sections provide a summary of Ireland's current performance and future policy plans and highlights developments in the three key areas of Human Resources for S&T, Private Investment in R&D and Public Funding of S&T. The arrangements in place to ensure implementation of the SSTI objectives and effective policy oversight are outlined in Section 4.

1. CURRENT PERFORMANCE AND FUTURE POLICY PLANS TO MEET THE LISBON AGENDA

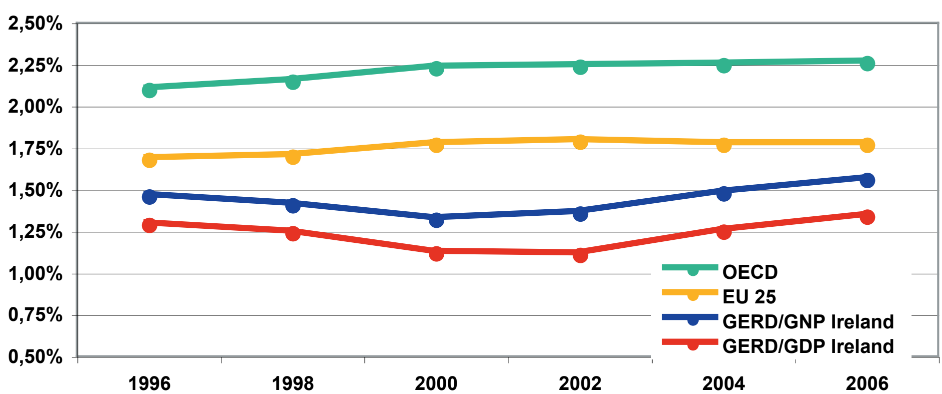
Latest data shows that good progress continues to be made in improving Ireland's knowledge economy performance in the context of the Lisbon Agenda. Total R&D spending across all performing sectors (GERD) increased by 14.3% to €2.33 billion in 2006.

Gross expenditure on R&D (GERD) – Ireland 1997-2006 €m



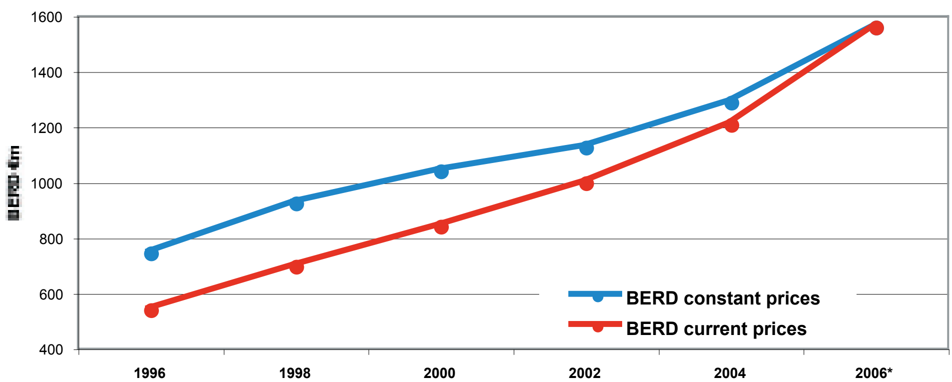
With robust R&D spending gains now outpacing economic growth, the overall R&D intensity ratio climbed to 1.56% of Gross National Product in 2006, ahead of the 1.32% GERD intensity ratio recorded at the start of the Lisbon process in 2000.

Gross expenditure on R&D (GERD) as a percentage of GDP/GNP - Ireland, EU & OECD 1996-2006



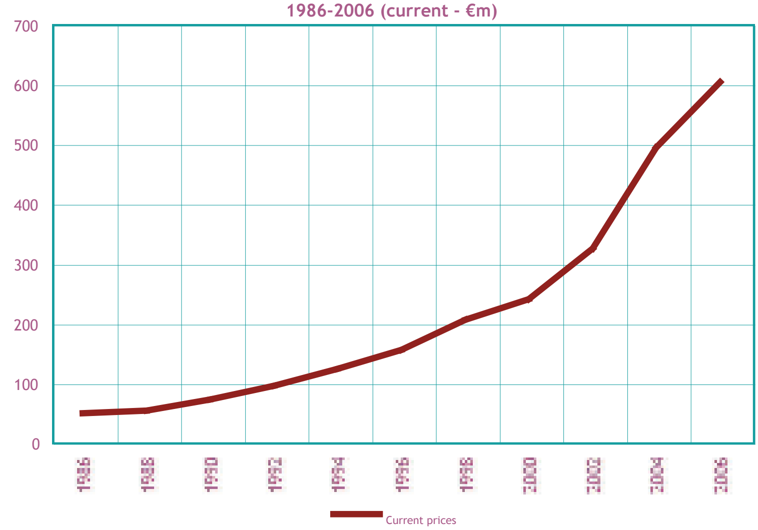
The strong progress in R&D spending has also allowed for a narrowing of the spending intensity gap between the EU and OECD averages. R&D performed in the business sector (BERD) rose to an estimated €1.56 billion in 2006, almost double the level recorded in 2000. The latest 17.3% annual increase between 2005 and 2006 facilitated a rise in the BERD intensity ratio to 1.05% of GNP.

Business sector performed R&D (BERD) in current and constant prices – Ireland 1996-2006 (€m)



Higher Education sector performed R&D (HERD) climbed to just over €600 million in 2006, over 2.5 times the €238 million HERD recorded in 2000.

R&D Expenditure performed in Higher Education Sector (HERD)
1986-2006 (current - €m)

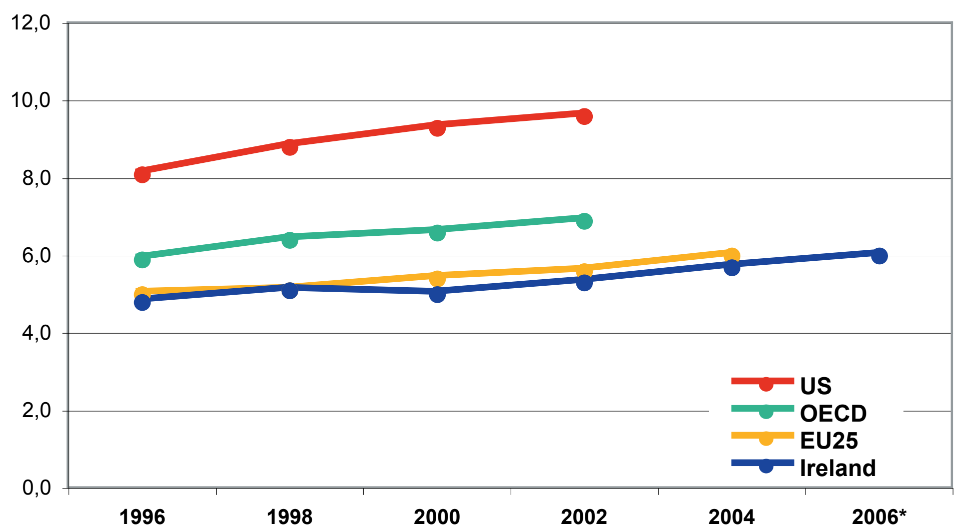


The HERD intensity ratio at 0.40% of GNP is now in line with the EU and OECD averages. Finally government sector performed R&D (Goverd) rose to €170 million in 2006 (0.11% of GNP).

Funding for R&D activities was sourced mainly from businesses, which contributed 65.5% of funds for R&D in 2006. This was in line with the target for two-thirds of total R&D investment to come from businesses. The next largest source of funding for R&D came from the public sector which funded 32.8% of R&D investments. A further 1.7% of R&D activity was financed from other sources.

On the human resources side, the number of employed researchers has risen significantly since 2000, in parallel with the strong increases in R&D investment. The ratio of full-time adjusted equivalent researchers per thousand in employment has risen from 5.0 in 2000 to 6.0 in 2006, and is now in line with the EU average and only slightly below the OECD average.

Total researchers (all sectors - FTE) per 1000 total employment - Ireland, EU, OECD & US 1996-2006 (or latest available data)



While the increases noted above provide Ireland with a strengthening research base on which to build, the Government recognised that it is vital for Ireland's long-term national economic success to continue to promote greater investment in R&D. The key challenges will be to:

› accelerate the positive trend in business R&D performance and
› to continue consistent investment in publicly-funded R&D.

In line with this the Irish Government completed the preparation of and published its Strategy for Science, Technology and Innovation 2006-2013 (SSTI) in June 2006.

The SSTI represents a further step-change in national support for R&D and innovation with €8.2 bn in investment over the period (increased from €2.5bn in the current funding period of 2000-2006 and €0.5bn in the period 1994-1999). It is a whole of Government strategy and Government backing was demonstrated in the co-operation across eight Government Departments (Ministries) in the formulation and now in the implementation of the SSTI.

The SSTI sets out initiatives for Ireland in the context of the Lisbon and Barcelona objectives in the following areas:

› Strengthening the higher education research base
› Capturing, protecting and commercialising ideas and know-how
› R&D in enterprise
› Science, education and society
› Sectoral research
› All-island and international R&D
› Policy oversight and review

Ireland's research efforts have benefited greatly from transnational collaboration through the promotion of scientific excellence, access to state-of-the-art facilities and enhanced researcher mobility and networking. Continued involvement in international activities will be pursued in a co-ordinated and strategic fashion over the next period with a view to HERD funded from foreign sources to increase to 20% by 2013 (from 10% in 2004). The Advisory Science Council is currently undertaking work to develop an internationalisation strategy for Ireland in respect of science, technology and innovation. It is expected that this work will help public funding bodies and the private sector to adopt a more strategic approach to international linkages in terms of priority countries and technologies that should become the focus of activity going forward. The Advisory Science Council will provide its recommendations by early 2008.

Particular attention is being given to our participation in the EU's Seventh Framework Programme and new support structures have been put in place to ensure maximum return from our participation in the programme. The new post of National Director for FP7 was created in late 2006. The National Director leads the overall national engagement in the programme and ensures that a coordinated approach is adopted across all government departments and agencies. As well as engagement in other European activities such as the European Space Agency and various inter-governmental research organisations, we will examine the potential for co-operation with economies in Asia and continue to develop our links with the US.

All-island collaboration is a horizontal objective of the Strategy and, where appropriate, related initiatives will be undertaken, as is happening in a number of instances across the sectoral areas.

2. HUMAN RESOURCES FOR S&T

Ireland will make a number of important changes to science education at primary and secondary level in order to increase and improve their outputs and throughput to higher levels.

Science has recently been re-introduced into the primary curriculum and corresponding training for teachers is undergoing enhancement, both in the Colleges of Education and via in-service training. At secondary level, a revised syllabus was introduced to the Junior Certificate in 2003 with a greater emphasis on investigative work.

While approximately 90% of students take science in this cycle, this falls to 60% in the Leaving Certificate (senior cycle, second level) and work is required to address this falloff. This will be tackled by:

› Reform of the Leaving Certificate science curricula to ensure a continuum from the Junior Certificate and to increase the emphasis on project/ hands-on activity,
› Increased investment in teacher professional development and consideration of technical assistance,
› Improved information and awareness activities.

The latter is supported by the Government's integrated awareness programme Discover Science and Engineering (DSE) whose budget has tripled from 2004, its first full year of operation, to €5M in 2007. DSE continues to support curriculum change at primary level and is now also supporting the changes outlined above at Junior Certificate level. It is implementing further support initiatives, including one for

Transition Year (the year between the junior and senior cycles) while continuing to develop support material in the area of career choice. Continuing the pipeline, more students who study science at secondary level will be encouraged to continue their science focus in third level and beyond.

Emphasis is also being placed on promoting Women in Science. Science Foundation Ireland, operates a number of schemes designed to increase participation of women including a career advancement scheme and a scholarship scheme in cooperation with Industry which aims to attract more women into 3rd level education in designated 4 year engineering degree programmes.

Continued increased investment in higher education R&D has resulted in significant strides being made in the development of Ireland's third level academic base under the current National Development Plan 2007-2013. The Programme for Research in Third Level Institutions and the initiatives of Science Foundation Ireland, in particular, have changed the scale and quality of research undertaken in Ireland and the infrastructure supporting it.

This work will continue and intensify over the coming years because investment in human capital development is viewed as pivotal to the success and sustainability of Ireland's national innovation system. This next phase is addressing a number of priorities, including:

› Research capacity, quality and output
› Investment in fourth level and the public research system
› Reform in the universities
› Better management of the research and innovation environments to ensure effective transfer of knowledge and technology.
› Two overarching goals are being pursued:
› To build up a sustainable system of world class research teams across all disciplines, but particularly in biotechnology and information and communication technology, in terms of people and supporting infrastructures,
› To double the annual output of PhDs in Science, Engineering and Technology by 2013.
› These goals are interlinked since the quality of both research and postgraduate formation is dependent on access to world-class principal investigators to lead teams of postdoctoral and postgraduate researchers.

To achieve these, further investments in research infrastructure will be made across the country to build on progress under the current NDP. The PRTLI continues to make significant investment in infrastructure. A further €230 million research investment was announced in 2007 under the fourth cycle of the PRTLI. The SSTI will address the remaining shortfall and provide for new infrastructure. The activity under the SSTI is complemented by the announcement in the 2006 Budget of €900m for a 5-year capital programme and a further €300m Strategic Innovation Fund (SIF). The Strategic Innovation Fund was introduced in 2006 and €130 million is to be allocated under the second call. Through an internationally peer-reviewed competitive tender, the SIF will support universities in increasing their capacity to produce high quality 3rd and 4th level outputs. It will be based on national priorities and individual institutional strengths as well as inter-institutional collaborations will be encouraged.

Research activity by more world-class well-structured research teams will be supported by the establishment of graduate schools which will ensure the more effective development of our researchers (e.g. with greater transferable professional skills training), shorter PhD duration and improved completion rates.

Sustainable career development for researchers is being tackled under the auspices of a special task force of the national Advisory Science Council which is due to report in 2007.

In addition to domestic activity, obstacles to the attraction of international of researchers are being addressed, e.g. through the Irish Researcher Mobility Centre, fast-track work permit arrangements for research and implementation of the Third Country Researchers Directive.

The governing bodies of several institutions have been undergoing several modifications, including the appointment of external chairpersons and greater representation of non-academic stakeholders. In addition, enhanced policies for both external and internal quality assurance procedures are being implemented across the universities.

SSTI Indicators

Number of new doctorates in science, engineering and technology earned annually to nearly double from 543 in 2005 to 997 in 2013.

Number of new doctorates in humanities and social sciences to increase from 187 in 2005 to 315 annually by 2013.

Ireland will significantly increase its performance in the publications league table (currently ranked 12th).

Ireland will aim to significantly enhance its performance on the citations index.

2. PRIVATE INVESTMENT IN R&D AND COMMERIALISATION

Manufacturing and international services will continue to be fundamental to Irish economic growth. Future opportunities primarily lie in the development of knowledge-intensive industry, both in terms of indigenous activity and in those element(s) of foreign direct investment that Ireland seeks to attract and embed. It also means greater use of technology in all sectors to improve productivity and competitiveness.

Business expenditure on R&D is increasing in absolute terms but relative to economic growth levels and international comparators remains weaker than desirable. There is therefore a strong push in the SSTI to engage a larger number of companies 'more' in R&D activity in Ireland. The key elements of this new approach are:

› Raising awareness and increasing the number of companies carrying out R&D,
› Improving soft support systems to secure the development of appropriate technology strategies by companies,
› Achieving step changes in quality and quantity of R&D activity in existing R&D performers,
› Building in-company technology capability,
› Increasing inter-company and industry-HEI collaboration,
› Simplifying the administrative and operational procedures of R&D programmes.

Consideration is currently being given to the improvement of the financial supports available for in-company R&D in order to deliver a more holistic and systematic offering to client companies. The tax credit for R&D introduced in 2004 is another important element of the portfolio of public support for enterprise R&D. The scheme (which is incremental and operates on a rolling baseline starting from 2003) was enhanced in the Finance Act 2007 and will be monitored to ensure that it is supporting the SSTI targets as effectively as possible.

This work is complemented by activity within the enterprise development agencies to enhance the 'soft supports' available to firms. For example, Enterprise Ireland recently rolled out its R&D Advocates: people with appropriate expertise and experience to contact and engage with firms who have not previously undertaken R&D. The IDA is running a new international promotional and marketing programme aimed at MNCs with operations in Ireland and those in target markets overseas.

Also on the international front, technology transfer from foreign sources will be enhanced through the TechSearch initiative and linkages between MNCs and SMEs in Ireland.

Industry-academia linkages are another critical part of the SSTI agenda. Initiatives such as Innovation Partnerships run by Enterprise Ireland over the course of the current NDP are being added to with fresh efforts to increase the levels of collaborative activity in Ireland (between firms and third level institutions and also between firms themselves). These include industry-led networks in which companies engage with each other to agree a shared strategic research agenda and then to select a research group(s) with whom to collaborate. The most recent examples of these are in the areas of functional foods and e-learning.

Further structured engagement between industry and academia will be supported through the establishment of competence centres similar to the existing Tyndall Institute in Cork and the newer National Institute for Bioprocessing Research and Training based in University College Dublin. Establishment of such centres will be based on the identification of strategically important technologies for Ireland.

The Institutes of Technology are a key resource for applied research and human capital development in the regions. The Applied Research Enhancement Initiative has recently been rolled out nationally to strengthen the research capability of the Institutes in areas relevant to regional enterprise needs. For example, an Applied Marine Biotechnology centre has been established at the Institute of Technology in Letterkenny, Co. Donegal.

SSTI Indicators

Business investment in R&D to increase to €2.5bn by 2013.

No. of indigenous companies with meaningful R&D (> €100,000) to increase to 1,050.

No. of indigenous companies with significant R&D (> €2m) to increase to 100.

No. of foreign affiliate companies with minimum scale R&D up to 520.

No. of foreign affiliate companies with significant R&D to grow to 150

Transfer of knowledge into market opportunities is a critical link in the innovation system and one to which Ireland is increasingly turning its attention. Returns on our growing research investments will be optimised through informed researchers, well-resourced and connected technology transfer offices and up-to-date expertise on the protection, management and commercialisation of emerging intellectual property.

A two-pronged approach will be employed to this end:

1. Third level institutions are being assisted to strengthen their IP/ commercialisation function by way of a €30m competitive Technology Transfer Office Fund. The Fund supports, inter alia:
   - Training for researchers on the importance and potential of technology transfer,
   - Recruitment of expert staff to engage in IP scouting, selection and protection.

   An essential criterion for institutions' success in securing funding under this mechanism is the importance that they attach to IP and commercialisation within their overall strategic mission.
2. A central unit has been set up in Enterprise Ireland to provide access for technology transfer offices to particular expertise and support, e.g. on legal matters, IP marketing.

A National Code of Practice for managing intellectual property from publicly funded research was launched in April 2004. This was followed in November 2005 with a Code of Practice for Managing and Commercialising IP from Public-Private Collaborative Research. Together these Codes provide a comprehensive set of guidelines for IP management and commercialisation and a framework for IP negotiations to facilitate the development of enterprise-academic relations.

SSTI Indicators

Within the context of the funding being provided to the third-level sector to strengthen research commercialisation, each research performing institution is being asked to set targets in the following areas:

- Financial and human resources devoted to technology transfer, IP management and other commercialisation activities,
- Number of invention disclosures reported,
- Number of patents applied for and granted,
- Number of patents generating revenue,
- Number of licence agreements with companies,

- Total revenues from licensing and fees from royalties,
- Number of actively trading spin-off firms established and their survival rates,
- Private sector investments in public research spin-offs,
- Number and size of industry-commissioned projects.

3. PUBLIC FUNDING OF S&T

As indicated above the Government has committed €8.2 bn over the period of the current National Development Plan 2007-2013 to achieve the SSTI. Over the lifetime of the NDP, the State will invest €6.1 billion in STI as detailed in the Programme areas below:

- World Class Research STI €3.46 billion
- Enterprise STI €1.29 billion
- Agri-Food Research €641 million
- Energy Research €149 million
- Marine Research €141 million
- Geo-science €33 million
- Health research €301 million
- Environment Research €93 million

The investment in human capital, physical infrastructure and commercialisation of research outlined above is complemented by investment in initiatives set out in the NDP allocations for Higher Education and the Industrial Development Agency. Taking account of these amounts, the global NDP investment in STI amounts to €8.2 billion.

Within the framework of World Class Research, Science Foundation Ireland (SFI) will commit €1.46 bn in strategic areas relevant to economic development, particularly the areas of Biotechnology and Information Communications Technologies. The new Programme for Government includes a commitment to include a third research pillar in the area of sustainable energy and energy efficiency technologies within the remit of Science Foundation Ireland.

One of SFI's most significant programmes is the Centres for Science, Engineering and Technology (CSETs) which links researchers in academia and industry. CSET grants can be up to €25m over five years. The objective of this programme is to have centres that can dramatically advance knowledge, exploit opportunities for discovery and innovation as no smaller research project can, link academic and industry researchers in promising ways, generate products of considerable value in the marketplace, and contribute to the public's understanding of and interest in science and technology.

SFI currently supports seven CSETs – four in the ICT sector and three in the Biotechnology sector involving research partnerships between Irish Universities and multi-national companies.

Significant areas of sectoral research right across the various realms of Government activity hold strong potential to deliver socio-economic progress for Ireland. These include:

Agriculture and food: RTDI has a key role to play in the sustainable development of the sector and research funding provided is being focused even more on identified sectoral needs and its future competitiveness. Stronger links with other relevant research activity will be promoted, e.g. on agri-environment issues.

Health: Strong research competence is essential to the future delivery in Ireland of world-class healthcare and the recruitment of top professionals. In 2006, the Advisory Science Council published a review of key policy requirements in the sector (*Towards Better Health: Achieving a Step Change in Health Research in Ireland*) and recommended, *inter alia,* the establishment of a number of translational research centres, with a view to strengthening health research and policy research capacity and addressing strategic national priorities. A Health Research Group has now been established to advise on the formulation and implementation of a comprehensive health research strategy.

Environment: Future research in Ireland will focus on addressing changing circumstances and generating new knowledge of the environment and environmental technologies. These will be assisted by the development of an environmental research centre.

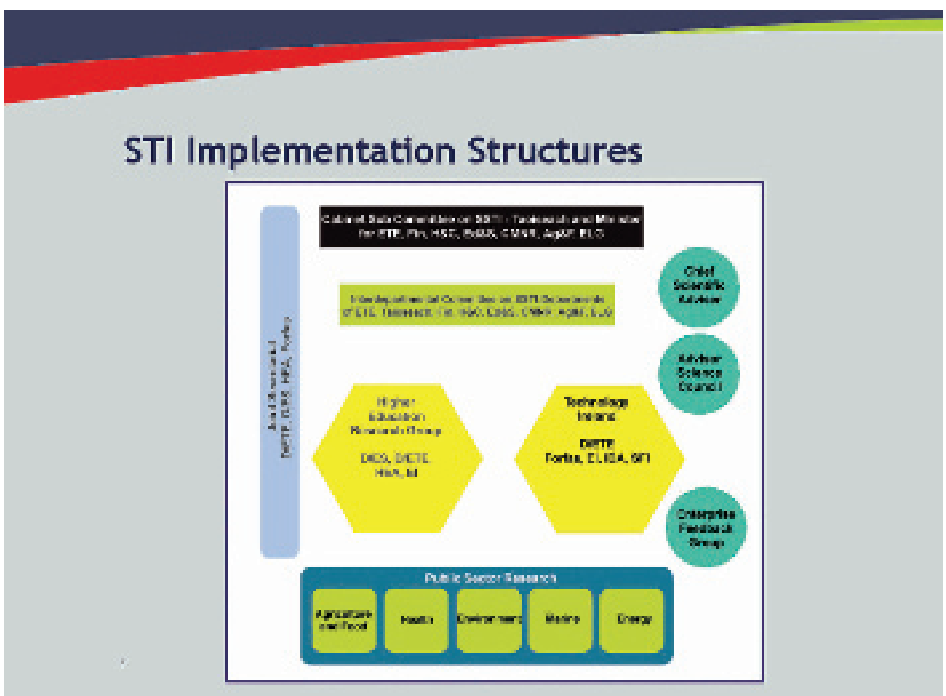
Marine: the Marine Institute's strategy for the period to 2013 aims to deliver an integrated research and innovation programme that prioritises (i) activity within existing industry, (ii) the development of new research capability and (iii) policy support research.

Energy: the energy sector is characterised by high dependency on imported fuels and international environmental obligations. Work on the articulation of national energy policy is underway and thematic areas will include Smart Grids, the rational use of energy, wind energy, marine energy and biomass for heat and fuel. The dependence of enterprise and the economy on cost-effective energy supply is increasingly being viewed as a national priority.

4. POLICY OVERSIGHT AND REVIEW

In order to ensure implementation of the SSTI objectives effective policy oversight and review is essential. The Inter-Departmental Committee (IDC) for STI, reporting to the Cabinet Sub-Committee, has overall responsibility for the implementation of the SSTI for which there is a total budget of €8.2 bn over the period to 2013. Its key role is in assessing progress against indicators as set out above.

In addition to the inputs of the Advisory Science Council and the Chief Scientific Advisor, the IDC is supported by implementation groups composed of representatives from the relevant Departments and related agencies. The Higher Education Research Group has responsibility for ensuring coherence among key funding initiatives such as PRTLI and the funding awards schemes of the relevant agencies and councils. Technology Ireland is responsible for enterprise R&D activity. The IDC and implementation groups are backed up by a Joint Secretariat comprised of representatives from the Department of Enterprise, Trade and Employment, the Department of Education and Science, Forfas and the Higher Education Authority.



The Future of Science & Technology in Europe

Lithuania

Virginija Būdienė

Vice Minister of Education and Science

Virginija Būdienė

The future of science & technology in Lithuania

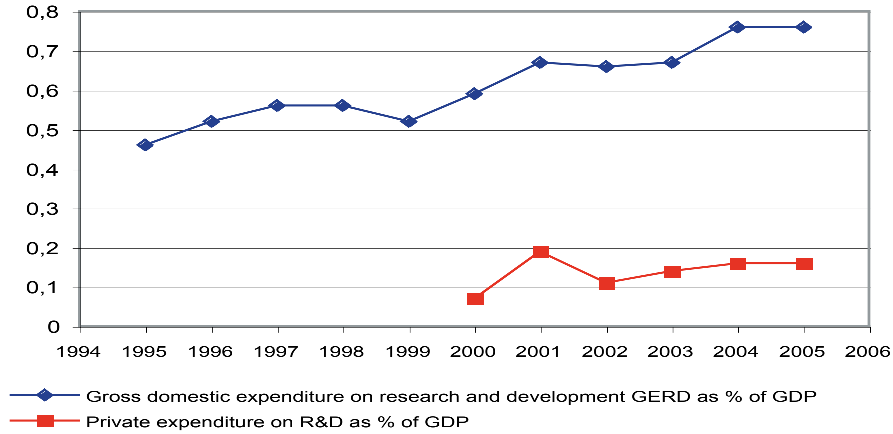
I. BACKGROUND SITUATION

Lithuania's name has been known to the civilized world for at least a thousand years. During its long history, it had been fighting hard to remain a recognized country on the map of the world. Now, Lithuania, with the help of the European Union, is doing its best to enhance a stable and intellectual status within Europe's geographical footprint.

Lithuania's economy has a GDP per capita of 50.9 % of the EU average in 2005 (Eurostat, 2006). Its growth, however, in GDP 2000-2005 has been considerably higher than the EU average. In 2005, it was 6.5 % compared to 2.3 % on EU average (World Bank Report, 2005).

In 2005, the country invested 0.76% of its GDP on R&D (EU average is 1.85%). The share of public R&D expenditure in GDP is 0.6% but there is a tendency to grow (Fig. 1). We expect that the situation will improve, to a large extent due to Structural Funds resources, as within the new Structural Funds period (2007-2013) the share of financing earmarked to R&D and higher education will be approximately 14.5% from the whole Structural Funds budget allocated to Lithuania.

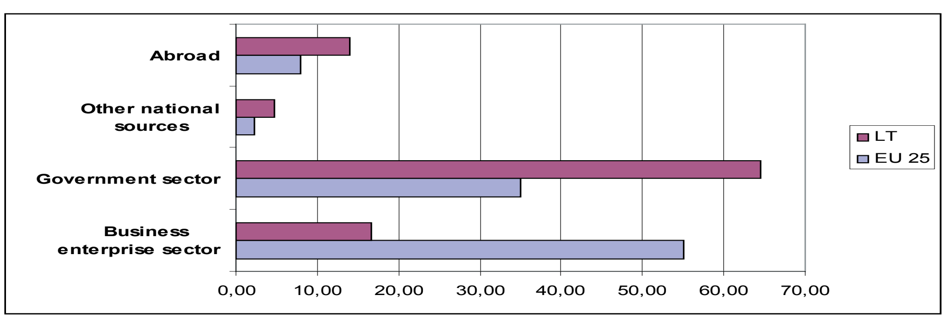
Figure 1 › The expenditure of GERD



Source: Department of Statistics under the Government of the Republic of Lithuania

Concerning private expenditure on R&D in Lithuania in 2005 business spent 0.16% of GDP for research (18.5 million), compared to 1.18 % on the EU average (Fig. 2). Accordingly, the share of researchers in business employment is so far insignificant. However, discussions show that real private expenditure on R&D may be considerably higher. This could be explained by the fact that business is not interested declaring its R&D expenditure due to the lack of fiscal incentives.

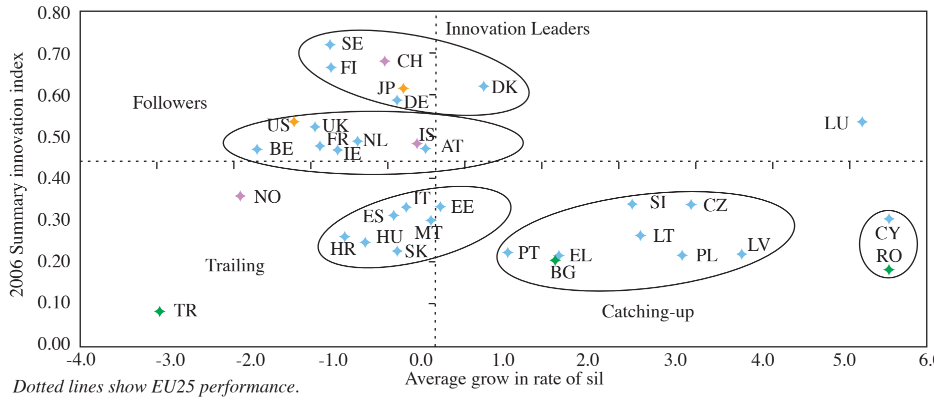
Figure 2 › **The distribution of R&D financing in Lithuania compared to EU 25.**



Source: Eurostat (2007)

Measured by the Summary Innovation Index, Lithuania is a catching-up country, with the overall level still beyond the EU average, but with a strong upward dynamics (Fig. 3).

Figure 3 › **Summary Innovation Index and Trends**



Dotted lines show EU25 performance.

Source: European Innovation Scoreboard, 2006

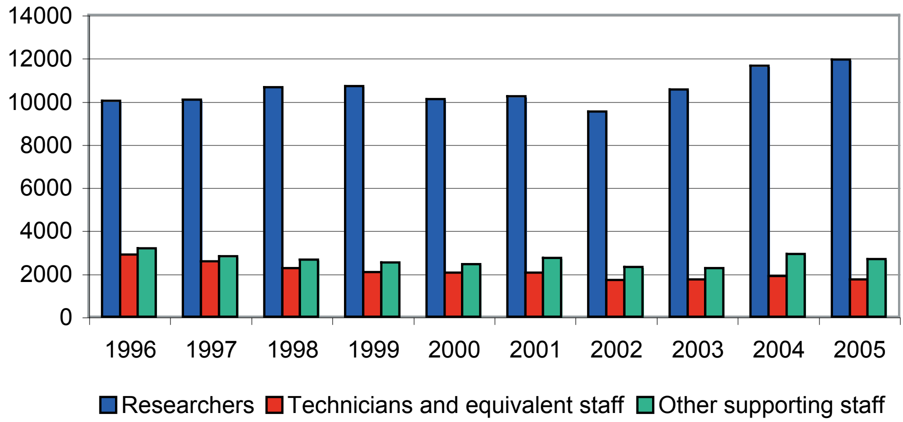
Compared to other new member states of the EU (accession 2004), Lithuania has a considerable number of companies that are innovative (23.4% in 2002-2004), they employ around 45 percent of all the employees. Although only every fourth national company has been carrying out innovative activities, the turnover of these companies is more than a half of the total turnover (56.9 percent in 2004. Source: Department of Statistics under the Government of Lithuania).

At present, the Lithuanian innovation system is oriented to innovation distribution, modification of technologies and their adaptation to market needs. Lithuania is ranked in position six according to applied innovation, and it ranks 19th according to research based creative innovations. However, as a rule, Lithuanian companies adapt imported new technologies to their needs.

R&D and university education are carried out at 15 state and 6 private universities, 18 university institutes, 17 state research institutes, and 8 state research establishments. Despite a high number of institutions and, consequently, related quality, effectiveness and efficiency issues, Lithuania is among the countries with a high number of population with tertiary education that is above the EU average. This is a sound basis for the renewal of R&D human resources.

In terms of personnel for R&D in general, Lithuania is catching up (Fig. 4): the annual growth rate of R&D personnel was 4.5 % in 2005 (compared to 1.3 % at EU level), and the growth rate of researchers was 6.5 %. (EU - 3.0 %). In 2004, there was 4.5 researchers per 1000 labour force (EU 25 average – 5.5) (Eurostat, OECD).

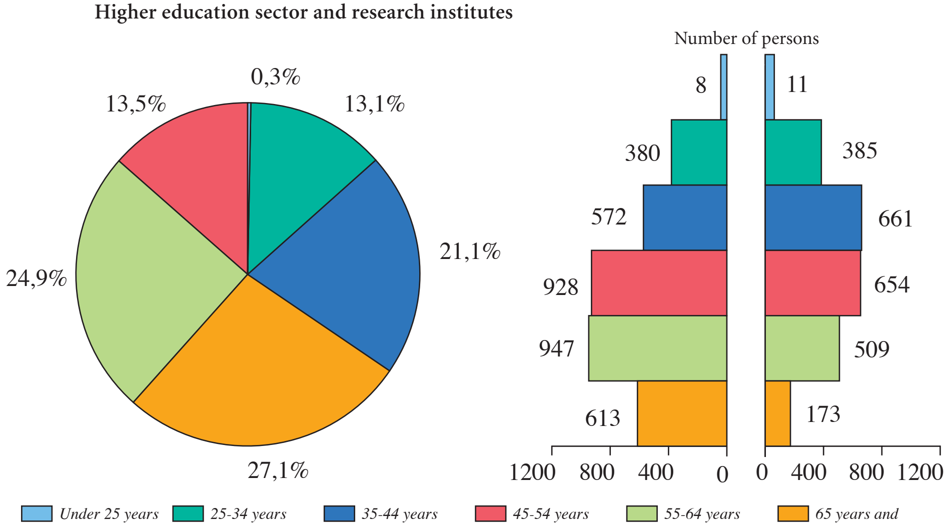
Figure 4 › **R&D personnel**



Source: Department of Statistics under the Government of the Republic of Lithuania

However, the age structure of the public research and higher education staff in Lithuania as in many other EU countries is an issue as well: over 50 % of scientists are older than 50 years of age (Fig. 5). The diminishing social status and low income level of public researchers are the main reasons why a researcher's career is not attractive to young people.

Figure 5 › **Researchers with title and scientific degree by age and sex, 2006**
Higher education sector and research institutes

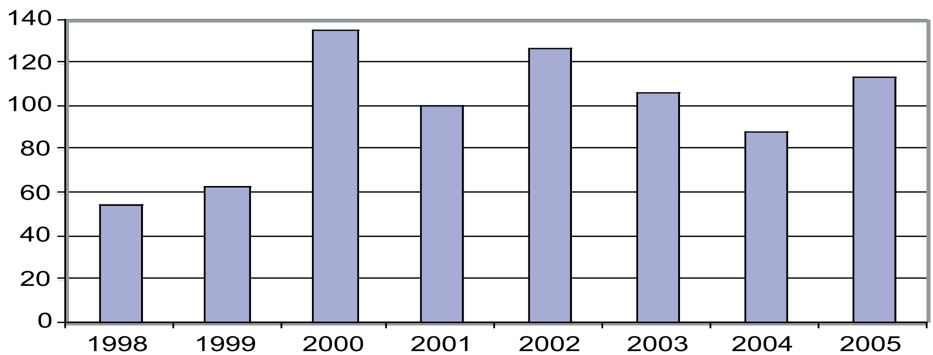


Source: Department of Statistics under the Government of the Republic of Lithuania, 2006

The system thus produces insufficient number of PhDs in order to make up for the retirement of scientists (150 PhDs per one million inhabitants are produced per year, 300-400 would be needed) (Fig. 6).

Furthermore, Lithuania, like other new EU comers, suffers from a net loss of talent in research.

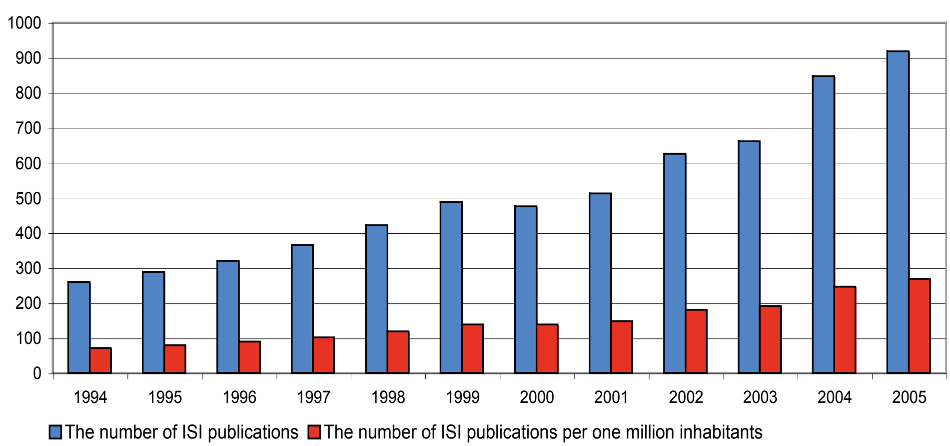
Figure 6 › **The number of PhD awards per million inhabitants**



Source: Department of Statistics under the Government of the Republic of Lithuania

The number of publications in the ISI Science Citation Index per 1 million inhabitants is still not high but with a clear catching up tendency (Fig. 7).

Figure 7 › **The variation of the number of ISI publications**



Source: Lithuanian Science Council, 2007

The areas where Lithuania claims to have the most specific strength are biotechnology, laser technology, biochemistry, chemistry, mathematics, physics, material sciences and environmental protection.

In respect of research and industry connections, the level of cooperation or strategic interaction between university and business is rather low. This has to do both with low responsiveness of the science base and with the lack of initiative and absorptive capacity in industry and subsequently with a low demand for the output of research carried out at the universities and research institutes.

II. MAIN OBJECTIVES OF THE R&D REFORM

Lithuania has a national R&D Strategy (2002-2015), the aim of which is to create favourable conditions in order to increase R&D investment, promote research and business relations, and strengthen human resources. The main goals of the strategy are detailed in the National Lisbon Strategy Implementation Programme. The Programme was prepared in close cooperation with the research and business community and social partners. The stakeholders active participate in implementation of the Programme. The major goals of the Programme are to:

› Increase the R&D expenditure to 2 % of GDP by 2010; private sector investment in R&D should reach 1 % of GDP.
› Achieve a 20 % of GDP share of high-tech industries by 2010.
› Raise the computer literacy rate to 70 % during the first 5 years.
› Integrate the R&D system of Lithuania in ERA and use the EU Structural Funds for research and development.
› Strengthen the level of strategic intelligence in order to support policy making.
› Invest in human resources and keep in and fully use the intellectual potential of the country.
› Integrate into global knowledge creation and benefit from it.

MAJOR STEPS TO INCREASE PUBLIC INVESTMENT IN R&D

A new concept of Lithuanian Higher Education and R&D Reform has been developed in order to realize the National Lisbon Strategy Implementation Programme and to achieve objectives set up in other national strategic documents on R&D and higher education. It foresees new principles of governance and financing of R&D and higher education, measures for strengthening of R&D human resources, developing closer partnerships between science and business and implementing structural changes in the institutional system of HE and R&D. The goals are the following:

› Strengthening of the coordination and the governance of the R&D and innovation systems.
› Development and implementation of the national research programmes system on a competitive basis.
› Improvement and development of modern research infrastructure and knowledge transfer between research and business sectors.
› Introduction of special support measures for scientific centres of excellence and centres of competence in major sectors of industry.
› Development and strengthening of human resources in R&D and HE sectors through national grant schemes and support for young researchers.

The agreement of political parties on the basic principles of Research and Higher Education Reform was signed in June 2007. In the area of R&D, the agreement includes the following:

› Introduction of a programme- and competition- based funding system.
› Increase of investment in R&D from the national budget and other sources, reaching the average of the EU Member States by 2012.
› Setting-up of the Science Policy Committee chaired by the Prime Minister.
› Restructuring of the Lithuanian Science Council into a research funding institution.
› Creation and support for integrated research, higher education and business centres (valleys), centres of excellence, national integrated programmes, science – economy interface, international integration of the Lithuanian research and higher education.
› Support for the modernization of research and higher education infrastructure.

The first structural changes have been made already. The reorganization of the Lithuanian Science Council has been approved by the Lithuanian Parliament. The reformed Lithuanian Science Council will be responsible for the implementation of the model of R&D tender-and programme-based financing as well as for the support for centres of excellence and competitive grant schemes for young and established scientists. The new role of the Council was jointly developed by the

Lithuanian Science Council, the Ministry of Education and Science, and the Ministry of Economy.

Another significant step towards the implementation of the Reform is the preparation of new legislation. At the moment (November 2007), two new draft laws are under discussion by political and administrative actors and stakeholders of the Lithuanian national innovation system: The Law on Science and Higher Education and the Law on Management and Use of Property of Public Higher Education Establishments.

The new RTDI governing and financial structure is based on the efficient use of state budget allocations and structural funds schemes and it will improve strategic administrative capacities in the RTDI sector and strengthen the quality of R&D activities. Moreover, it is proposed to revitalize the Science, Technology and Innovation Development Council chaired by the Prime Minister, which would promote horizontal R&D development and involve more representatives from public and private sectors, the scientific community and society.

We expect that the model of programme financing on a competitive basis will create favourable conditions for excellent researchers to apply their talents and potential and improve their financial situation. As a result, the profession of a researcher might become more attractive and popular.

A working group on Lithuanian research infrastructure development strategy was formed. It is working on a stocktaking exercise of the existing infrastructure and preparing Lithuanian national research infrastructure roadmap and defining national needs to join the European infrastructures. The ongoing survey will provide recommendations on the reform of the Lithuanian research institutions network and concentration of national research potential. It will also help decide how to restructure public research institutions and where to concentrate the public funding for R&D.

Under the supervision of the Ministry of Economy, the first Economy Foresight Study has been carried out in Lithuania. It aroused wide debate among interested groups. And the discussions are still going on about what would be of the utmost benefit to the state and society: either to focus on high technology sub-sectors or on balanced development of the traditional industries together with horizontal development of high technologies.

The strategic policy development process is to be continued. It is foreseen to prepare a long-term science and innovation system development strategy in 2008, which would coordinate and update the existing strategic documents, new initiatives and instruments for their implementation.

MAJOR STEPS TO INCREASE PRIVATE INVESTMENT IN R&D

It is foreseen by the National Lisbon Strategy Implementation Programme to reach the 2 % R&D target by 2010 by equal shares from public and private sectors. As the first step to increase the R&D private and industry investment, the Ministry of Economy has carried out a feasibility study on the commercialization of science. The aim of the study is to create the whole chain of mechanisms: from obtaining scientific results to their commercialization. On the basis of the findings and recommendations of the study, the Ministry of Economy is drafting a new Innovation Development Programme.

The Programme will include legal and fiscal measures to promote private R&D investment. Such measures as effective profit tax incentives, draft amendment on profit tax law, voucher system for consultant services and others would stimulate companies to additionally invest in R&D.

Another important instrument for the coordination of science and business interests to implement the Lisbon Strategy is the Structural Funds Programme. It provides the basic policy guidelines for effective and efficient use of the Structural Funds for R&D activities. The measures foreseen in the Programme are coordinated by the Ministry of Education and Science and the Ministry of Economy and are intended to promote synergy between public and private investment in R&D. In view of the implementation of the Programme, three separate programmes are intended for R&D. Two programmes will deal with the issue of increasing private business and industry R&D investment:

› The National R&D Programme for Cooperation between Public R&D and Business Sectors has been prepared. The Programme is aimed at strengthening research capacities for research intensive businesses and ensuring closer links between research and business sectors. It will also indicate the science base where we have excellent capacities and potential and increase the R&D in industry and private business.
› Furthermore, the National Integrated Programmes will help, by means of the Structural Funds, increase the competitiveness of the Lithuanian economy in an integrated way, by focusing on and developing research intensive business sectors. National Integrated Programmes involve the updating of study programmes and research infrastructures in strategic R&D technology areas with scientific and/or

production potential; they define measures on how to use financial assistance for preparation of excellent experts, implementing R&D programmes and strengthening cooperation between science and business sectors.

Simultaneously, the Programme for Establishment and Development of Integrated Research, Study and Innovation Centres (Valleys) has been developed and approved by the Government in March 2007. After consultation with international experts, five valley visions will be further developed and selected for implementation using both the Structural Funds and budget allocations. The public investments in the centres are expected to form the basis for knowledge economic-clusters and help attract not only higher national knowledge intensive, business resources but also international companies which are interested in professional resources in R&D and HE sector.

The financial measures related to the development and strengthening of scientific excellence, establishment of the centres of excellence, creation of national infrastructures, integration of science and universities and optimization of internal institutional governance structures are foreseen in the above mentioned Structural Funds Programmes.

Also, as one of the components of the R&D reform, the above mentioned amendment to the law on property has been proposed which, if adopted, will enable the universities to have at their disposal the results of their research activities, including intellectual property rights and commercial results.

It should also be noted that representatives of the science and business communities are successfully cooperating in establishing the Technology Platforms. This process started rather recently, in 2006, and is very intense: with the financial support of the Ministry of Economy, 28 national Technology Platforms have been created, most of which are involved in the activities of the European Technology Platforms. The platforms collaborated and participated in the preparation of the national integrated programmes mentioned above. At the moment, 10 feasibility studies of these programmes are under evaluation. Together with integrated research, study and innovation centres (valleys), these programmes are expected to constitute the basis for research and business cooperation in the future.

MAJOR STEPS TO STRENGTHEN HUMAN RESOURCES FOR R&D

To strengthen the public research base and human resources, the reform foresees certain changes in the internal institutional governance and network as well as creation of a support system for raising a new generation of researchers, solving the problem of brain return and brain circulation.

The third programme of the Structural Funds in R&D sector is the Researchers Career Programme. It will significantly help solve the issues related to the qualitative and quantitative development of R&D human resources. Measures to enhance the competence of researchers in all career paths, to increase inter-sectoral and international mobility and to promote public awareness of science and technologies are planned. It will also provide PhDs and young researchers with grants, that will create new working places, ensure favourable working environment and reduce 'brain drain' from Lithuania. The programme to regain our 'brain' is under preparation now. Special grants will be provided for researchers employed in business and industry sectors.

Given the fact that the level of salaries for researchers and teachers is still very low, recently the increase of about 50 per cent of salaries for the least paid researchers took place. This measure in combination with the above mentioned tender- and programme-based financing scheme will help increase the income of young researchers, PhD students and post-docs. The post-doc system has been implemented by the Lithuanian Studies and Science Foundation since 2006.

In conclusion, the wish of the scientific, political and business communities and society at large to reform the research and higher education system has been in the air and under discussion in Lithuania for years already. But everybody understands that reforms are not carried out in one night and that patience and time for them are needed. Now, there is a feeling that Lithuania has already matured enough for dramatic changes in research and higher education fields. We strongly believe that it will happen and will benefit our country and contribute to the common goals of the EU.

The Future of Science & Technology in Europe

Switzerland

Charles Kleiber

State Secretary for Education and Research

The future of science and technology in Europe: a Swiss contribution

Charles Kleiber

1. INTRODUCTION:

The Europe of knowledge as a necessity

There will be no sustained development in Swiss science and technology without a strong integration into the European area of education, research and innovation. Switzerland needs Europe, yet we are also convinced that Swiss creativity in science and technology, confirmed by many indicators, can be useful to Europe.

Switzerland with its twenty-six canton-states, its three national languages and cultures is in a sense a small mirror of Europe; our experience of creating one national space while respecting the sovereignty of the cantons can be a laboratory for Europe.

Knowledge must be anchored within culture. Yet this culture cannot be a global one, for has to link us to our past, and open us to our future. It has an identity, and this identity is Europe.

2. WHERE DO WE STAND:

Switzerland meets the Lisbon agenda

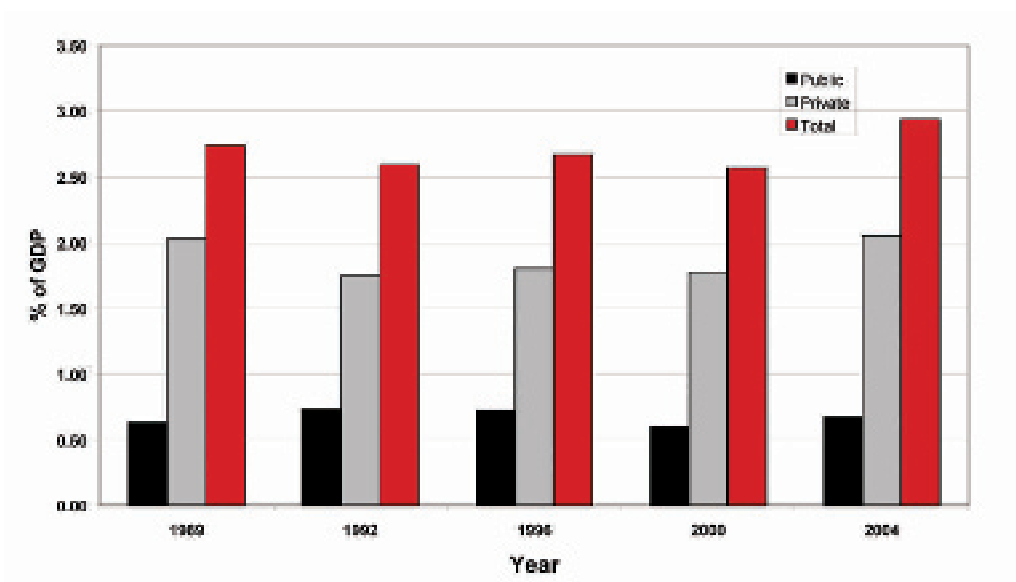
1. Private and public R&D investment

Switzerland R&D investment is increasing. In 2004, – the year of the latest survey – the total (gross) R&D investment in Switzerland was 2.94% of GDP. It is safe to state that by 2006, Switzerland will have reached the Lisbon goals of gross R&D investment, since this investment has been increasing since 2000 (**Fig. 1**) . The driving force of this increase is private investment; private investment was decreasing in the nineties, but has since been building up. In 2004, private R&D investment represented 70% of total R&D investment, amounting to 2.06% of GDP; private R&D investment reaches the Lisbon goal. Public R&D investment represents 0.68% of GDP.

Three additional considerations on Swiss R&D investment.

1. Private R&D is dominated by the pharmaceutical sector, and amounts to two thirds of total private R&D; in addition, two multinational companies, Roche and Novartis, account for the bulk of pharmaceutical R&D.
2. Swiss SMEs are very innovative, but many small SMEs do not engage spontaneously in R&D. A lot of effort has been devoted to foster technological transfer from universities to enterprises; technology offices that allow these SMEs to pull knowledge from the research centers have also been put into place.
3. Switzerland can boast of having reached the "3% goal" of the Lisbon agenda; yet similar countries whose prosperity lies, as for Switzerland, in the added-value of high-tech goods, have invested much more in R&D, notably at the public level and reach now the 4% GDP level of gross R&D. Switzerland is far from catching up, since the annual growth rates of R&D investment, both gross and business R&D, are below OECD average.

Figure 1 › **R&D Investment in Switzerland**



In 2004, the total R&D investment in Switzerland was 2.94% of GDP (red bars); private R&D investment was 2.06% (70% of total; grey bars). It is safe to state that by 2006, Switzerland will have reached both Lisbon goals of total and private R&D investment.

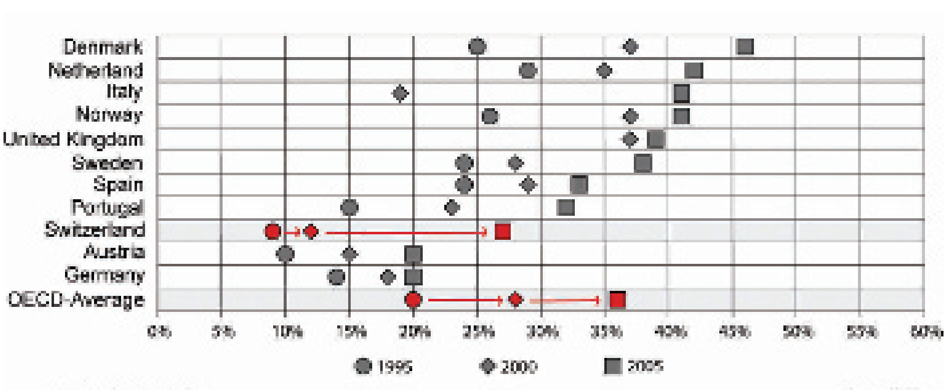
2. Human resources

a) Importance of tertiary education

Switzerland enters the knowledge society. In 2005, 27% of the population of diplomaage possessed a **tertiary** diploma (Cite 5A and 6, see **Fig 2**). This is still 10 percentage points below OECD average, but Switzerland has increased the university diploma rate from less than 10% in 1995 to 27% in 2005, one of the fastest increases in Europe; the establishment of universities of applied sciences has played a driving role in this endeavor. With Portugal and Sweden, Switzerland holds also the highest doctoral graduation rates of the OECD, twice as high as the OECD average.

Education of scientists and engineers. In 2004, 25% of all new degrees awarded in Switzerland were in science and engineering (S-E); although the share is declining, it still higher than the OECD average (21 %). In absolute terms, S-E student numbers increase thanks to influx of foreign students: the number of Swiss nationals in engineering studies has remained constant for the past 20 years, while the number of foreign students has quadrupled. The same trend holds for the natural and technical sciences: a 28% increase in twenty years of Swiss students, but a 226% increase of foreign students. Interestingly, the trend is different for social sciences and humanities (+73% of Swiss students, + 54% of foreign students, since 1986).

Figure 2 › **Tertiary diplomas (ISCED 5A; 1995, 2000, 2005). Rate of first diploma as pecentage of typical age group**



Switzerland has launched an important effort for tertiary (ISCED 5A and 6) education. The rates of tertiary graduates (as compared to age group) are still below the OECD average, but from 1995 to 2006, this rate has moved from 9% to 27%, notably with the development of the universities of applied sciences.

b) Science and Technology workforce

The Swiss science and technology (S-T) workforce grows in importance.
S-T employment has grown by about 30% since 2000. This hints to a structural evolution toward knowledge society. This is also suggested by the declining numbers of persons working in S-T domains without a prior S-T training, and the declining numbers outside S-T domains. In 2005, 37% of total employment was attributable to human resources in S-T (HRST) occupations; the EU27 average is at 29%. The average annual growth rate of HRST occupations is however lower in Switzerland than in the EU.

All in all, Switzerland belongs to the top countries in terms of HRST; notably, the share of HRST employees in services (45%) is among the highest in Europe.

c) R&D workforce and researchers:

Stable research force. In 2005, Switzerland had 13 R&D personnel per 1000 employment, slightly over the EU27 average (2004) of 10, but much less than most of our comparator countries (e.g. Scandinavian countries). Moreover, the annual growth rate of R&D personnel, for the past 10 years was barely 0.2 %, as compared to over 2% for the EU27.

On the research side only, Switzerland has about 6 researchers per 1000 total employment, half of which are employed in business enterprises. This is below the OECD average (7.5). The annual growth rate (1996-2006) of the R&D workforce was less than 2% in Switzerland, as compared to nearly 4% for the EU27; these lower growth rates affect both public and private enterprises.

d) Gender aspects of science and technology workforce

Switzerland presents an important gender imbalance in S-T. For instance, 23% of the male student population have a diploma in the S-T domain (the EU27 average is 25%); but it is only 15% for the female student population, that is half the EU27 average of 31%!

The same imbalance affects the S-T workforce. In 2006, two thirds of the S-T educated population were men, and men represented 60% of the S-T active population. But ongoing efforts in universities and gender specific federal programs bear some fruit: the average annual growth rate of HRST occupations in Switzerland in the period 1996-2006 is much higher for women (around 3%) than for men (about 2%).
The gender difference remains a concern.

e) Internationalization of S-T workforce

Switzerland is a small but open country and has always had an important quota of international students and an important international workforce.

Internationalization of S-E studies. Switzerland has the highest share of foreign doctoral students in the world. In fact, for S-E studies, Swiss students are now a minority since close to 60% of doctoral students in these domains are foreign. Underlying Switzerland's attractivity are on the one hand the quality of teaching and research at Swiss universities, and on the other, the salaries offered.

Internationalization of the highly skilled. Over 30% of the R&D personnel at universities and in firms are foreign. Foreign R&D personnel have very good training and are twice as likely to have a tertiary degree as the Swiss R&D personnel.

As for the S-T workforce, 18% of the total of employed professionals and technicians was foreign (2001); this is double the OECD average of 9%. At the same time, 7% of the highly skilled Swiss workforce migrated to other OECD countries; this outflow is also double the average outflow of OECD countries. Switzerland is therefore best characterized by strong *brain circulation*, and this brain flow is beneficial to both the countries that send highly skilled, and to those that receive them.

Interestingly, recruitment of foreign highly skilled workforce is especially vigorous for business leaders: in 2006, more than one fifth of leaders were foreign-trained. And two fifths of the top one hundred enterprises in Switzerland have a CEO that is foreign-trained.

f) Career perspectives of researchers and international mobility

Remuneration of researchers in the public and private commercial sectors is among the highest in Europe according to a study commissioned by the DG Research in 2007. Total annual salaries (standardized for purchasing power) amount to 59 902 € in Switzerland, as compared to 40 126 € in EU 25 and 62 793 € in the USA. Moreover, Switzerland shares with the Netherlands and Ireland the best progression of salaries along the research career. In Switzerland, the relative earnings by level of education are among the highest for tertiary education within the OECD. Maintaining these good scores on career perspectives seems to us paramount if we want to attract young people, and especially women into S-E tracks.

3. *S&T investment*

The S&T investment of Switzerland for the coming four years is packaged in a science policy dispatch entitled "Message d'encouragement pour la formation, la recherche et l'innovation pour les années 2008 à 2011", that the Swiss parliament adopted in October 2007. The Swiss government and the Swiss parliament consider education, research and innovation to be of strategic importance for the development of society and for economic prosperity.

Therefore, an annual increase of 6% of public investment in education and research was decided, for a period of 4 years. This fostering of education, research and innovation for the years 2008 to 2011 will cost 11.8 billion €. Compared to the 9.9 billion € available for 2004-2007, the budget is increased by 1.9 billion €.

The strategy of the federal government is to *stimulate competitiveness and growth* in research and innovation. The following priorities have been decided for the coming four years:

- › Invest in free basic research to consolidate the position of Switzerland as a « laboratory for ideas » with international impact;
- › Encourage knowledge transfer form higher education institutes to firms; support promising practice-oriented research projects;
- › Support professorships for promising young researchers;
- › Support the Swiss Institutes of Technology, whose institutes present a model of excellence in quality and performance for all Swiss universities;
- › Strengthen universities of applied sciences as well as professional training in order to create a solid professional and technical base for our economy;
- › Create the best framework conditions for education, research and innovation by linking Switzerland to European projects, processes and organizations.

4. *Conclusion: where do we stand?*

1. S–T investment: Switzerland has made a clear public and political priority with a 6% yearly increase of S-T investments for the next 4 years;
2. R&D investment: Lisbon targets for total and private R&D investments are reached; countries of comparison however have already surpassed the goal and Switzerland should not and cannot stop there.

3. S-T resources: Switzerland has a very internationalized S-T human capital, be it students, researchers, R&D personnel or the S-T workforce. Switzerland is just average in output of S-T graduates it educates, and is underperforming – by EU standards - in recruiting women into S-T careers.

3. WHERE SWITZERLAND WANTS TO GO

Swiss perspective as nation of education and research

The future of Swiss science and technology, and also of higher education is linked to our capacity of integrating European dynamics and initiatives. Three strategic objectives are developed; all three will only be sustainable if they are in tune with European developments.

a) Create a national knowledge area

"The Confederation and the cantons shall, within the scope of their powers, jointly ensure the high quality and accessibility of the Swiss Learning Area. They shall coordinate their efforts and ensure their cooperation through joint administrative bodies and other measures." This constitutional amendment was adopted in May 2006 by the Swiss people. Despite political fragmentation of Switzerland into cantons, and their historical responsibilities in higher education, Switzerland is decided to build a national area for higher education. This area is to be open to Europe and the world.

The governing principle is to regulate only the domains of interdependence (where decisions by one stakeholder influence the other stakeholders) and leave the rest either to the institutions of higher education themselves or to their canton.

The domains where the joint decisions will be taken are defined as follows:

1. Establishing common standards of quality assurance. Since universities are the solely responsible for quality of education and research, quality assurance implies autonomy of the institutions. The common standards ensure that institutional conditions for creativity are in place.
2. Establishing the general framework of tertiary education (e.g. Bologna process), including gangways between general and vocational courses of studies.
3. Establishing standard funding principles, both for basic and competitive funding.
4. Establishing strategic planning in particularly cost-intensive fields.

b) Empower universities as drivers of knowledge

In our view, the basis of the knowledge society are flourishing, autonomous and socially responsible universities. Universities must develop into public enterprises of knowledge. In order to fulfill their tasks, they must:

1. be **autonomous**: have a good governance and be able to develop and implement their own academic strategy;
2. be **sustainable**: financial support and incentives should push universities into entrepreneurship through three different support mechanisms :
   1. a base funding, a financial input that guarantees stability. It can slowly evolve as a function of defined inputs (e.g. student numbers);
   2. competitive funding, both national and European, based on research performance (notably research projects). This competitive funding is a warrant for creativity and entrepreneurial spirit;
   3. financial incentives to cooperation between universities and portfolio development (to ease priority setting). Switzerland has introduced this kind of financing 8 years ago and made excellent progress.

c) Develop European regions of knowledge

It is our conviction that regions more than nations will be the engines of the knowledge society. There are three regions of great importance for Switzerland:

1. Lake Geneva-Grenoble-Lyon region, a European powerhouse which comprises top European research centers, innovative firms, medical faculties and hospitals;
2. Zurich-Basel-Upper Rhine Valley, a powerful region comprising Zurich with outstanding universities, financial power, and the pharmaceutical powerhouse of Basel with the combined « biovalley » extending to some of the best German universities;
3. Ticino and upper Italy (Lombardy – Piemonte – Milano) a region with strong cooperation between Swiss and Italian universities.

The success of these “regions transfrontalières” depends critically on the EU which can, through financial incentives and common regulatory frameworks, push these regions to be centers of excellence able to pull much larger regions.

4. WHAT DO WE EXPECT FROM THE EU?

Create a single space for training, research and innovation based on national areas

In higher education and research, the autonomy and high authority of nations must be respected. But the EU should push the member (and associated) states to become nations of knowledge and innovation; the EU would interfere only where the intervention brings added value, namely in interdependences. This implies a limitation of political and administrative coordination at the European level; and at this level, education and research policies should be simplified and integrated into a single process. In this sense, a simplification and reinforcement of the framework programs is in order.

We think it important to take initiatives at three levels: regions (of knowledge), institutions (universities) and people (mobility).

a) Foster regions of knowledge

Foster the emergence of knowledge regions rich in companies and institutions of higher education and research that can create an "ecosystem of knowledge" where its member can learn through "osmosis", through the easy and daily exchange of views and products. Set up a process to select and strengthen knowledge regions that offer the potential for innovation, by devising an open and competitive list; it is unnecessary to create new instruments; rather, existing instruments should be used in this perspective.

b) Empower universities

The central role of universities seems to be underrated in European research policy. A few thoughts to give them more power and responsibilities.

Autonomy: we must instigate universities to take on greater autonomy and responsibility, based on competitive funding linked to performance.

Excellence: as many European universities as possible should be pushed into the world champions league; they, in turn, will pull the European Knowledge Area as a whole to higher performance. In this sense the development of the EIT is good news, if it is able to select and improve the great European universities so that they become global universities, on the basis of an open and competitive list.

Financial incentives: use economic incentives to stimulate quality; reward national and institutional initiatives aimed at reinforcing the European Area of Knowledge.

These financial incentives should be outcome oriented and "Help those who help themselves". At the national level also, financial incentives should be competitive; a coordination of financial incentives at European seems desirable. The ERC is one such success story where excellence becomes a driver for the whole European area, and its resources for projects and junior scientists should be vastly increased.

c) Encourage brain mobility

Ensure that the education and training provided by the great European institutions radiate outwards through networks of cooperation and affiliation with other universities. Encourage mobility by regulating portability of scholarships of all levels, including for top-level researchers, and by increasing resources for all mobility programs, notably in the science and technology area.

These possibilities should contribute to the attractiveness of S-E studies: young Europeans should, through communication and exchanges, understand that science, in the twenty first century, is both indispensable to our survival and directly useful to solve the major challenges of our planet.

4. WHAT CAN WE OFFER THE EU?

Pragmatism and openness

Switzerland wants to be a good partner for the EU in S-T. First, Switzerland can offer a highly motivated student population, eager to travel and to exchange, and receive students from the EU. We can also offer great and autonomous universities, eager to compete and cooperate at European level. The model of university autonomy could be useful and directly inspire European policies. We can offer many Swiss enterprises operating in Europe in a spirit of competition and cooperation. We have a tradition of competition-based and peer-reviewed science funding and of cooperation oriented financial incentives for universities. We think transnationally, within the larger knowledge regions that Switzerland belongs to.

Switzerland vows to contribute to Europe as a major knowledge area. All European countries should belong to this knowledge area. Europe cannot afford to have regions left behind, where talent is unused. In this sense, as an example, our offer of « mille bourses » to the new members of the EU. The necessity to be competitive in the world arena does not preclude the necessary equity within Europe.

5. OUTLOOK

Openness and excellence

All European initiatives, tools, instruments should be infiltrated with the ideas of openness and excellence. **Openness**, by the free circulation of researchers, students, highly skilled force, grants, professors, ideas, publications, databases, data, through networks of knowledge regions. **Excellence,** by selecting and supporting those who have demonstrated their capacity to drive and pull the others, show the most promises, without considerations of regional or national origins.

There should be no compromise on excellence: Europe is not wealthy enough to afford mediocrity.

The Future of Science & Technology in Europe

Iceland

Katrín Gunnarsdóttir

Minister of Education, Science and Culture

Katrín Gunnarsdóttir

Changing Views on Science and Techonology Policy

HUMAN RESOURCES FOR S&T, PRIVATE INVESTMENT ON R&D AND PUBLIC FUNDING OF S&T

These are the three issues that for a long time have been at the heart of science policy at national as well as European level. Irrespective of the field of knowledge or research you are addressing, these are among the cross-cutting issues that need to be attended to – and very attentively so. From time to time the policy emphasis in this important field has been dressed differently, focusing on more specific objectives, but at the return of the pendulum the resource issues persistently keep showing up. This has been the case in my country and most likely also in all other countries. The S&T policies founded upon these basic features have brought us a long way and indeed been quite successful in most countries effectively pursuing such policies.

However, these three resource-features albeit important, do neither provide sufficiently elaborated picture of science and technology as a social enterprise leaving no sphere of human involvement behind, nor the guidance necessary to make wise decisions. From the perspective of elaborated theoretical articulation this approach may seem one-dimensional. We spend or rather invest for a purpose and such a purpose guides all S&T policies. Any decision on RTD spending, including public spending, is first and foremost very contextual and is of course embedded in political intentions: To increase the prosperity and wellbeing of our citizens while coming to terms with due consideration to the environment.

RECENT POLICY TURN

It may seem to be a bit confusing that when elaborating on RTD policies today we are also addressing a number of issues that by tradition may be regarded to belong to different policy fields. And so it is! In the same manner as science and technology are having impact upon society at large, so is society exerting a number of influences upon RTD. Among the reciprocal influences we count the internationalisation of RTD and the impact of science and technology upon international issues; global and climatic change – partially caused by man – the impacts of which do not respect any boundaries and at the same time are a great source of opportunities and an issue that has to be given due respect; free movement of people, funds, knowledge and goods, etc These are but a few factors that do influence our approach to RTD today, of course along with the traditional issues pertaining more directly to S&T.

THE LISBON IMPRINT

One example of this new turn in science and technology policy in a broader context is the Lisbon strategy, which is already playing an important role not only among the EU Member States but in all countries paying attention to what is happening on the European scene and in particular in those countries having a close co-operation with the Union.

In spite of the fact that Iceland is not a member of the European Union, the objectives set out in the Lisbon Agenda are highly relevant to my country for a number of reasons. Collectively Europe is the by far the largest and most important trade partner of Iceland. This mere fact necessitates that the legal provisions such exchanges require need to be compatible. The provisions of the EES-Agreement make all EU Directives in the fields covered by the Agreement applicable in my country as well. We are also deeply engaged in cooperation in the political field, which facilitates our mutual interests and understanding. Our participation in the EU's Programmes on Education and RTD may serve as good examples of this. I will return to that. One can argue that my country in the high-Atlantic is not separated from, but joined with Europe by the Ocean.

FROM THE PERSPECTIVE OF ONE COUNTRY

In order to be able to ripe the benefits of the progress and opportunities brought about by science, development and innovation, including the globalisation and ever more intensive international cooperation in these fields, all nations are in need of a sufficiently sensitive instruments to read and interpret the changes of times and mechanisms to implement policies.

In recent years the Icelandic government has undertaken profound improvements and changes of our science, technology and innovation policy machinery. The guiding principle has been to call stakeholders, including academia, the partners of the labour market and Government to the table for deliberations on science, technology and innovation developments. It should not come as a surprise that most of the issues raised below are either a part of or highly compatible with the Lisbon objectives.

A SCIENCE AND TECHNOLOGY POLICY COUNCIL

The Science and Technology Policy Council of Iceland established in 2003, operates under the chairmanship of the Prime Minister. It is now composed of eight Government Ministers, and 16 members of industry and the science community. It has proven to be an effective platform for dialogue between science, industry and Government to set policy and follow implementation of policies. The Council meets twice a year and sets the policy agenda and follows up on its policy declarations through budgetary and legislative proposals from the Government on one hand and through operational guidelines and strategic directions provided by its two working committees, the Science Committee and the Technology Committee.

ADAPTING INSTITUTIONS TO CHANGES

The increasing importance of research and innovation calls for new measures and modernization of public research institutes, including a revised division of labour between the private and the public, facilitating public-private-partnerships. During the last few years a number of our public research institutes and universities have been merged, reorganized and a new legal framework adopted. These changes include public-public mergers providing for increased involvement of companies, and a merger of two universities one private and another public in to a private sector university. In addition two public universities will be merged in early 2008. These changes all encompass increased independence of universities and RTD institutions in combination with increased accountability demands and quality assurance measures. Institutions in the food technology sector, agriculture and the energy sectors have all been reorganised to become more competitively oriented in a global context. Support to innovation has been reorganised to create the Icelandic Centre for Innovation.

ICELANDIC PARTICIPATION IN THE FRAMEWORK PROGRAMME FOR RTD

Iceland has actively participated in the Framework Programme (FP) since 1994. This has been both rewarding and a successful cooperation. During this period the emphasis in our participation has changed.

In FP4 enterprises, mostly SMEs, made up 30% of the Icelandic participants, receiving approximately same percentage of all grants to projects with Icelandic participation.

In FP6 enterprises made up 25% of the our participants, of which large enterprises, accounted for over 42% of funding received. The number of participations in information technologies has however dropped considerably. One reason for this being the short lead time from knowledge generation to implementation in IT. On the other hand participation in **health related topics** including genomic, biotechnology and bionic technology has increased, accounting for around 35% of received funding from the FP. This is also strongly reflected in our national expenditure on research, and technological development (RTD). According to the preliminary results of FP7 calls in 2007 this trend appears to continue.

THE GREEN PAPER ON THE ERA: NEW PERSPECTIVES

The Green Paper on the future development of the European Research Area (ERA) is a timely and welcomed Commission initiative to launch debate on necessary change. It motivates national debates on the role of the European research cooperation and the interplay between national and common policies.

MOBILITY OF RESEARCHERS

Attracting foreign scientists is vital for any country in order to meet its objectives. Iceland has participated in the Steering Group on Human Resources and taken part in its initiatives. In 2005 Iceland set up a Researcher's Mobility Portal which continues operation now when the Commission contribution has ceased.

The European Charter for Research and the Code of Conduct for the Recruitment of Researchers was endorsed by all the Icelandic universities in May 2007. We have carefully considered the Commission proposal for a directive on improving the portability of supplementary pension rights and Council *Directive 2005/71/EC on Mobility of Third Countries Researchers.*

RESEARCH INFRASTRUCTURE

Competitive research requires joint ventures for providing high quality infrastructures which should be operated and shared at a European level. Iceland supports the work initiated by the Commission in this area. We are participating in ESFRI work and are currently mapping all major public research infrastructures in Iceland and an Icelandic Roadmap is expected by mid-2008.

We note that FP7 does provide incentives for companies to share their infrastructure at an European level through the Research Infrastructure Programme as well as the PEOPLE Programme. We think there are many more opportunities where Iceland with its natural setting and microcosm of socio-economic needs, short lines of communications and a technologically positive population provides an ideal "natural laboratory" or "test bed" for carrying our user-oriented research and stimulating the uptake of technological innovations coming from research and new knowledge.

COORDINATED RESEARCH PROGRAMMES

For many years Iceland has participated in regional coordination of programmes together with the Nordic countries. We are currently participating in 10 ERA-Net schemes and are preparing an assessment of our participation. We welcome the Commissions efforts to facilitate voluntary coordination of national and regional research programmes and further development of tools and methods for collaboration where FP7 plays an important role.

OPENING OF ERA

We fully support the Green Papers vision of opening the ERA to the rest of the world. Internationalization of research poses both challenges and opportunities for Europe. The Commission can provide a platform for the states to agree on a specific agenda with priorities for coordinated actions towards third countries. This applies especially to the challenges faced by Europe and the World through global warming.

We have argued for a close cooperation among Circumpolar Arctic States on education and research to promote stronger focus on the changing environment and to facilitate adaptation. Education and research are the most powerful/reliable instruments available to guide government policy and underpinning social and economic adaptation.

FORESIGHT – CREATING SHARED VISION FOR THE FUTURE

The STP Council recently organized a foresight exercise, involving participants from science, Government, industry and civil society, to create visions of the future and provide directions for focussing the national efforts in science and technology. Many of the issues put forward in the Green Paper have figured prominently in this work. The themes are broad, multidisciplinary and crosscutting with the view of stimulating maximum interaction among researchers and between academia and society. They are as follows:

› Natural resources, the environment and sustainable development (facing and adapting to climatic change).
› Health, wellbeing and healthy lifestyles (in times of life-style changes and shifting demographic development).
› The strength of a small nation (in the era of multiculturalism and globalisation).
› Industries, trade and the funding of knowledge production and innovation (facing the competition in a globalised knowledge- based economy).

The Science and Technology Policy Council will have a discussion of the visions drawn up for these themes at its meeting next month. The Council expects these to be subsequently translated into recommendations for Government to take action through programming of research and investment in infrastructure facilities for research.

PARTICULAR INTERESTS

Climatic change and sustainable energy

In light of recent scientific reports and impact assessments it is clear that scientific knowledge of climate change requires research cooperation at global and regional levels. The FP7 is a pivotal instrument for a strong systems approach needed in dealing with these challenges. As indicated in my earlier comments during the preparation of FP7 we think this area will become even more important in the future as we have already become aware of signs of climate change and the accompanying effects. It is clear that adaptation to climatic changes will become an extremely important socio-economic and political issue in the years to come, - no less than the mitigating measures so often discussed at the political level. I do note with interest your intention to support research on carbon capture and storage (CCS) and it is my pleasure to inform you that back home we are already out on a similar mission investigating the feasibility to harness the high CO2 take-up capacity of basalt which makes up most of the country.

Developing sustainable energy systems with reduction in greenhouse gas emissions is part of these challenges, both as a mitigating measure and an opportunity for technological innovations. Iceland is already well on its way with 72% of its total energy supply coming from sustainable/ renewable resources. Geothermal energy, covering 98% of space heating in Iceland is increasingly being used for other purposes as well. Geothermal energy is a large renewable energy potential in many of the new EU Member States, as well as elsewhere in the world. We therefore suggest that FP7 should always explicitly include geothermal energy along with other types of renewable energy and take note of the global perspective.

New developments in harnessing geothermal energy through deep drilling at 5 km depth near volcanologically active areas could create an exponential increase in the energy output and may enlarge the regions of the world, including large areas in Europe, where geothermal energy is a feasible option.

Marine Research and Maritime Policy

The Blue book of the EU on Marine Research and Integrated Maritime Policy recognizes the importance to focus more strongly on research on the Seas. Research priorities and acknowledge that measures need to be taken to strengthen the links between science and policy marking.

However, we would like to see more emphasis on marine research, especially in the support of improved sustainable fisheries were the precausary management principle is acknowledged: Biodiversity, stock structure, new fishing and processing technologies, long-term monitoring databases, coordination of surveillance activities and forecast modelling that will help to forecast future trends and changes in the marine environment.

There is also a common need for an European centre for modelling. We need a common platform in Europe or a European Marine Agency that will bring together all the different networks, institutions, agencies, industry, national and international associations and conventions and ensure the sustainability of networks by long-term funding schemes. It is also important to offer stronger educational programs to inform the public, industry and policy makers on the importance and outcomes of marine research.

CONCLUDING REMARK

Science policy will to a greater extent concern itself with the working conditions for research and technological development and the societal impact: How to reap the benefits, how to disseminate knowledge effectively, how to resolve ownership issues, how to translate knowledge into innovation and improved services. Among the most important objectives of all Governments will be to ensure the best available conditions for RTD and innovation that met international criteria. This field is an important instrument for society and a way to understand the processes that do have an enormous impact on our lives.

Liechtenstein

Klaus Tschütscher
Deputy Prime Minister

Science and Technology in Liechtenstein

Klaus Tschütscher

1. LIECHTENSTEIN ECONOMY: A GENERAL OVERVIEW

Structure

The Principality of Liechtenstein is a small country of 165 km^2 and has a population of 34,600. At the same time, its national economy has created about 29,500 jobs. The economic structure is broadly diversified with a significant emphasis on industrial production besides its better known financial services sector. In comparison with other national economies, Liechtenstein is more industrial and less service-oriented than it is generally assumed.

The highly industrialized economy of the Principality of Liechtenstein is characterized by a broad diversification of sectors, businesses, and products. The average added value is very high, based on research and development, qualified expertise, a wide range of high-tech and niche products, strong export orientation, and a highly developed financial services sector. The gross domestic product (GDP) of 4.1 billion Swiss francs (2003) is, however, 100 to 1000 times smaller in absolute terms than the GDP of Switzerland or Germany.

About 39% of GDP is covered by added value in industry and manufacturing, 30% in the financial services sector, 25% in general services, and the remainder of 6% in agriculture and households.

The employment numbers in Liechtenstein are extraordinarily high. With a population of 34,600, Liechtenstein offers 29,500 jobs. This is only possible because the number of cross-border commuters to Liechtenstein is many times higher than the number of cross-border commuters from Liechtenstein. About 13,900 people from the region (Austria, Switzerland and Germany) commute daily to their workplace in Liechtenstein. This is about 45% of the total employment. As of 31 December 2004, jobs were distributed as follows: 51% commerce and services, 47% industry and manufacturing, and 2% agriculture and forestry. In an international comparison, the very low proportion of agriculture and forestry as well as the relatively high proportion of the manufacturing sector are striking. The service sector is considerably smaller than in comparable European countries. The unemployment rate in Liechtenstein is traditionally very low; the maximum rate so far has always been below 5%.

Despite the small size of the country, the Liechtenstein national economy covers 15 of the 16 economic segments in the international classification, more than most small European States. The most important branches of the strongly export-oriented industry are mechanical engineering, plant construction, manufacturing of precision instruments, dental technology, and the food-processing industry. In all of these areas, the emphasis is less on the production of mass and inexpensive goods, but rather on the development of high quality, high-tech products.

Many industrial firms are active in very specialized market niches. Through intense research and development work, domestic companies have achieved the status of global market leaders in their areas.

In addition to the 17 large companies with more than 250 employees, there are many small and medium-size businesses that make up the backbone of the Liechtenstein industry (3236 firms). The average business in Liechtenstein has less than 10 employees, but these employees distinguish themselves by high qualifications and productivity.

The successful national economy of Liechtenstein has, as already mentioned, created about 29,500 jobs, not all of them can be filled with employees from Liechtenstein. The proportion of foreign employees is over 65%, primarily cross-border commuters from Austria and Switzerland. But also the proportion of foreigners living in Liechtenstein is 34%. These numbers clearly demonstrate that Liechtenstein is an open country with an international orientation, which cultivates intensive bilateral and multilateral relations and takes its responsibility seriously as a successful industrial nation in the heart of Europe.

Economic history

For centuries, the orientation of the Liechtenstein economy was primarily agricultural. Given existing production methods, a population of only about 8000 could be sustained. This population number was reached in the 19th century and could only be maintained through various waves of emigration, especially to the New World. Only in the 1920s the economy did slightly improve, which also resulted in an increase in the population. Foreigners increasingly took up residence in Liechtenstein for economic reasons. The economic boom after the Second World War quickly pushed the domestic employment market to its limits, as there were many employees brought into the country, including cross-border commuters from the neighbouring countries.

The first wave of industrialization was relatively late. Especially the Customs Treaty of 1852 with Austria-Hungary was the basis of this industrialization. This treaty opened up the large market of the Danube Monarchy. Some Swiss textile industrialists founded operations in Liechtenstein. The consequences of the First World War, however, led to an economic catastrophe, especially also the implosion of the value of the currency. In 1924, the Customs Treaty with Switzerland entered into force, and the Swiss franc was adopted as the official currency. The period after the beginning of the Customs Union with Switzerland was quickly burdened by the global depression. An actual boom only took place after the Second World War, sustained primarily by strongly increasing industrial exports. The financial services sector (banks and later also insurance companies) experienced high growth primarily in the 1980s and 1990s.

Due to the small domestic market, above-average success of the Liechtenstein economy is only possible as clients from foreign markets can be attracted. Accordingly, the integration objective of the Liechtenstein economic and foreign policy is very important. Liechtenstein joined the European Free Trade Association (EFTA) in 1991, the European Economic Area (EEA) in 1995, and the World Trade Organization (WTO) and its subsidiary organizations also in 1995.

2. R&D IN LIECHTENSTEIN

Status Quo

The Principality of Liechtenstein is a small country, with a population of 34,600. This means that industry has access to only a very limited domestic market. Furthermore, Liechtenstein does not have any natural resources worth mentioning, the income level is high, and there are no State subsidies such as export supports. Liechtenstein businesses are in direct competition with businesses in far larger national economies. At the same time, Liechtenstein is too small to influence international developments.

The Liechtenstein industry counters these conditions, which may at first glance appear unfavourable, through high flexibility and adaptability to the international market. Especially through intensive research and development work, domestic companies achieve an advance compared to their international competitors. Liechtenstein therefore has an unusually high proportion of employment in the area of research and development.

In 2005, about 1047 employees of the industry members of the Liechtenstein Chamber of Commerce and Industry (LCCI)[1] were occupied in this R&D field. In monetary terms, in 2004 LCCI industrial companies invested around 307 million Swiss francs in research and development.[2] This corresponds to almost 8,900 Swiss francs per capita and represents more than 6% of the Liechtenstein GDP, which is far beyond the Lisbon target of 2% as regards private investment in R&D. In 2005 LCCI industrial companies invested around 278 million Swiss francs in research and development.

However, this private investment represents more than 99% of the Liechtenstein R&D budget. The public contribution, representing less than 1% of the GDP, is spent for the financing of the Liechtenstein-Institute, for contributions to the Swiss National Science Foundation (SNSF) and the Austrian Science Fund (FWF), as well as for the European research programmes. Since its membership in the European Economic Area (EEA) in 1995, Liechtenstein and its undertakings participate very successful in the research framework programmes of the EU. In addition, since 2007, the Competitiveness and Innovation Programme (CIP) has also been integrated into the EEA.

Advisory Council for Research and Technology

As already mentioned, a particular strength of the Liechtenstein economy is rooted in the innovative research and development work of domestic industry. Only by focusing on research and development some of the Liechtenstein industrial companies have been able to establish themselves as global market leaders in their respective segments.

The Advisory Council for Research and Technology (ACRT) was founded in 1989 as an innovation circle of the Liechtenstein Chamber of Commerce and Industry (LCCI). The duty of the ACRT is to provide important research and technology information to the LCCI and the Government. Its objective is to improve the basis for decision-making

[1] The Liechtenstein Chamber of Commerce and Industry (LCCI) is a private association with voluntary membership. Currently, it represents 39 members in 2007 (37 in 2005) Liechtenstein companies. Most of the larger industrial companies, the three major banks and some service companies are among its members.
[2] The amount includes expenditures on personnel and kind.

relating to technology policy and thereby to further increase the competitive strength of Liechtenstein. At the same time, the ACRT promotes contacts and exchanges of experience in research and technology matters between researchers and businesses. General questions concerning the recruitment of qualified specialists are also an important topic for the Advisory Council for Research and Technology, as well as the relationship with universities and scientific institutions for technology transfer.

Next steps

As it can be noted from the comments above, there are not abundant figures available on R&D in Liechtenstein. As the official statistics are still silent, one has to focus on the figures of the private Liechtenstein Chamber of Commerce and Industry (LCCI). This has been recognized as problematic by the current Government, due to the importance of statistics as central steering instrument. Therefore, the relevant figures are currently in the process of being collected and will be published in spring 2008. On this basis, decisions on the future framework and conditions for R&D in Liechtenstein and the public investments therein will follow.

In addition, respecting the importance of R&D for the Liechtenstein economy, the Liechtenstein Parliament has approved recently to participate in the 7th Research Framework Programme of the European Union (EU). This was linked to a considerable increase of the annual contributions from about 700 000 Euro annually to almost 2 Mio. Euro.

The Future of Science & Technology in Europe

Norway

Tora Aasland

Minister of Research and Higher Education

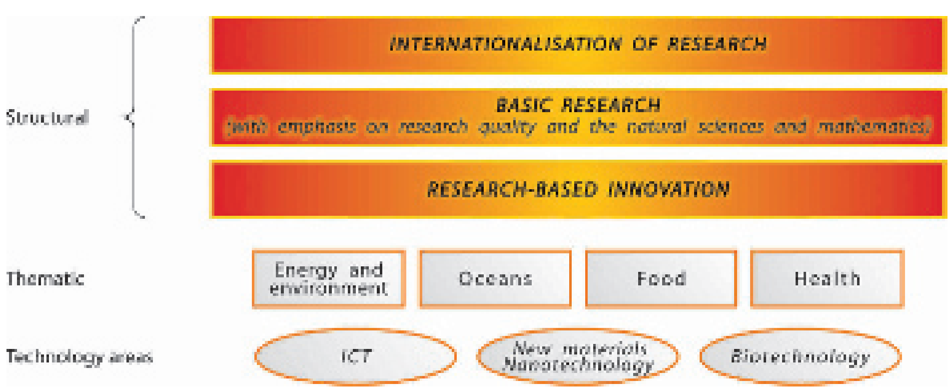
Tora Aasland

Main Priorities in Norwegian Research Policy

The Government's programme declaration from 2005 and the White Paper "Commitment to Research" (Report no. 20 to the Storting (2004-2005) constitute the basis for the Norwegian Government's research policy. The Government aims to increase total investments in research. Contributions from researchers, society and industry are called for and actively stimulated. Norway is not a part of the Lisbon-strategy, but shares a target of 3 percent of GDP to research investments with the European Union. Norway also takes part in European Community programs that underpin the strategy, such as the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013). Norway is an Associated State to the EU Framework Programme.

1. NATIONAL PRIORITIES IN RESEARCH

Figure 1 › **Priorities in Norwegian research**



As stated in the White Paper "Commitment to research", three structural areas are given priority in Norwegian research policy. Firstly, internationalisation constitutes an overall perspective. International participation is emphasised when resources are channelled into research. Secondly, basic research is a priority. Special attention is given to research in the field of mathematics, science and technology. Thirdly, priority is given to investments in research-based innovation and business development, to provide support for the reorganisation and renewal of Norwegian business and industry and the public sector.

In addition priority is given to four thematic and three technological areas. The four thematic priority areas - energy and the environment (including petroleum research), food, oceans and health have been defined on the basis of national strengths and needs. The three technological areas have wide areas of application and are undergoing substantial development. They are information and communication technology (ICT), biotechnology, and materials and nanotechnology.

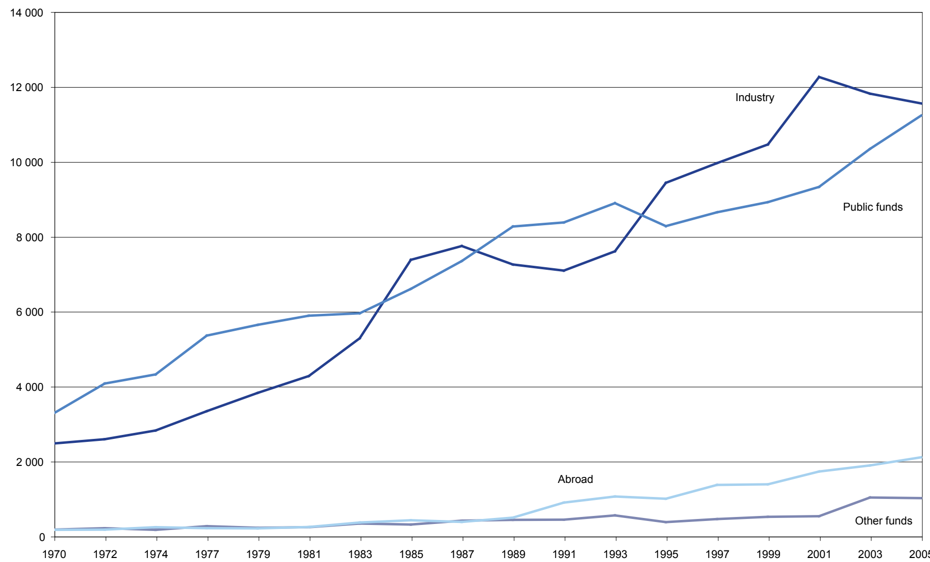
2. IS NORWAY APPROACHING THE 3 PERCENT FUNDING TARGET?

Total public appropriations for R&D in Norway have increased substantially in the latest years. The Government proposes to spend NOK 17,8 billion (2,3 billion Euro, 1 Euro=7,7 NOK) in the state budget for 2008. Despite the substantial increase in public spending, total R&D-expenditure as a percentage of GDP has decreased from 1,7 percent in 2003 to 1,5 percent in 2005, which is the latest figure from the official R&D statistics. The decrease is mainly due to the large growth in nominal GDP, with 11 per cent in 2005 and 9 per cent in 2004 – considerably above the OECD – and EU-average. The relationship between a strong macroeconomic performance and the apparently weak performance on research indicators is discussed in chapter 7.

Total R&D expenditure for all sectors, including government and higher education, amounted to NOK 29.6 billion in 2005 (3,9 billion Euro). Of this total, public sources funded NOK 12.9 billion, or 44 per cent. Public funding amounted to 0.67 per cent of GDP in 2005.

Private investments in R&D amounted to NOK 13.6 billion in 2005 which constituted 0.7 per cent of GDP in 2005 (compared with 0.9 in 2004 and 1.0 in 2003). These figures include research institutes serving business and industry. Rising public investments and decreasing investments in industrial R&D, made public and private R&D expenditure almost par in 2005 – as demonstrated by the figure below.

Figure 2 › **Development of R&D expenditure in Norway 1970-2005, by source of funds. Constant prices Intramural R&D expenditure in Norway 1970-2005, by source of funds. Constant 2000 prices**



Source: NIRJ STEPI/Statistic

3. PUBLICLY FUNDED RESEARCH

The Research Council of Norway

About 30 percent of all public R&D funding in Norway is channelled through the Research Council of Norway (RCN). The Ministry of Education and Research has the administrative responsibility for the RCN, but, practically all ministries with a sector responsibility for research, contribute to R&D programs and institutions funded by the RCN. The RCN identifies strategic areas of special effort, allocates research funds and evaluates the resulting research. The Council is the principal research policy adviser to ministries, and acts as a meeting-place and network-builder for Norwegian research.

Higher education institutions

About 30 per cent of all R&D in Norway takes place within the system of higher education. R&D is mainly funded over the ordinary budgets of the institutions, but supplementary financing is obtained for programmes and equipment, mainly from the Research Council of Norway. There has been a substantial increase in research expenditure in the higher education sector from 2001 to 2005.

Norway has been an active participant in the Bologna-process. Substantial changes have taken place within tertiary education in Norway during the last ten years, mainly aimed at encouraging institutions to be more responsive to the needs of society and the economy. As a result of the *Quality Reform* introduced in 2001, all higher education institutions were given significantly greater autonomy in managing and organising their activities.

The Norwegian higher education system consists of both public and private institutions. Government funds are the main source of income for both public and private institutions. Government funds are distributed to all institutions based on a funding system, which is partly performance based. The funding system consists of three components. The basic component represents on average about 60 per cent of the total allocation to the institutions. The education component implies that an average of about 25 per cent of the total allocation is distributed on the basis of the number of study points (ECTS-credits) achieved. Third, about 15 per cent of the allocation is distributed through a research component. The research component has a strategic part and a performance-based part.

In addition to government grants, the institutions are encouraged to get external funding. The most important sources of external funding are research grants from the Research Council of Norway and the EU.

Table 1 › **R&D in higher education sector and institute sector**

	EXPENDITURE. NOK BILLIONS, CURRENT PRICES		MAN-YEARS	
	2003	2005	2003	2005
Higher education sector	7.5	9.1	7 918	9 420
Institute sector	6.4	6.9	7 238	7 276

Research institutes

Some 23 per cent of total Norwegian R&D takes place in the institute sector. The sector is diverse in terms of R&D activity, research topics and size of institutes. Norwegian research institutes serve a wide range of clients, including the civil service and the industrial sector. The variety of customers also reflects the range of subject areas in the sector. Technology is the dominant area with more than one third of total R&D in 2005.

The second largest subject area is the natural sciences with 20 per cent in the same year.

In 2005 public funding in this sector amounted to NOK 4.4 billion, while funding from industry amounted to NOK 1.5 billion and funding from abroad amounted to NOK 0.8 billion. Funding from abroad has increased substantially during the last decade. A major part of this funding comes from the EU.

In the budget proposal for 2008 the Government has introduced principles for a new system for basic funding for the research institutes. The new system is performance based and gives incentives to increase both quality and relevance.

4. PRIVATE INVESTMENT IN RESEARCH AND DEVELOPMENT

The majority of the Norway's workforce is employed in the service sector. Norway's great access to energy resources has been instrumental in the development of energy-based business sectors, wealth and growth. Norway also has a technological industry that produces inter alia electronics, industrial machinery, ships and equipment. A large share of exports relies on energy resources, but exports of consumer products and goods, most notably fish, are also significant.

The manufacturing industry has traditionally been the main R&D contributor in the industrial sector. In 2005, the sector proportion of total R&D costs was slightly less than 50 per cent. The service industry's proportion was 41 per cent. Small and medium sized enterprises, with less than 100 employees, reduced their spending on R&D by 2 per cent in 2005 compared to 2003. Enterprises with more than 100 employees on the other hand increased their spending by 10 per cent, led by enterprises with more than 500 employees. They increased their R&D spending by 500 million NOK (65 mill. Euro) compared to 2003.

Internal funding of R&D is the most common source of funding in Norwegian enterprises and constitutes slightly less than 80 per cent of total funding. Funding from abroad, including from the EU, increased from 2003 to 2005, and represents 10 per cent of total funding from abroad. In addition, the business enterprise sector also has several sources of public financing of R&D.

As a whole, the Norwegian business sector is less research intensive than in many other countries. This reflects the fact that the Norwegian economy is characterised by a large share of GDP originating from low-tech or medium low-tech manufacturing, oil and gas, services and fisheries. However, value creation in Norway is high, and a comparison of research investments in each sector with investments in similar sectors in other OECD countries reveals that Norwegian branches of industry are performing well.

Meeting the 3 percent is clearly a particular challenge given the composition and the structure of Norwegian trade and industry. By continuing to support industrial R&D, we aim at contributing to international competitiveness and secure adaptation and development of new business areas in the Norwegian economy.

5. MAIN NORWEGIAN INITIATIVES IN R&D

Internationalisation of Norwegian research

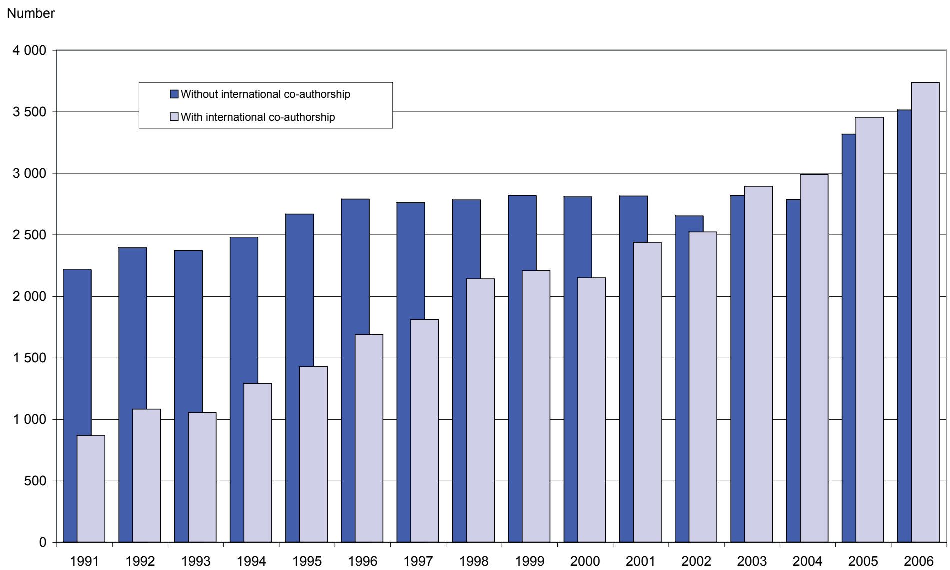
International research cooperation is of vital importance if the quality of Norwegian research is to be enhanced and its renewal ensured. International cooperation also allows Norwegian scientists, research institutions and industry to take advantage of knowledge and technology developed abroad. In addition, international cooperation is necessary to share the risk and costs of large research investments.

The Government places particular emphasis on active participation in European research cooperation. Norway's participation in the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013) is a significant public investment. The strengthening of participation of Norwegian R&D actors in the programme is emphasised in national support actions for international research cooperation, and synergies with national R&D priorities is actively pursued. Norway's total contribution to the Seventh Framework Programme will be approximately 9 bill. NOK (1,2 bill. Euro). In the proposed state budget for 2008, the Norwegian contribution to the Framework Programme constitutes just below 6 per cent of total public appropriations to R&D.

Other priorities include a strengthening of bilateral research cooperation - particularly in relation to North-America and countries in Asia, and better utilisation of national assets to attract researchers and research funding from abroad. Norway also has a global responsibility for contributing to the global development of knowledge, particularly in areas that benefit the least developed countries.

The number of Norwegian scientific articles with international co-authorship is increasing. This development can serve as one measure of the internationalisation of Norwegian research ref. Figure 3 below.

Figure 3 › **Norwegian publications with and without international co-authorship. 1991-2006**



Source: National Citation Report for Norway, Institute for Scientific Infomation (ISI)

Enhancing quality in research

In recent years there has been a strong focus on quality in Norwegian research. Increased attention has been given to carrying out and following up evaluations of disciplines and thematic areas within Norwegian research. As a result increased attention has been given to academic leadership and concentration of resources. As mentioned above, a new and more competitive funding mechanism for universities and university colleges has been introduced.

To promote excellence in Norwegian research, schemes like Centres of Excellence (CoE) and Outstanding Young Investigators have been introduced . The CoE-scheme is a committed focus on Norway's best researchers, enabling them to gain recognition within the international researcher community. The scheme is intended to encourage research communities to establish centres dedicated to long-term, high-level basic research. Only research groups carrying out scientific work at the highest international level are awarded status as CoEs. The CoE-scheme now comprises 21 centres. The centres receive funding of 6 to 20 mill. NOK per year. Initiatives to promote excellence will be continued, but also supplemented and balanced by measures introduced to enhance quality in Norwegian research more broadly.

A number of international scientific prizes are awarded in Norway. The Abel Prize was awarded for the first time in 2003, followed by the Holberg Prize in 2004. In addition three Kavli Prizes for astrophysics, nanoscience and neuroscience will be awarded in 2008.

Strategic programmes to meet national R&D priorities

As part of the effort to meet national research-policy priorities, the Research Council of Norway has established several Large-scale Programmes. These programmes have been developed in a dialogue with research actors, industry and public administration, and extend across various sectors and value chains. The current Large-scale Programmes represent a key component of the Research Council's efforts to follow up the priority areas in the White Paper on research from 2005, and include programs in areas like functional genomics, nanomaterials, ICT, climate change etc.

Research-based innovation and business development

Promoting research in Norwegian industry is pivotal to reaching targets relating to innovation, restructuring and wealth creation. Measures have been taken in Norway to promote research in Norwegian companies and better cooperation between industry and the university sector. A scheme based on user-driven research and innovation including all types of R&D actors has been a main activity in this area for several years. Main new initiatives are:

› A scheme called *Centres for Research based Innovation* was launched in 2006. The main objective is to enhance the innovative capability of the business sector by forging close alliances between research-intensive enterprises and prominent research groups in conducting long-term research projects. The host institution for a centre can be a university, a university college or a research institute, or an enterprise with a strong research activity. Participation from foreign companies and research institutions is encouraged. The scheme emphasises the generation of research findings, increased cooperation between various research centres and technology dissemination, but also education and further qualification of researchers. A centre is financed for a period of five years, with the possibility of a three-year extension.

Each centre receives an allocation from the RCN of roughly NOK 10 million per year. The host institution and partners must contribute with at least the same amount.

› *Norwegian Centres of Expertise (NCE)* is a targeted effort aimed at specialised business clusters with profitability potential, for the purpose of promoting the development of internationally competitive businesses and industrial centres. The programme was launched in 2006. Regional partnerships and the industrial centres shall ensure that this program develops into a long-term effort, strengthening both the regional and national innovation system.
› The Norwegian tax credit scheme, called *Skattefunn*, was introduced in 2002 and was originally restricted to small and medium sized enterprises (SMEs). As of 2003, all enterprises operating in Norway are eligible for a deduction in tax payable for expenses in approved R&D projects. About 50 per cent of the users are companies with less than 10 employees, and the scheme is used in all parts of the country and across many sectors. The objective of the scheme is to stimulate R&D activity in the business enterprise sector. In 2005, the total tax expenditure was NOK 1195 million. 74 per cent was refunded in excess of assessed taxes. The reduction of total tax revenues (tax expenditure) turns the scheme into the largest R&D programme in operation directed at the business enterprise sector.

The Skattefunn scheme is currently subject to a comprehensive evaluation by Statistics Norway that will be finalised in 2007. This evaluation will study the scheme's effects in terms of creating more R&D in the private sector, change in R&D behaviour in enterprises, returns of increased R&D, and will also look at whether the scheme stimulates real R&D or reclassification of costs. On the basis of the conclusions in the evaluation report, the Government will decide on the scheme's future scope and configuration.

Commercialisation of research based business ideas may increase national welfare and wealth creation. In 2002, the University and University College Act, as well as the Employee Invention Act, were amended, implying that universities and university colleges were given an expanded responsibility for the application of their own research and the commercialisation of patentable inventions made by their employees. After the amendments the universities and university colleges have been linking up with industry through the establishment of Technology Transfer Offices (TTOs) and also through existing incubators and science parks.

As a follow-up of the White Paper on Research from 2005 and political aims to boost commercialisation efforts, the existing programme for commercialisation of projects by employees at tertiary institutions in the RCN (FORNY) has been reinforced.

The Fund for Research and Innovation

The Fund for Research and Innovation was established in 1999. The main purpose of setting up the fund was to provide a basis for long-term stable funding of research activities. In practice, the Fund is a budget mechanism that secures a fixed allocation outside the yearly budgets of ministries. Since its establishment, the fund has been increased considerably and its returns constitute a significant part of all government appropriations to research (16 per cent in 2007, or NOK 2.6 billion). From 1 January 2008 the total capital in the Fund will be NOK 66 billion.

The yield from the Fund finances research that cut across sectors. Investment in functional genomic research and long-term petroleum research are examples on research financed by the Fund. Important new policy instruments financed by the Fund are the Centres of Excellence and the Centres for Research-based Innovation. Resources have also been earmarked to finance Norwegian participation in the International Polar Year (IPY) and in the EU Framework Programmes.

Incentives for private donations to basic research

Norway has initiated a scheme where private donations for research of at least NOK 5 million are matched with a state contribution corresponding to 25 per cent of the amount of the donation. The donation must come from private individuals, companies or non-profit organizations, and must be given to one of the universities, the state colleges with the right to grant PhDs, the Norwegian Academy of Science and Letters, or the Research Council of Norway.

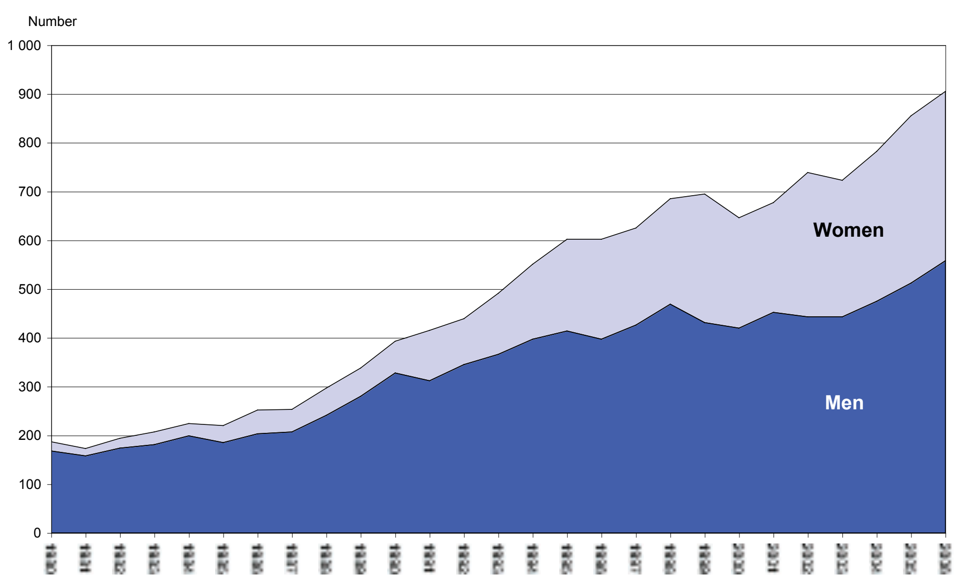
6. HUMAN RESOURCES

Great importance is attached to the issue of Human Resources in research and technology and the need for more and better scientists. A new White Paper on recruitment will be presented to Parliament in 2008. It will analyse future needs and lay out a plan for increased efforts in doctoral education. In 2005, almost 55 000 persons participated in R&D in Norway. Some 68 per cent of these were researchers and university graduates. The number of researchers per thousand total employment was 12,9 in 2005, which is above the EU-average.

Norway is committed to increasing the number of researchers. The number of posts for doctoral students was increased by more than 30 per cent from 2000-2006. In 2006, 905 doctoral degrees were earned in Norway, of which 347 (38 per cent) by women. In the state budget for 2008, the Government proposes to increase the number of PhD positions by 350.

Women in research is a subject that Norway is particularly occupied with. The Government has appointed a Committee for Women in Research. The Committee works in close dialogue with universities, colleges and research institutes. It acts as an advisory body for both institutions and authorities, and proposes concrete measures to achieve a better balance between the number of men and women in academic positions. The Committee has succeeded in engaging academic institutions and relevant authorities in discussions on gender equality.

Figure 4 › Earned doctoral degrees in Norway by sex: 1980-2006



Source: NIFU STEP / The Doctoral Degree Register

The challenges Norway faces regarding supply of and skills in Mathematics, Science and Technology (MST) are the same as in many other European countries. The Government has a holistic approach to the MST challenges, starting with developing competence in kindergartens and following up throughout the entire educational system, including also teachers' education. A Strategy for a Joint Promotion of Mathematics, Science and Technology to meet the challenges has been established. There has also been an increase in public awareness of the society's needs for MST-competence and a rapid growth in related jobs, especially in knowledge-intensive services. A shift is now emerging, with an increase in the recruitment to MST, and also in the number of girls choosing these subjects.

7. A NORWEGIAN PUZZLE - ARE OUR MEASUREMENTS RIGHT?

The macroeconomic performance of Norway is outstanding with Mainland-GDP[1] growth averaging 4½ per cent for the past three years. GDP per capita and productivity is high and inflation and unemployment rates are low. The labour market has tightened significantly over the last couple of years and the unemployment rate is now the lowest in nearly 20 years.

In contrast to the strong macroeconomic performance stands the weak Norwegian performance on a large number of research and innovation indicators. The 2006 European Innovation Scoreboard (EIS), ranks Norway 16 out of 34 countries (SII). In a recent economic survey the OECD called this a paradox, the Norwegian puzzle. The OECD survey spurred a debate in Norway about innovation performance. The discussion is important, because our understanding of what takes place in the innovation system may have serious repercussions for Norwegian innovation policies.

Many scholars claim that EIS indicators do not provide an adequate depiction of strengths and weaknesses of Norwegian research and innovation performance. This is due to biases in the set of indicators chosen. If it turns out that the puzzle is caused by fundamental misconceptions as regards measurements or the role of innovation in the economy, it may even have consequences for innovation policy development in other countries. Norway therefore welcome further discussions on what indicators best reflect the innovation capacity of various countries.

[1] Petroleum activity excluded. Norway's petroleum industries, mainly crude oil and gas extraction, accounted for 25 per cent of GDP and 50 per cent of exports in 2006.

8. THE WAY AHEAD

As shown above, the total R&D-expenditure as a percentage of GDP was 1,5 percent in 2005. It is evident that Norway will not reach the 3 percent target by 2010. The large growth in GDP is the main reason for this. However, the Norwegian government still believes that higher general R&D intensity is important for several reasons, such as to solve challenges related to climate change and the environment and to strengthen the international competitiveness of Norwegian companies. In the state budget for 2008, the Government proposes to strengthen public R&D allocations by NOK. 1.3 bill. Our ambition is to strengthen our efforts even further in the years to come.

Private investments also need to increase. According to the OECD, Norway has a solid institutional framework and relatively generous public measures for supporting private R&D.

Still, there is a potential for increasing research efforts in the various trade and industry sectors and for stimulating adaptation and the development of new business areas, and we are addressing this. New measures have been introduced, and we will continue to improve public R&D measures supporting innovation in Norwegian companies. The Government will also present a White Paper on innovation next year, addressing challenges in innovation also in a broader sense.

The Future of Science & Technology in Europe

Greece

Ioannis A. Tsoukalas

General Secretary for Research and Technology

Ioannis A. Tsoukalas

Science and Technology Policy in Greece

Where do Member States stand in the implementation of the S&T policy targets of the Lisbon Agenda, namely in respect to R&D public and private investment and human resources? Is there a need to renew or to streamline policy targets in the field of S&T in the context of the Lisbon Agenda?

The transition process towards an economy of knowledge, in compliance with the Lisbon strategy, as well as with the objectives of the new EU cohesion policy, has been the central development national strategy for Greece, within the increasingly demanding European and international R+D and economic environment. Consequently, Innovation, Research and Technology play a key role to this end.

The official national target for Greece is to increase investment in the Research domain up to 1,5% of the GDP by 2015. Respectively, the participation of the country's private sector to the above mentioned figure should reach 40%.

In the period between 2000 and 2004, the overall (private and public) investment in Research has been slightly decreasing amounting to about 0,6% of the GDP. 30% of the above mentioned percentage comes from the private sector. It is important to underline that these figures do not present the real picture, since GERD[1] has been constantly increasing in absolute figures. During the same period, though, GDP[2] in Greece has been increasing, by an impressive rate of >4% at an annual basis. (Among the fastest in the Euro zone). Innovation and Technology, though, appear to have a small contribution to this GDP increase. It was mainly due to economic activities, such as the turnover of banks or the construction sector (for example those connected to the 2004 Athens Olympic Games). It is, therefore, apparent, that the so-called catching-up countries with fast-growing economies, like Greece, with not yet strongly knowledge

[1] Gross Expenditure on Research and Development.
[2] Gross Domestic Product.

based economy, are facing additional difficulties trying to meet the Barcelona targets calculated as a percentage of their GDP (and not on the basis of their net contribution).

In the frame of the revised Lisbon strategy of 2005, the Greek government decided to maintain its initial target, also included in the country's **National Reform Programme**. The government believes that both the Lisbon Strategy and the NRP alongside can create a strong momentum for development and growth. Research and Innovation are key priorities in the country's national planning.

Certain positive results have already been identified:

› GERD has increased by more than 10% from 2004 to 2005.
› With a view to the Planning Period 2007-2013 a National Strategic Plan for R&D and Innovation has been adopted in order to mobilize RTDI activities and, consequently, utilize resources in the framework of the different Operational Programmes, both sectoral and regional, to be carried out in the period 2007-2013.
› In this spirit the Greek Government has decided that the R+D budget be twice the budget of the period 2000-2006.

Concerning the contribution of the private sector to the R+D activities:

The main objective of Greece's **Research and Innovation policy** is the enhancement of competitiveness of the national economy. To this end a great effort is made towards restructuring the industrial sector, in particular that of goods and services of high added value. Incentives are, therefore, given in order to:

› Stimulate research activities of the private sector both by direct grants and/or tax incentives
› Develop research results by creating spin off companies and incubators,
› Support and promote cooperation between industry-academia with specific emphasis to knowledge intensive clusters,
› Strongly emphasise the importance of the regional dimension of innovation by creating **Regional Innovation Poles**,

Being pragmatic, and taking into consideration the abovementioned planning it is estimated that Greece's national target could be reached by the end of the Planning Period 2007-2013, or even slightly later, namely, by 2015.

Recalling that about 60% of the GERD corresponds to labour costs, it is realistic to say that meeting the Barcelona target relies, to a great extent, on the country's ability to create, train, integrate and sustain the necessary R+D personnel in the labour market. Avoiding " brain drain" and securing the best possible R+D personnel especially in terms of studies, experience and training is a key factor in the transition process of the Greek economy towards an economy of knowledge .

It is considered necessary for Greece towards meeting the Barcelona target that it significantly increases the number of the new PhD holders graduating, at an annual basis, from Greek universities, in addition to those coming from abroad. At the same time, and at an annual basis, 40% of this new/young human potential is not integrated into the Greek labour market.

Against this background, policy responses should address not only the issue of the offer, but also how to increase the demand for researchers, in particular in the private sector. To this end it is important to, among others:

› Promote entrepreneurship of researchers, in particular young researchers,
› Provide direct and indirect incentives to the private sector to hire scientists and researchers,
› Plan and implement the necessary reform for Universities and Research Centres. It is considered absolutely important to seriously work on the country's education system, as a whole, starting from the elementary schools, High Schools and Vocational training. Special attention should be paid to the teaching personnel, via lifelong training.
› Promote social models and success stories from the research community.

With regard to the Lisbon strategy targets two additional remarks should be made:

1. It is realistic to take into consideration the net amount of resources[3] spent in R+D activities rather than the percentage of GDP it represents, due to the reasons mentioned in previous paragraphs. (page 1).
2. In addition to what is written above, much attention should be given to qualitative indicators such as quality of the produced knowledge, and, in particular, to the impact of the knowledge based economy (the main target) both on the competitiveness of the greek economy and the quality of life (i.e. environment, living conditions etc).

[3] E.g. GERD, BERD, GOVERD

With a view to sustaining sufficient levels of qualified researchers in Europe, how can we attract more young people to study science and technology and to pursue research careers? How can the participation by women to the research effort be enhanced? What are the measures taken by each member state to avoid brain drain and to encourage brain gain?

In 2005, the total number of the personnel, being employed in R+D activities in Greece amounted to 61 569; 33 033 of them being researchers (headcount). Their number in full time equivalent (FTE) is 19 360,3 in 2005. Annual growth rate (%) of FTE per 1000 labour force in Greece was roughly the double of the EU-25 average from 1997 to 2001 (5,8 and 2,8 respectively)

The main axes of the Greek policy concerning the Planning Period 2000-06, with a view to supporting human resources in Science and Technology domain, may be highlighted as follows:

a. Development of highly qualified R+D personnel by the Greek Universities and the public Research Centres.

b. Incentives to retain the Greek talent in the country and attract back to Greece those expatriates, as well as foreign talent- thus enhancing geographical mobility of researchers.

c. Creating, Increasing and Securing employment opportunities for highly skilled personnel in the greek private sector, as well as enhancing inter-sectoral mobility of researchers, thus improving, among others, their skills.

d. Support of entrepreneurship of researchers, in particular of the young ones.

e. Career opportunities for women in the RTD system– Promotion of scientific and technological careers for young scientists.

The above axes have been promoted and implemented through a set of financial schemes launched by the Greek government and mainly the General Secretariat for Research and Technology/Ministry for Development:

a. Development of highly qualified R+D personnel by the Greek Universities and public Research Centres

The "Programme for the development of the Research Personnel (PENED)".
The main target of this Programme is the training of young/new researchers in cutting

edge sectors, in the frame of research projects, **through the elaboration of their PhD theses.** The scheme launched under the Planning Period 2000-06 by the General Secretariat for Research and Technology (GSRT), addressed all higher education institutions and public research centres in Greece, as well as private enterprises. Additional schemes supporting PhD preparation in Greek Universities have also been launched by the Ministry of Education.

b. Incentives to retain the Greek talent in the country and attract back to Greece those expatriate, as well as foreign talent- thus enhancing geographical mobility of researchers

The "ENTER - Programme for incorporation of foreign PhD holders into the Greek RTD system -" has been launched in 2001and 2004 by the General Secretariat for Research and Technology (GSRT). The main target of the Programme is to attract back to Greece researchers living and working abroad. It is not addressing exclusively researchers of greek origin or Greek-speaking ones, as it is also open to researchers wishing to work in Greece for a period of 3 to 24 months. Proposals may be submitted by Greek Universities or public Research Centers, on condition that there is secured co-funding (at a 10% minimum of the project total budget) by an enterprise of both private and public sector, being able to develop the research results.

Again, brain circulation, geographical mobility of researchers and international networking, including collaboration with Greek expatriates, are, in parallel, supported by bilateral cooperation programmes and a national programme supporting and funding participation of Greek researchers to international RTD projects co-funded by International Organizations.

Finally, it has to be mentioned that all national RTD competitive Programmes so far are open to international cooperation, under the condition that the foreign partners will subsidize their participation on their own means.

c. Creating, Increasing and Securing employment opportunities for highly skilled personnel in the Greek private sector, as well as inter-sectoral mobility of researchers, thus improving, among others, their skills.

The Programme "HERON", encouraging the hiring of research personnel in enterprises": It supports industrial research (new knowledge to create and/or improve new products, methods or services.) and pre-competitive research. The Programme had limited uptake so far thus showing, to a certain extent, the low RTD absorbing capacity of the Greek private sector.

Incentives for supporting RTD personnel in the private sector are also provided by the GSRT Programme for the Development of Industrial Research and Technology (PAVE). The Programme covers up to 25% of the costs of existing RTD personnel involved in the projects approved for funding, as well as up to 75% of new RTD personnel hired in order to implement the projects. Similar incentives are also provided by various schemes promoting industry- academia collaborative projects.

d. Support of entrepreneurship of researchers, in particular of the young ones.

Reference to the Programme PRAXE of the GSRT (creation of academic spin – offs) has to be made under this policy line. The Programme PRAXE supports young researchers in order to establish their own business in high tech fields, and aims at promoting entrepreneurial spirit in the Greek academic community, in general. Establishment of new high tech business is probably the most challenging/promising way to restructure the Greek economy towards sectors of higher added value and to cope with the unemployment of young, highly qualified personnel.

e. Career opportunities for women in the RTD system.

Statistics in Greece show that women in research are in a rather better situation than in other European countries; however there is a broad field of interventions to be undertaken in order to improve career development for women in research, both in the public and, in particular, the private sector. Shortages have been identified mostly in highly ranked positions (in the private sector, public Research Centres and Universities) as well as in certain scientific areas and mainly in engineering. A national network of women researchers has been established by GSRT (the "PERIKTIONI" Network) with both financial and administrative support. In parallel, a series of studies was launched on gender issues and equal opportunities in the Greek R&D system.

Finally, there exists also the Programme "TECHNOMATHEIA" (education in crafts), launched by GSRT, and addressing students of secondary education and offering opportunities to develop their talents in technological, scientific or technological – cultural content.

What are the main barriers for the growth in R&D private investment? What are the main measures each Member State is carrying out in order to encourage R&D private investment?

The rather low rate of of the Greek private sector's mobilisation is one of the weak points of the Greek Research, Technology and Innovation System. In depth analysis of this "phenomenon" is necessary with regard to this part of the booklet (and not only).

The R&D business expenditure has long amounting to ~ 16% of the European average. Half of the research activity in Greece is estimated to be implemented by the Higher Educational Institutions. The private sector's participation is rather low and seems to be stuck at about 30% of the overall R+D activity.

The low contribution of the private sector in R+D is rather due to the structural weaknesses of the Greek industrial base (e.g. many small enterprises, traditional sectors and also small investment in innovation, import of mature technology from abroad. Also, lack of in-house RTD in the private sector, lack of highly qualified personnel, reluctance of taking risk etc.).

Trying to face this complex and multidimensional problem, in the long run, the Government/GSRT/Ministry for Development has made it of a priority and has also decided to increase BERD by elaborating and funding a series of programmes, among which are the cited below:

1. "Programme for the Development of Industrial Research and Technology (PAVE)"

It was the first GSRT financial scheme, initially launched in 1985, to support R&D and innovation activities in the Greek private sector.

The Programme aims at supporting industrial and pre-competitive development activities of established, dynamic enterprises whose objectives match the general guidelines of the Programme, namely:

- It improves the Greek firms production capacity through the development of new or improved production processes.
- It supports the development of new or improved products or services of high added value, thus, mainly trying to enhance the competitiveness and access to new markets of Greek firms/enterprises.
- It also supports transferring and adapting of new technologies to traditional branches of industry.
- It promotes activities of technological innovation in Greek enterprises.

It covers:

- Up to 60% of the eligible costs for industrial research projects.
- Up to 45% for SME's for pre-competitive development activities and up to 35% for big enterprises.

The PAVE programme is considered to be a good practice in Greece taking into consideration its duration and the considerable participation of Greek enterprises to its activities.

2. "Programme for international cooperation in industrial research"

The program has been planned as an incentive to increase participation in the European EUREKA initiative, to encourage international cooperation and to create permanent links with foreign counterparts. It provides funding for firms in order to implement RTD projects in cooperation with firms or different kind of organizations (universities, research centres) from abroad. The main objectives are the development of new products, innovative processes and services in order to successfully access and "survive" in the international markets.

3. "PEPER" Programme – Promotion of demonstration projects and innovation

It supports the application of new technologies in Greek enterprises. According to the programme the proposed technology must have already been tested and demonstrated measurable economic results, either in the same technological sector (abroad), or in a different one (in Greece or abroad). It must have also produced results at a laboratory or at pre-industrial level and require scale-up to the industrial / productive level.

The Programme may cover all sectors of the economy. The projects may be carried out by one single firm or by two or more firms jointly. Part of the project can be subcontracted to a University, a Technological Institution, a public Research Centre or an Industrial Research and Technological Development Company.

4. "RTD Consortia in sectors of national priority"

The general objective of the above Programme is to promote collaborations between business enterprises and research organizations through long-term research and technological development projects and demonstration projects. The target is to develop innovative products and services and to meet social and cultural needs.

The Programme focuses on the following priority fields or objectives:

› Natural Environment and Sustainable Development
› Renewable Energy Sources and Energy Saving
› Culture – Knowledge Intensive Tourism
› Sports
› Food – Agriculture – Aquaculture
› Transport and Navigation Technologies
› Health – Biomedical Research – Diagnostics and Therapeutics
› Built Environment and Risk Management
› New Forms of Business, Work and Training Organization
› E-learning, e-business (General Secretariat for Information Society)
› Imaging -Speech – Language

The Programme supports basic research, industrial research and initial demonstration. The intensity of the aid varies accordingly (up to 100% for basic, 50% for industrial research and 35% for initial demonstration).

It should also be mentioned:

The **law 3296/2004** concerning the deduction of expenditures for scientific and technological research from the enterprises' profit. A campaign for the broader dissemination of the benefits of this measure took place, while GSRT examines the possible amendment of this measure in order to render it more attractive.

<u>The relatively recent Scheme "ELEFTHO"</u> aiming at supporting the creation of incubators for new knowledge-intensive companies. Its main axes are the following:

› The Incubator Administrator should be a private company
› It receives a grant from 4,5 M. euros up to 15 M. euros.
› The grant can be spent on:
  • Premises and equipment
  • Starting up expenses
  • Business Consulting
  • Equity Contribution to the new start-ups

What are the main recent policy measures and programmes established by Member States to develop and to strengthen public R&D investment? What are their main targets?

The gross expenditure in R+D (GERD) in Greece reached in 2005 0,6%[4] of the GDP. The public sector is the main contributor, while the private sector has low participation. This is mainly due to the number of SME's and the structure of the Greek economy, as mentioned in previous paragraphs.

In the effort to improve this situation, the Government has, on the one hand planned a new legal framework for RTD, while promoting measures, basically aiming at improving the existing R+D infrastructures and/or establishing new ones, improving the cooperation and synergy between public research organizations and enterprises, and providing economic incentives for private investments in R&D.

The New Legal Framework for Research and Technology

The Ministry of Development and the Ministry of Education, following a consultation with the Greek research community, have formulated a new draft R+D Law. This Law, among others, provides for the establishment of new decision-making procedure, with the involvement of new decision-making bodies to be created. It has been brought to the relative Parliament Commission in July 17th. The voting procedure is in process.

New Measures

Certain new measures in **line with the revised Lisbon strategy** have been elaborated. A **strong regional component** is the main characteristic for some of them.

› The Regional Innovation Poles: This ambitious action aims at increasing the innovation performance of Greek regions by funding/supporting the establishment of poles of technological skill and excellence in them. The **enhancement of competitiveness in the regions** is of a high priority. This new action is actually a policy instrument bringing together almost all stakeholders of the economic, scientific and social activities of the regions, thus creating an opportunity for regional development.
› The Innovation Zone of Thessaloniki: A new action supporting the development of an "Innovation Zone" in Eastern Thessaloniki, where a significant number of RTD bodies such as enterprises, research bodies, knowledge-intensive business incubators, universities and other education/training institutions are located.

[4] Temporary data.

- The Hellenic Technology Clusters Initiative -HTCI
  In 2005 the Ministry of Development launched the funding of innovation clusters in selected technology areas with knowledge intensive and export-oriented industrial potential. The creation of the Hellenic Technology Clusters Initiative (HTCI) has been, so far, the result of this effort.
  The first cluster created by HTCI is in the area of microelectronics and embedded systems. New clusters in the domains of biotechnology and language technologies are also in the process of their creation.
- The " Hellenic Observatory for Research and Technology Specialties-HORT" has been created under the auspices of GSRT, in order to monitor mismatches between offer and demand in the R&T labour market and to identify shortages in R&T domains. A HORT portal providing services to researchers is anticipated by the end of 2008.
- **The** pilot application of "DIODOS" program, aiming, mainly, at the reduction of the costs of broadband access - for students who using Internet home.
- The establishment of a new research centre in Thessaly (KETEATH). Two more Research centres in Epirus/North Western Greece and in Eastern Macedonia-Thrace are in the process of their establishment.

At last it is noted that:

- Following Greece's accession to the ESA Convention as a full member in July 2004, Greece is making a big effort, through the actions/activities carried out in the frame of the so-called 6-year "transition period". Greece has been granted this period by ESA in order to boost its industrial sector to participate in and benefit from the Agency's programmes/activities at the end of this period. In this effort Greece is assisted by ESA.

The Strategic Development Plan for Research, Technology and Innovation within NSRF, for the period 2007-13

The Strategic Development Plan for Research, Technology and Innovation has been elaborated by GSRT for the planning period 2007-13. The thematic priorities are still to be defined, following an open national consultation procedure. The Strategic Development Plan for Research, Technology and Innovation is the strategic tool for the formulation of the Operational Programmes of the new planning period.

A serious effort has been made that the Plan comprises important R+D and Innovation actions/activities for the country and, in parallel, secures their implementation. with the participation of the competent ministries and regional authorities.

The total public expenditure for the promotion of research, technology and innovation in the context of NSRF 2007-13 will, presumably, exceed the amount of 1 billion €. Significant impetus to innovation is anticipated to be given by the new actions within the NSRF 2007-13 Operational Programs, in particular the new RTDI measures within the Operational Programs, namely: «Competitiveness and Entrepreneurship», «Digital Convergence, «Education and life long learning», and the Regional Operational Programme of Attica.

Italy

Fabio Mussi

Minister for University and Research

Bringing Italy into the knowledge society

Fabio Mussi

We live in the knowledge economy. With productive processes ever more characterized – to say it with the words of the Italian sociologist Luciano Gallino – by increasing endless volumes of scientific knowledge and technological innovation.

In all the countries of the world, in mature and emerging economies alike, research and development (R&D) activities represent an absolute priority among policies for growth. This year, according to the *2008 Global R&D Report*'s data, published by *R&D Magazine*, the entire world will spend over $1.100bn in scientific research and technological development. It's an unprecedented investment, that is reshaping the technical, scientific, and economic landscape of the planet. The knowledge economy does not only involve countries – like those of North America and Europe – with strong scientific tradition and culture of technological innovation, but also ever more countries – like China, India, Brazil – that only a few years ago were defined under-developed or developing, and that now compete on equal terms with the West, not only in the production and exchange of low and medium technology goods, but also, and mainly, in the production and exchange of high technology ones.

We live more than ever in a multi-polar world of science and technology. Asia is once again – after many centuries – the continent with the highest level of investments in scientific research and technological development. In China, R&D expenditure has been growing for several years at a rate of well over 20%. However – with a constellation of big, medium and small countries – it is the whole continental Asia, together with Japan, that is asserting itself like a new, large pole of research and innovation.

But also in Latin America and, finally, in Africa, many are the countries that, with increasing investments in R&D, have started to run at an ever-faster pace towards the knowledge society and economy. It is indeed significant, and this fills one's heart with hope, to learn that a small country like Rwanda, recently come out of the civil war's tragedy and of genocide, is trying to build its own future on knowledge. Today, already, it invests 1.6% of its GDP in R&D and its government leaders have declared their will to reach the target of 3% as soon as possible. The same target that Europe set for itself no more than five years ago in Barcelona.

The truth is that almost everyone has understood that scientific research and technological development are key factors for the cultural progress of a country as well as for its economic progress. For they contribute in a potent way to create "new knowledge" and hence more culture. And because they are drivers for innovation processes, contributing more than any other factor to increase competitiveness in the economic and productive system.

Italy encounters some difficulties to keep up with the rest of the world. And also with the rest of Europe. We invest less than the others. We still adhere to a "development without research" model. We must recognize that, since the Lisbon European Strategy was launched (2000) and since its relaunch (2005), Italy has not achieved significant progress towards the objective of 2.5 percent of GDP for use in R&D spending by 2010, with two-thirds to come from the private sector. Many are the causes that have contributed to slow down the entry of Italy into the knowledge society. But it is certain that the failed increase of R&D expenditure had a negative impact of economic growth and that, in the absence of a clear turning point, it will be hard to succeed in avoiding the decline of the country.

Marking such a turning point is now possible. I am convinced that today we can start a knowledge-based policy "against the decline". Because at least two general conditions have changed: our government has brought public finances back under control, respecting the commitments entered into with the European Union; and, after five years of modest growth, not to say stagnation, a slight upturn was recorded in 2006.

The country, even if conditions are still not easy, can count on a certain amount of resources. It must now demonstrate the capacity to use well such resources, unlocked by financial recovery and by economic growth: we must increase investments in R&D, according to Lisbon's indications.

Italy does not only have a problem of quantity, but also of quality. We must act on the structural Italian research system's weaknesses.

We must favour the growth of companies' investments in R&D that, despite a slight growth from 2001 to 2005, represent less than 50% of the global funding (48,4% in the year 2005). For the same turnover, an Italian company invests in R&D up to four times less than an American or a Japanese one. And this even if in no other country private companies receive aids for investments in R&D as they do Italy. Before an economic operation, there is a need for a large cultural one. We must accept the challenge of the knowledge economy. We must modify the productive specialization of the country, increasing in a considerable way the production of highly knowledge-added goods. We must switch from a "without-research" productive model to a "research-based" one. I know that it's not an easy task. But I also know that it's a necessary task.

We must, at the same time, get over the insufficiency and the fragmentation of funds dedicated to R&D. Italian public investments in R&D are up to 20% lower compared to those of other European countries. We must start and fill such gap. By increasing the expenditure, but also by qualifying it in a better way. By acquiring, for example, a deep culture of assessment and merit. The constitution of the National agency for assessment of university and research goes into this direction.

Finally, we must catch up by dealing with the structural shortage of researchers. In Italy, the number of researchers is too low, in absolute as well as relative terms. They are often good. Indeed, in contrast to several *clichés*, our researchers are the most productive in the world, after the Swiss. They work more than the others. And the quality of their work is on average higher than international standard. But they are few. In universities as well as in public research centers. And, particularly, in enterprises. Their number must increase.

PRIVATE INVESTMENT IN R&D

Objectives indicated in the Lisbon Strategy require that the share of private spending on R&D should be two-thirds of the total expenditure. In most industrialized countries, this condition is a reality. Not in Italy. In our country, the two components of expenditure, as previously said, are largely similar. Private companies spend in R&D as much as the state. Actually, less. Even if their expenditure in R&D is one of the most publicly funded in the world.

This reflects the low number of large Italian firms able to support wide-ranging R&D programmes, and the difficulties encountered by small and medium-sized companies

(SMEs) in directing their growth priorities towards research. We must certainly keep in mind that the existence of a productive structure based on SMEs makes recording statistics on R&D spending by companies much more difficult, with significant potential for under-representation in this respect.

However it's a fact that the country's productive specialization is based on low and medium technology goods requiring few investments in R&D, while the most dynamic sector of the world trade is that of high technology, which needs large investments in R&D.

We must modify this specialization of our productive system. Because if we don't start and compete in the high-tech arena as well, we will grow quantitatively less and qualitatively worse compared to other countries. Indeed, a country that does not innovate is less equipped to face social disparity and environment degradation.

Companies' research activity is one of the key conditions to modify the productive specialization. And it's to stimulate research and innovation activity, that the 2007 Budget Law made provision for a tax credit to be assigned to companies for the 2007-2009 period, up to 10 percent of the costs incurred in connection with pre-competitive industrial research and development activity. With a view to favouring interaction between public and private research activity in particular, such credit is raised to 15 percent when the R&D costs refer to contracts entered into with universities and public research entities. The upper limit for spending is €15m for each tax period. In addition, with the draft Budget Law 2008, currently under the examination of the Italian parliament, the government intends to further strengthen this measure via an increase in the share of costs incurred in respect of contracts executed with universities and research centers for which credit can be claimed, up from 15 to 40 percent, and a rise in the spending threshold, from €15m to €50m.

Moreover, a total of €86m has been set aside to subscribe for units in closed investment funds (i.e. mutual funds invested primarily in financial instruments) promoted and managed by one or more fund management companies (SGRs). The aim is to finance the creation, development and innovation of small and medium-sized enterprises in under-utilized areas throughout Italy. This is intended to encourage inflows of private capital towards small and medium-sized businesses located in Italy's *Mezzogiorno* and involved in process or product innovation using digital technologies. The action is intended to promote investments in risk capital during the initial phase of a company's activity, including funding the analysis, valuation and development of the original business idea prior to the phase of launching the business. Investments may also be directed towards financing the development and first sales of a product. The above does not constitute state aid: public involvement in each individual closed investment fund may not exceed 50% of the total assets of the fund in which said investment is being made, i.e. a lower percentage than that stated in the terms and conditions of operation. The duration of the public investment in each fund or segment does not exceed ten years, without prejudice to the time strictly required to complete disposal of the investments.

Bringing Italy into the knowledge society is an emergency that must be addressed immediately, starting from today, and being well aware, however, that such emergency will not be over tomorrow. It is a long term process. To manage it, an industrial policy with a strategic vision is required.

That's why the government has launched the programme "*Industria 2015*", the aim of which is to relaunch a new strategy for industrial policy that will have to strengthen the business system, and that of SMEs in particular, and to favour its structural evolution towards arrangements that are more compatible with the new competitive scenarios, i.e. towards more knowledge-added productions.

Several of the most important measures provided for in the original draft law were included in the 2007 Budget Law. A Fund for competitiveness and development has been set up and will, in particular, support industrial innovation projects. Such projects will be able to provide strong impetus to the productive apparatus and, through larger investments in research and development, increase production in high-technology content sectors, and requalifying, by strengthening it, the SMEs system.

We identified five areas of action, in line with the objectives stated in the Italian National Reform Programme for the Lisbon Strategy and, at European level, in the VI and VII Framework Programmes for research and development and in sector-based technological platforms: energy efficiency, sustainable mobility, new technologies for "made in Italy" products, new life technologies, and innovative technologies for cultural heritage. In the 2007 Budget Law, too, approx. €1bn in funds was set aside to finance these projects, which may also be eligible for other sources of funding, such as the Fund for under-utilized areas, the 2007-2013 plan, and regional resources.

Towards these strategic objectives we call for the joint commitment of the whole country: the central government, local administrations, the world of enterprises, universities and research bodies, and the financial system.

The operating instruments for this new model of industrial policy are the industrial innovation projects, by which we intend to realize:

› an increasingly targeted intervention by the public sector in technological/productive areas considered to be strategic for the development of the country;
› a reorganization of the model of supporting productive activities through the "project" method, with clear definition of the objectives to be pursued, public and private entities to be involved, and the action to be carried out;
› a strong integration of all public instruments used in terms of granting incentives to businesses, e.g. for R&D and innovation or even to carry out new investment in productions, in terms of tangible and intangible infrastructure, and in terms of qualifying public and private demand.

The industrial innovation projects are at an advanced stage of execution.

Another important component of the government's programme is the Fund for corporate finance, for which provision is also made in the Budget Law, and which, like the industrial innovation project, is also at the enactment stage. The objective here is to support a process of financial strengthening in SMEs, in particular through the use of instruments facilitating access to credit, finance and the financial market. To this end: we have notified to the European Commission's offices the scheme to aid risk capital; we have finalized an outline of the scheme to mitigate credit risk; , we are trying to draw up a draft decree (in conjunction with the Ministry for Economy and finance, having consulted with the Bank of Italy), for the Fund's methods of operation. The fund's provision will be €300m, as stated in the 2007 Budget Law, to which should be added sums still in the two other funds which will now be closed (Single guarantee fund, and Fund set up pursuant to Article 4, para. 106 of Italian Law 350/03).

PUBLIC INVESTMENT IN S&T

Private research has a crucial value for the country's economic development. This awareness doesn't diminish but, on the contrary, strengthen the public role. State must do more. In terms of governance, indicating the strategic targets and building suitable cultural fabric and regulatory framework for innovation, but also by strengthening universities and public research bodies.

Of course, the state itself must be aware of the strategic role research occupies in defining plans for the country to grow. Our government is starting to acquire full knowledge about this aspect. Accordingly, the Italian Ministry for University and research has been included in the Inter-ministerial Committee for economic planning for the first time. In addition, the 2007 Budget Law introduced provisions to strengthen co-ordinated management of funds earmarked for research and innovation therein, for which three different ministries are competent: the Ministry of University and research, the Ministry of Economic development, and the Ministry of Innovation and reform in the public administration. In a joint statement signed in July 2007, the three ministries undertook to support Italian participation in European R&D initiatives, with particular reference to the Joint Technological Initiatives and co-ordination of national research programmes pursuant to Article 169 of the EC treaty, through joint preparation by the three ministries of specific national plans to highlight objectives, strategies and methods for such involvement, and identify the regulatory instruments and financial resources required. The first round tables have already been launched following submission of the JTIs at the Competitiveness Councils in May and June 2007.

But, as previously said, the state has also the duty to create a cultural environment suitable to innovation and to competitiveness. It must start by encouraging merit and by building an efficient network of public higher education and research assessment. From this point of view, novelties are not negligible. In December 2006, constitution of the national agency for assessment of university and research was approved ("*Agenzia Nazionale di Valutazione dell'Università e della Ricerca*", "ANVUR"). The agency, with the assistance of external referees, will have to: assess the quality of universities' and public research bodies' activities; act as a "evaluator of evaluators" by orienting, co-ordinating and monitoring the assessment activities performed by the internal assessment bodies; assess the efficiency and effectiveness of state funding and incentives for research and innovation programmes. The structure and functioning of the agency is currently under review by the competent parliamentary bodies, and ANVUR is expected to become fully operative early in 2008.

The government's duties regarding the relations with the scientific communities are very delicate. It must coordinate and elaborate main directions of research policy.

It must not abuse its power though. It must not intervene into research. Autonomy is one of the basis of research. It is with this spirit that, in September 2007, the parliament approved a proxy-law to launch reordering of the national public research bodies under the authority of the Ministry for University and research, precisely with the objective of granting them increased autonomy, efficiency and responsibility. Reference criteria in the new regulatory framework will involve, in particular: recognition of statutory autonomy for the bodies; assessment of quality of research results, to be carried out by ANVUR; criteria for funding, to reflect the results of the assessment; adoption of measures to promote the European and international dimension of research; identification of systems aimed at deriving value from the professional qualities of researchers; introduction of measures to encourage co-operation with the regions in the field of scientific and technological research; and support for innovation by productive sectors.

The fragmentation of funding is another limit on the Italian research system. With the aim of ensuring greater effectiveness, the 2007 Budget Law established a new fund, the Fund for Investment in Scientific and Technological Research, or FIRST. FIRST will enable resources to be managed organically, implementing the comments made in the 2008-2010 national research programme, to support both academic activity and research proposed by companies. The fund includes the annual resources from the funds previously managed by the Ministry for University and research, i.e.: University Research Projects of National Interest ("Progetti di ricerca di interesse nazionale delle Università", "PRIN"); Fund for Research Incentives ("Fondo per le Agevolazioni alla Ricerca, "FAR"); Fund for Investment in Basic Research ("Fondo per gli Investimenti della Ricerca di Base", "FIRB"), and the share assigned to the Ministry for the Fund for Under-Utilized Areas ("Fondo per le Aree Sottoutilizzate", "FAS"). In addition to these resources, the 2007 Budget Law increased FIRST by €300m for each of 2007 and 2008, and by €360m for 2009.

Research activities are carried out on the territory and need several levels of integration: international, national, but also regional and local. The government's duty is also to promote this integration at different stages. In practice, it means thinking about the policy for innovation and competitiveness with a view to complementing national and regional dimension on the one hand, but also ordinary industrial policy with the research policy in private companies on the other. From this point of view, actions co-financed by the European structural funds as part of the National operating programme for the 2000-2006 are particularly important. Such funding represent, up to 2006, more than €3bn, €1bn of which in aid to the productive system for innovation and technology transfer, establishment of networks and co-operation between companies and research institutes, and approx. €800m for high-quality training.

More than €300m has been committed to the creation of infrastructure for research and technological development. Seven regional technology centers and laboratories have also been financed, and 169 research projects at universities and research institutes funded for a total of around €30m. Throughout the country as a whole, €360m in funds has been committed from the Fund for under-utilized areas, corresponding to around 700 projects.

The attempt to create a culture of research and innovation in order to enter into in the knowledge economy must be realized at every level. To this end, the strategy for research, innovation and competitiveness will mark with great emphasis the new consolidated programme of national and EU resources drawn up in the National Strategic Reference Framework 2007-2013. Research priority for just the regions of Italy's *Mezzogiorno* accounts for around €14bn. To this end, regional operating programmes have been drawn up for both the Convergence regions and those of the Regional competitiveness and employment objective.

Economic resources are necessary. However different analyses have shown that increased investment in research and innovation on its own is not sufficient to bring about growth. As previously said, the best conditions around innovation must also be created, at every level: macro and micro. This means establishing integrated regional policies for research, innovation and competitiveness. This is what we try to realize with the National operational programme 2007-13, which targets the regions of the Convergence Area for "Research and Competitiveness" and which, through huge volumes of funds, proposes a significant change to the productive specializations of the territories, through high-impact initiatives both in terms of research production, and above all its assimilation into productive processes. The programme, in addition, intends to favour a widespread modernization of the productive structure in the areas requiring intervention, in line with the need to develop the local production fabric to higher and more efficient levels of competitiveness.

The institutional methods by which the programme will be implemented will lead to close collaboration between the administrations (the Ministry for University and research, which will primarily be responsible for action promoting research, draws up a programme strictly integrated with that of the Ministry of Economic development, which shall primarily be responsible for action to support and develop competitiveness, with the involvement of the Department for Technological innovation on various initiatives dealing most directly with effects on the issues related to the information society). The objective is to build up a strong critical mass linking the National research programme and the new national industrial policy plan ("*Industria 2015*").

A good synthesis of the programme's ambition is represented by the target indicators for 2015: to bring public and private R&D spending in the areas requiring intervention up from 0.84 percent to 1.36 percent of GDP; to increase private spending on R&D from 0.24 percent to 0.39 percent of GDP; and to bring the number of staff employed in research and development up from 1.6 to 2.66 per thousand.

HUMAN RESOURCES FOR S&T

An indicator that, more than any other one, measures the distance, including the cultural one, between our country and the rest of the world that is rapidly entering into the knowledge society, is the number of researchers. Italian researchers are few in absolute and extremely few in relative terms.

Figures speak for themselves. In absolute terms, in Italy the number of researchers is far below that of the other leading European countries:[1] they are around 72,000, compared with 271,000 in Germany, 200,000 in France, 158,000 in the United Kingdom, and 101,000 in Spain. In relative terms this means that Italy is one of the lowest-ranking European countries, with a ratio of three researchers to every 1,000 employees, as against a European (EU-15) average of 6.2. Less than half of European average. There is no doubt that that we must catch up if we want to increase our capacity to compete in the present economy, based on increasing endless volumes of scientific knowledge.

Recruitment of new researchers is therefore vital to our research system as a whole, but it is equally important that such recruitment should be the result of a serious, open selection process based on criteria of merit. In order to launch such virtuous process (more researchers, better selected), the 2007 Budget Law made provision for an extraordinary plan to recruit researchers to work in universities and public research bodies. For universities, a specific decree in the process of being issued establishes the methods of procedure for competitive examinations for researchers, with the aim,

[1] Source: OECD (2004), FTE unit; United Kingdom: 1998.

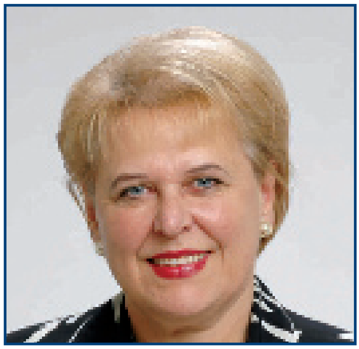
stated in the law, of ensuring swiftness and transparency in such procedures, in line with international standards. Funds of €20m have been set aside for 2007, €40m for 2008, and €80m as from 2009, which, once the system is fully operative, will translate to approx. 1,600 new posts for university researchers. For the national research bodies, recruitment procedures will be slightly different but shall be based on the same criteria of seriousness. Once the new system is fully operative, around 600 new posts should become available.

Upstream of researchers recruitment, the government has already implemented actions to encourage students to orient themselves toward scientific subjects. In particular, the "scientific degrees project" ("*Progetto Lauree Scientfiche*") aims at increasing the number of new students and graduates doing degrees in scientific disciplines, and helping them enter the workplace. The project involves thousands of teachers and students according to the different types of action: guidance, renewed teaching methods, use of workshops, work placements and apprenticeships. The project also makes provision for a sizeable number of grants to students enrolling on degree courses in mathematics, physics, chemistry and material sciences. Different types of action are being implemented: careers guidance and teacher training, for which €2m has been disbursed, and activities more strictly reserved to students, such as laboratories, work placements and workshops, in respect of which €6.17m has been set aside, with over 80 percent of this figure having already been disbursed.

It is a piece of news of these days that, this year, reversing a long-term trend, registered students are increasing in "hard" scientific faculties. It's a signal that makes us hope for the best. And strengthen our belief that Italy has human resources capable of reversing the path to decline and enter as a protagonist in the knowledge society. With such resources, any other hurdle can be easily cleared.

The Future of Science & Technology in Europe

Latvia



Baiba Rivža

Minister for Education and Science

Baiba Rivža

Science and Technology Policy in Latvia: Present and Future

Questions

1. Where do Member States stand in the implementation of the S&T policy targets of the Lisbon Agenda, namely in respect to R&D public and private investment and human resources?

2. Is there a need to renew or to streamline policy targets in the field of S&T in the context of the Lisbon Agenda?

3. What are the main recent policy measures and programmes established by Member States to develop and to strengthen public R&D investment?

Latvian opinion

All Lisbon Strategy related activities are laid out in the National Lisbon Program of Latvia for 2005-2008. It reflects the most essential problems for Latvia to achieve the Lisbon strategy goals, indicates the main lines of action and activities to solve these problems, and includes performance indicators to achieve these goals. The Program shows how Latvia will promote growth and employment in the medium-term.

In order to foster research and development and to increase national innovation capacity, the Program defines the following priority tasks:

› ensure substantial growth of public investment and foster private investment in R&D;
› strengthen the leading role of higher education establishments in the development of science and research;
› consolidation of the intellectual potential of science and development of applied research in the area of innovative technologies, create conditions for conducting research in fields, which have adequate applied potential in Latvia;
› ensure renewal of intellectual potential in science, improving the system of doctoral grants and modernising scientific infrastructure;

› promote transfer of knowledge and technologies in production (including business incubators and technology parks).

Along with this, Latvian national policy documents also address other R&D issues such as the promotion of links between science and industry, strengthening of the public research base, the human resources in S&T and intellectual property rights. The most important one is the funding issue.

As to our main current achievements implementing the National Lisbon Programme one of them concerns **increased public investment in research and development**. The Law on Research Activity (adopted by Saeima in 2005) envisages an annual increase in the public R&D funding of at least 0,15% of GDP until it reaches 1% of GDP. As the result the allocations for R&D from state budget were increased in 2006 if compared with the funding level in 2005. In 2007 the state budget allocations are as twice as much as in 2006 and have reached 32,372 million LVL (about 46 million EUR).

Earlier governmental documents (the Declaration of Intended Activities of the Cabinet of Minister and the Law on Research Activity) aimed to reach the target of 3% of GDP spent on R&D by 2010. Recently, in the National Lisbon Program this target is lowered to a more realistic 1,5% of GDP by 2010 (and 1,1% by 2008), in particular when the currently still low R&D funding level of 0,57% of GDP in 2005 are taken into account. Another factor is the high growth rates of our national GDP during last years.

Latvia is a small country therefore we need to set priorities for research investments. For the more efficient use of financial resources there have been defined and Cabinet of Ministers has in summer 2006 approved nine research priorities, to contribute more efficient and strategically oriented development of science and research:

› Agro-biotechnology (innovative and environmentally friendly food production)
› Biomedicine and pharmacology (gene technology, new drag synthesis)
› Energy (environmentally friendly renewable energy, energy safety, effective use of energy)
› Information technologies (secure software, integrated information and communication systems and networks, electronics)
› Letonics (Latvian language studies)
› Material science (nanotechnologies for the functional material creation; new composite materials)

› Wood science (new products, technologies, durability)
› Medicine (research and technology based development of clinical medicine)
› Environment (influence of the climate changes on the water systems).

Respectively nine state funded research programmes have been financed starting from 2005.

We consider that it is not necessary to change policy targets of Lisbon agenda, however there are concerns regarding the timetable of implementation. In our case the problems of implementation are connected with the fact that Latvia's GDP is growing very rapidly and at the same time the inflation is increasing.

We believe that in order to strengthen public R&D investment it is important to implement a set of several activities starting from development of legal basis, definition of research priorities, modernization of research infrastructures, as well as effective use of Structural funds for research activities, including the development of human resources.

Question

What are the main barriers for the growth in R&D private investment? What are the main measures each Member State is carrying out in order to encourage R&D private investment?

Latvian opinion

We believe that in order to increase the private investment for research and development it is very essential, first of all, to create institutional environment and legislative background that is friendly for innovative activities.

Public research institutions and universities and their cooperation with industry play a central role in the innovation system and this cooperation should be further promoted by specific activities and measures. In the further development of RTD cooperation not only the transfer of knowledge such as the elaboration of new, competitive products and technologies should be considered. We see that there is a strong need to substantially enhance communication and interaction between research, industry and also government in definition of collaborative activities and development of research road maps. We believe that especially trans-sector and interdisciplinary interactions could provide new opportunities for emergence of new ideas, their realization and raising funds for this.

Very important issue in the context of raising private investments for RTD is also an issue on intellectual property rights. At least in Latvia we need to enhance the understanding on intellectual property rights and ensure higher appreciation of intellectual property.

Stimulation of research is defined as an integral part of the Latvian innovation policy. Latvian Development Plan for 2006-2013 and Innovation policy addresses research issues mainly through policy measures to promote science-industry links (*inter alia* through creation of technology transfer offices at higher education establishments) and supporting collaborative applied research projects involving entrepreneurs and scientists.

Since 1993 Ministry of Education and Science is implementing the Program of Market-oriented research projects. The goal of this Program is to promote co-operation of Latvian scientists and entrepreneurs (especially SME) in conducting the research necessary for development of new technologies and products.

An updated approach to research issues and ways of raising private investments for RTD in innovation policy will be set out in the new Program on Entrepreneurship and Innovation for 2007-2013, which is currently developed by the Ministry of Economics. To embody linkage between private investment and research and development in Latvia, it is important to mention that recently several centres of competence will be created. The research institutions and enterprises will be encouraged to co-operate to ensure the capacity for the solving of strategically important issues both for industry and for science. Latvia strongly believes that the development of the centres will increase the interest of private sector to invest in research and development.

HUMAN RESOURCES

Questions

1. With a view to sustaining sufficient levels of qualified researchers in Europe, how can we attract more young people to study science and technology and to pursue research careers? How can the participation by women to the research effort be enhanced?

2. What are the measures taken by each member state to avoid brain drain and to encourage brain gain?

During last 10-15 years there has been decrease in number of new doctors in Latvia. For example, in year 1990 there were about 25 000 researches in Latvia but in year 2006

– about 5 500. By developing infrastructure in the institutes and laboratories, by participating in international projects, etc, currently we have reached increase in number of new doctors.

Further improvement of human resources in research and science is one of our main tasks. Latvia has improved the system of doctoral grants and scholarships and has established the postdoctoral research support system co-funded by EU Structural funds – 8 million lats (10.5 million euros for the time period 2004-2006). In 2006/2007 there are more than 1800 doctoral students in our universities and this number is growing. 106 doctoral students defended their PhD thesis and in this year we expect about 170 to 200 graduates and new Doctors of science.

I would like to emphasize that the modernization of research infrastructure which was started in 2004 has stimulated the returning of researchers, which have left Latvia after the "Iron Curtain" fall, in the beginning of 1990s.

Besides, starting from 2006 additionally to the grant system and different programs the regular institutional funding for the research institutions is provided, including the salaries for research personnel. This guarantees more stability for researchers.

Latvia seriously works on the project on Science Adventure Centre which is planned to be created in 2008. The success of research and technology will be explained and demonstrated in this centre in interactive way to make scientific issues more comprehensible for school children. The main goals of this centre will be the increase of awareness on research issues and the raise of interest of youth on researchers' profession.

Regarding the involvement of women in the research Latvia has achieved good results – the number of women working in science is higher than the number of men. The disproportion may appear in the higher positions. Therefore we consider that it is necessary to improve the social support system for women that could facilitate the chance to work adequately.

The Future of Science & Technology in Europe

Luxembourg

François Biltgen

Minister for Culture, High Education and Research

Research and Innovation

François Biltgen

Trend in public budgetary credits for R&D

	2000	2003	2004	2005	2006	2007	2008 (forecasts)
Credits allocated to R&D [M€]	28,1	60,6	72,0	94,5	113,6	142,0	175,0
% of GPD	0,13	0,24	0,27	0,32	0,36	0,42	0,50

Domestic R&D expenditure by sector of operation

	2000 [M€]	2000 % of GPD	2003 [M€]	2003 % of GPD	2004 [M€]	2004 % of GPD	2005 [M€]	2005 % of GPD
Private sector	337,0	1,53	379,4	1,48	393,0	1,46	408,0	1,39
Public sector	27,5	0,12	46,4	0,18	54,7	0,20	64,0	0,22
Total	364,5	1,65	425,8	1,66	447,7	1,66	472,0	1,61

R&D personnel and researchers by sector

	2000 R&D p. [ETP]	2000 Res. [ETP]	2003 R&D p. [ETP]	2003 Res. [ETP]	2004 R&D p. [ETP]	2004 Res. [ETP]	2005 R&D p. [ETP]	2005 Cherch. [ETP]
Private sector	3337	1399	3500	1594	3655	1546	3662	1532
Public sector	325	247	510	355	663	485	729	559
Total	3663	1646	4010	1949	4318	2031	4391	2091

The Government's objectives in respect of research, development and innovation (RDI) policy as formulated in the government programme and, in particular, the wish to subscribe fully to the Lisbon strategy, given concrete expression in, among other things, the aim of increasing public credits allocated to RDI to 1% of GDP, assign to this policy a prominent position in the general context.

In view of the major changes in the research and innovation landscape in Luxembourg and, in particular, the establishment of the University of Luxembourg and the Government's commitment to increasing its investment in RDI in the coming years, the recommendations of the OECD review on Luxembourg's research and innovation system, with which the Government had commissioned the OECD and whose conclusions were presented in May 2006, are currently being implemented.

The Government will ensure a coordinated approach to defining and implementing public-sector research in Luxembourg and intends, in particular, to establish a high-level committee to develop the broad outlines of public-sector research in future.

The Minister of Research and the Minister of the Economy have agreed to strengthen coordination between their two departments. In the context of programming of national RDI policy, this coordination will find expression in the co-chairmanship of both the Ministers on the Senior Committee for Higher Research and Innovation and at policy implementation level it is represented by close and regular consultation between the two departments.

In its meeting of 26 January 2007, the Council of Government decided to create a Senior Committee for Higher Research and Innovation. The actual idea of creating such a committee was suggested by the OECD review on Luxembourg's research and innovation system as one of the report's recommendations.

The Committee is mandated to help to formulate and develop a national research and innovation policy that is consistent and effective, and to advise the Government on short-, medium- and long-term implementation of this policy. In this context, the Committee will draw up proposals for strategic objectives, national research policies (particularly as regards subjects), and for suitable instruments and measures for consistent implementation of national research and innovation policies.

The Committee will be co-chaired by the Minister of Culture, Higher Education and Research and the Minister of the Economy and Foreign Trade. Depending on the subjects being dealt with, one or more other members of the Government may be involved in the Committee's work.

The Committee will also include

› three Luxembourgian personalities from the scientific world
› three Luxembourgian personalities from the business world
› three personalities from Luxembourg, at least one of whom represents civil society.

The Government will ensure a coordinated approach to defining and implementing public-sector research in Luxembourg, will ensure that public-sector research activities are efficient, and will provide funding for them on the basis of clearly set out strategic and operating objectives

The concept of the performance contracts, which the Government is in the process of preparing and implementing, is an effective instrument of governance that is recognised by the OECD as a good practice, in as much as performance contracts clearly set out the tasks and functions of various institutions, linking them to clear and transparent objectives.

In September 2006, the Government approved the multiannual establishment contract between the state and the University of Luxembourg. Implementing the Law of 12 August 2003 creating the University of Luxembourg, the development of the University forms the subject of a multiannual establishment contract negotiated between the state and the University. The contract, concluded for a term of four years, covers the University's general policy, its strategic choices, its objectives, and its activities in the fields of teaching, research, student mobility and administration. With regard to the budget, the contract stipulates that in return for the commitments made by the University, the State undertakes to finance the University's activities with an annual budget that will increase each year, reaching 72 million euros in 2009.

In September 2006, the Government embarked on a process of strategic audits of the CRPs (public research centres) and the CEPS (Centre for the study of the population, poverty and socio-economic policies), with a view to drawing up and preparing a multiannual performance contract with these public research institutions. The strategic audit has been based on the self-evaluation reports drawn up by the centres in accordance with clearly defined guidelines communicated to the centres in advance, and on open discussions with external experts. The results of the strategic audit constitute the basis for drawing up the performance-based contracts.

Strictly speaking, the performance contracts comprise three different but related elements:

› the centre's mission: this part describes and defines the tasks of the centre in question, the type of activities and the target sectors for the activities;
› the objectives that the centre aims to achieve, which are to be consistent with the centre's mission and with the main focus of its activities;

› indicators designed to produce quantitative measurements of these objectives. There are two categories of indicators in particular: financial indicators (percentage of basic funding [state], of competitive funding [FNR (National Research Fund) and FP (Framework Research and Development Programme) in particular], of funding ensuing from research contracts with either the private or public sector), and result-based indicators such as the numbers of scientific publications, doctoral theses, spin-offs created, etc.

Evaluation and, in particular, ex-post evaluation of the research institution's activities is an integral part of the performance contract. The bilateral open discussions of the specific content of the contracts began during July 2007. The performance contracts will enter into force on 1st January 2008 and, for this pilot phase, will be valid for a three-year term. The state of Luxembourg undertakes to guarantee the budget, as far as the budgetary resources available allow, for the period under consideration in return for the results specified in the contract.

Following the same reasoning, last May the Ministry of Culture, Higher Education and Research initiated a strategic audit of the National Research Fund (FNR), with a view to preparing a performance contract following an approach similar to that employed for the public research institutions. The performance-based contract with the FNR will make it possible to define the latter's tasks and strategic objectives in the context of developing the national public research system. It is intended that the contract between the state and the FNR should enter into force on 1 January 2008 and should also cover a three-year period.

The Government will promote the concentration of national R&D efforts on a limited number of priority domains of high added value for the national economy, high-quality education in Luxembourg and social cohesion, taking account of the results of the foresight exercise currently being conducted by the FNR.

In this context, in 2006 the Ministry of Culture, Higher Education and Research had commissioned the National Research Fund to undertake a foresight exercise with a view to drawing up an informed and well-founded list of future priority subject areas for research of high socio-economic potential for the country, it being understood that these domains would receive the lion's share of supplementary public investment in research in the coming years. In May 2007, the National Research Fund submitted the results of the foresight exercise to the Minister of Culture, Higher Education and Research, proposing six 'national priorities' involving 20 subject areas, all being regarded as of equal priority.

With the aim of responding to the Government's wish to focus a key proportion of national research efforts on a limited number of domains adjudged to be priorities owing to their potential for socio-economic impact as stated in the government programme, the Ministry of Culture, Higher Education and Research is currently conducting consultations with ministries, public administrations, and the professional chambers and associations concerned. These consultations are intended to help better to target the priority research domains, and to establish the relevance of the research topics proposed, to make them consistent with the Government's general policy, and to ensure that sectoral needs are taken into account, with a view to proposing very soon a more limited list of priority research domains.

These meetings also fit into the framework of the more systematic collaboration, coordination and consultation advocated by the OECD for R&D policy.

The Government will ensure the development and mobility of human resources from within Luxembourg, and will ensure the promotion of intersectoral and public-private mobility.

In its meeting of 11 May 2007, the Council of Government adopted the draft law on aid for research training amending the 'research-training grants' instrument introduced by the R&D Law of 9 March 1987. When the new system was developed, account was taken of the recommendations of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers drawn up by the European Commission in 2005.

In fact, the current system of research-training grants offers the beneficiaries (usually doctoral or post-doctoral students) no security in terms of jobs, social security, etc. This grant is simply a lump-sum contribution to the beneficiaries' subsistence and training costs. It does not involve a formal contractual relationship between the researcher and the host establishment in which he carries out the research work constituting the subject of his training, nor does it involve a contribution to the social security system on the researcher's behalf.

The new system of aid for research training endeavours to fill this gap by combining the allocation of this aid with the existence of a (fixed-term) employment contract between the trainee researcher and the host establishment. Another aim of the draft Law on aid for research training is to promote trans-sectoral mobility, namely between the public and private sectors. In order to encourage this intersectoral mobility for doctoral and post-doctoral students, an additional grant is provided for if the project involves specific collaboration with one or more partners in the private sector. Lastly, it is also proposed that in future the National Research Fund will be given responsibility for managing the programme of aid for research training.

The Government will encourage the immigration of researchers and technical competences, including persons from countries outside the EU, and will transpose into national law without delay Directive 2005/71/EC of the Council of the European Union on a specific procedure for admitting third-country nationals for the purposes of scientific research.

In February 2006, a working group was set up with responsibility for transposing into Luxembourg law Council Directive 2005/71/EC of 12 October 2005 on a specific procedure for admitting third-country nationals for the purposes of scientific research. The working group, comprising representatives of the Ministry of Culture, Higher Education and Research, the Ministry of Foreign Affairs and Immigration, the Ministry of Labour and Employment, the Ministry of the Economy and Foreign Trade, and the Ministry of Social Security, completed its work in March 2007, and its contribution was incorporated into the draft law on free movement of persons and immigration. In its meeting of 15 June 2007, the Council of Government agreed on the broad outline of this bill, which will now begin a consultation stage.

The Government will ensure the development, at the University of Luxembourg and in the CRPs, of genuine 'competence centre' in the priority sectors, based on a model of public-private partnership, comprising the involvement of the private sector in specifying the tasks and research agendas and in managing and financing these centres of competence.

The Ministry of Culture, Higher Education and Research is currently drawing up, in close cooperation and consultation with the Ministry of the Economy and Foreign Trade, a competence centre pilot programme whose main aim is to strengthen the links between public-sector and private-sector research. The leitmotiv of the competence centre concept as currently being developed by the two Ministries is based on public-private partnership, with primacy for the private sector as regards specification of objectives, drafting of work programmes, and the implementation strategy. Following consultation with potential interested parties from the private sector, an initial pilot centre of competence could see the light of day in the course of 2008.

The Future of Science & Technology in Europe

The Netherlands

Maria J. A. van der Hoeven
Minister of Economic Affairs

Ronald Hans Paston Plasterk
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Towards an excellent research environment and an innovative economy in the Netherlands

1. INTRODUCTION

The fourth Balkenende government, which took office in the Netherlands at the beginning of 2007, is committed to strengthening the international reputation of Dutch academic institutions and research institutes, making the Netherlands more attractive to knowledge workers and strengthening the Dutch economy's capacity to innovate. The latter will be achieved by deploying knowledge and innovation more effectively, in the interests of solving social issues and developing new, innovative products and services.

The Dutch government has said that by 2010 it wants to invest 3% of GDP in research and development (R&D), of which 1% will be public and 2% private. According to the latest figures, private R&D intensity in the Netherlands was 1.02% in 2005, and public 0.75% in 2004. The fourth Balkenende government is contributing to R&D intensity by stepping up funding in the field of research and innovation, amounting to more than €500 million by 2011 (€300 million going to innovation, knowledge and research and €200 million to enterprise).

1.1 Introduction by the Minister of Education, Culture and Science, Ronald Plasterk

The Dutch government considers excellent basic research crucial to an innovative, creative and competitive economy, and we will therefore introduce measures to strengthen such research. Less emphasis will be put on funding institutions, and more on funding individual researchers at different stages of their careers. For this purpose, we will double the funding of our main talent instrument, the Innovational Research Incentive Scheme administered by our national research council NWO.

One of the main challenges Europe faces is sustaining sufficient levels of qualified researchers in Europe and attracting top-quality researchers to Europe. We have to focus on the quality of our researchers and institutions and on providing good career prospects for researchers. It should be stressed that this can go hand in hand with efforts to modernise universities and research institutes. Selecting top-quality researchers starts at the beginning of their careers, in the PhD period. PhD students are perfectly capable of selecting their own research topics and the research group they would like to join. This means that we have to give more freedom to our young researchers in the scientific domain. We should provide positions for top-quality researchers, enable them to be creative and allow them to profit from the experience of professors.

Graduate schools with integrated research masters and PhD programmes provide good models for researchers' careers policy. These graduate schools should give students the necessary guidance to embark on a scientific career, but they should also provide other skills. Within the graduate schools, PhD's should be free to pick the project and the supervisor of their choice. This will raise the quality of graduate schools. We are developing graduate schools based on the American model, but tailored to the Dutch situation. This requires a cultural change towards greater transparency and excellence, and a stronger focus on research specialisation within the institutions.

In conclusion, it is my ambition to further strengthen the position of Dutch science and technology within Europe and the world in general. In my 2008 science budget I have formulated concrete indicators to evaluate achievement of this goal.[1] In the European debate on science policy I would welcome greater focus on personalised funding of top-quality researchers, more open project funding on the basis of excellence, training researchers, large research facilities and networking and opening up national R&D programmes as part of the Lisbon process.

1.2 Introduction by the Minister of Economic Affairs, Maria van der Hoeven

In today's open world economy, we are working on a prosperous, sustainable, enterprising Netherlands. This is my ministry's new mission. The keys to increased prosperity are knowledge, innovation and enterprise – also the hallmarks of the European Union's Lisbon Strategy. Our aim is to build on the Netherlands' capacity to innovate and to stimulate corporate social responsibility. As part of this we are putting new emphasis on improving how businesses apply knowledge and innovation to solve social issues. After all, people want more than just material prosperity. They want solutions for problems that concern them. In 2008, as part of a project

[1] Notably:
- International scientific quality on the basis of citation index: global top 3;
- Scientific productivity: top 5 within EU;
- Number of doctorates per 1000 persons aged 25-34: a higher relative number of doctorates;
- Raising the number of researchers per 1000 persons in the working population;
- Raising Dutch participation in the EU Framework Programme.

focusing on the Netherlands as a country of enterprise and innovation (the NOI project), a number of social innovation programmes addressing the issues of energy, health care, security and water will be launched.

The Green Paper on the European Research Area also recognises the importance of research and innovation for social ends. For example, it highlights the importance of:

"a coherent approach towards international S&T cooperation, under the banner of sustainable development, can assist in building bridges between nations and continents." It is also recognised that through cooperation with developing countries we can strengthen their S&T capacity and support their sustainable development in close liaison with development policy. With emerging economies we can develop programmes of mutual benefit, particularly to address global challenges. In its response to the Green Paper, the present Dutch government would add that the European Research Area is also important for tackling social problems which the Member States are unable to solve individually. This could take the form of supporting scientific progress and policy substantiation aimed at sustainable development in the field of health, energy and climate change, as indicated by the Commission.

Last, but not least, efforts to tackle social problems have a bearing on the way in which science and technology are communicated to the public. This should be done in a manner that generates greater appreciation for science and technology among European citizens.

2. PUBLIC FINANCING OF SCIENCE AND TECHNOLOGY

As mentioned in the introduction, the fourth Balkenende government has decided to increase public expenditure on innovation, knowledge and research with an annual amount that rises from circa €60 million in 2008 to €250-300 million by 2011.

The Netherlands as a country of enterprise and innovation (NOI) project will focus on applying knowledge and innovative enterprise more effectively when tackling social issues. An Innovation Platform has been set up, involving key players representing different knowledge economy sectors. The platform will have a leading advisory role. As an independent 'icebreaker', it will propose ideas and drive innovation. Following on from the key areas approach, and as part of the NOI project, a number of technologically oriented social innovation programmes are being set up. These will enable the Netherlands to excel, contributing to the achievement of social objectives.

In 2008 three programmes will be launched, addressing energy, health care and water. The energy programme will focus on making better use of renewable energy sources like solar energy, and on the innovative, sustainable and cost-effective use of nanotechnology. The objective of the healthcare programme is to use innovation to improve care while deploying fewer staff. The water programme will focus on challenges in the fields of treatment and management.

In the “Knowledge ambition and research infrastructure” report (published in June 2005), the Dutch Innovation Platform emphasised the importance of **large-scale research facilities**, and called for more structural investments in such facilities. The government believes it is vital that Dutch research is given the opportunity to excel with such facilities and be involved in international initiatives. The importance of high-quality, large-scale research facilities is also recognised at EU level. The *European Strategy Forum on Research Infrastructures* (ESFRI) has drawn up a roadmap specifying European priorities. As a follow-up to this, the Netherlands has set up a national roadmap committee to map priorities. The committee will publish its recommendations by the end of 2007. Some extra funding has been allocated to the national research council (NWO) to cover major infrastructural costs. NWO will be responsible for selecting and assessing concrete proposals detailed in the national roadmap, on the grounds of quality.

The Dutch government has proposed in its budget 2008 to continue its investment in genomics by contributing €271 million to the **Netherlands Genomics Initiative** (**NGI**) in the coming years. With this decision, the Dutch cabinet recognises the excellent results of the NGI Genomics Centres during their first term, both scientifically and in terms of valorisation. The continuity that this decision provides for the most successful NGI Genomics Centres will ensure continued excellence in their performance, with an increased focus on valorisation. In its second term, NGI aims to maximize the economic and societal value of its excellent scientific research. This investment also underlines the importance that the Life Sciences sector, of which the Netherlands Genomics Initiative forms an integral part, has for the Dutch knowledge economy in general. The Dutch government has already shown its commitment to the Life Sciences sector by investing in several important initiatives such as Technological Top Institutes (TTIs) and innovation programmes. With the continued support for the second phase of NGI, the Dutch government underscores that in fostering innovation it is vital to support both fundamental and more application oriented research programmes.

3. HUMAN CAPITAL FOR SCIENCE AND TECHNOLOGY

Investing in human capital to benefit science and technology is of course another important public task.

If we are to strengthen our capacity to innovate, we need a well-educated labour force. The Dutch government has therefore set itself the goal of increasing the number of academics of outstanding quality in the Netherlands, while reducing the number of people dropping out at all levels of education. By introducing compulsory school attendance for all young people up to the age of 18 until they attain a basic qualification, and compulsory work experience placements up to the age of 26, the Dutch government is encouraging young people to obtain basic qualifications and to keep in touch with the employment market. Given the increasing shortage of technicians and technologists the government will set up a Task Force on Technology, Education and the Labour Market, in which the business community plays a leading role. The government is also working on an action plan designed to improve technology research, with the three Dutch Universities of Technology (Delft, Twente and Eindhoven).

The Dutch government believes that creating room for excellence and strengthening Dutch academic institutions' and research institutes' international reputation will attract the best students and researchers. New policy will focus on developing and exploiting room for creativity and for young academics' independence. The emphasis will be on the best, investigator-driven research. In order to further encourage excellence the government is committed to individually tailored **Talent Programmes**, such as the Innovational Research Incentive Scheme, and NWO's Aspasia and Mozaïek programmes (for women and ethnic minorities respectively). As of 2008 the Dutch government will earmark 1 million a year for grants for individual female professors in a bid to tackle the persistent problem of unfulfilled female potential and the comparatively low percentage of female professors in the Netherlands.

We will substantially increase the funding of our main talent instrument, the Innovational Research Incentives Scheme (Vernieuwingsimpuls) that supports young promising researchers, raising the budget from 27 million in 2007 and doubling it from 75 million in 2008 to 150 million in 2009 and subsequent years. We will also drop the requirement that universities must match one third of the funding. The scheme is administered by the national research council (NWO). Research will thus be financed more on the basis of scientific excellence and in competition between researchers, and money will flow to the best researchers. In the past the scheme was hampered by the co-funding requirement for universities. This made it difficult for the researchers selected to move to the institution of their choice. By dropping this requirement, we will give the selected researchers more freedom to choose where to work. This makes possible the bottom up formation of top-quality research clusters, driven by the choices of individual researchers.

Ensuring that sufficient people take up a career in science and getting talented young people interested in science is one thing; giving them the space to develop and offering them career development is the next step in a successful science policy. The Dutch government is currently investigating the possibility of reshaping researchers' training so it is closer to the American graduate school model. This would mean that training would be preceded by an orientation phase, and would end with a well-supervised research period, with the PhD's able to choose their own research topic and supervisor. This programme may be interesting for the European Union, as the training of PhD's is important for the European Research Area and the European Higher Education Area (through the Bologna Process). The specifics of the European proposals for improving career policy (the European Code and Charter for Researchers[2] in particular) and optimal use of European mobility and human resources instruments (the Marie Curie Actions) should all feature in our research institutes' personnel policy. Though Dutch universities are autonomous, the Minister of Education, Culture and Science can start a dialogue with them in order to strengthen human resource management, with the focus on improving career prospects for young researchers, women and ethnic minorities.

Attracting **knowledge workers from abroad**, partly by simplifying procedures, is one of the four Balkenende government's priorities. Admitting highly qualified knowledge workers enhances the quality of the working population and thus benefits the Dutch business climate. In 2006 the knowledge migrant scheme (simplifying the entry of knowledge workers from third countries) was broadened to include all scientific researchers, and the work permit requirement for foreign students taking up placements was abolished. In 2007 the permit requirement was also abolished for asylum seekers taking up placements as part of a vocational training course. This resulted in a sharp

[2] Signed by the Association of Dutch Universities on 4 June 2007.

increase in the number of knowledge migrants applying to the Netherlands for residence permits; from 2,007 in 2005 to 3,934 in 2006. In the first quarter of 2007 1,579 applications had already been made. The main theme of the government memorandum 'Towards a Modern Migration Policy' (published in May 2006) is currently being elaborated in the form of new policies, and subsequent legislation. The most important changes envisaged are:

1. increased transparency, by reducing the number of schemes for different target groups to five categories (temporary work; regular work and study; knowledge workers; family; humanitarian);
2. a possible introduction of a points system for innovative entrepreneurs, independent researchers and creative people of outstanding ability; and
3. a new voluntary agreement system which divides responsibilities between government, businesses and institutions and knowledge migrants. These changes are expected to result in a better response to knowledge needs, an increase in selectivity and transparency, and faster processing of applications.

4. PRIVATE INVESTMENTS IN RESEARCH AND DEVELOPMENT

As stated in the introduction, private R&D intensity in 2005 was 1.02%, which means that it lags behind the 2% goal for 2010. Within the framework of the Innovation Platform's Knowledge Investment Agenda, the ten largest R&D companies have expressed their intention to increase R&D expenditure by 5% per year. The initial figures for R&D expenditure by the top 25 Dutch R&D companies in 2006 show a clear increase in excess of 7.5% relative to 2005.[3]

Research shows that about 60% of the Dutch lag in R&D intensity relative to the OECD average can be attributed to the specific sectoral structure of the Dutch economy.[4] However, even allowing for that, the Netherlands spends relatively little on R&D compared to the OECD average. In addition, foreign companies conduct relatively little R&D in the Netherlands – measured in terms of the openness of the Dutch economy – which is another cause of low R&D spending. The sectoral structure makes it more difficult for the Netherlands to achieve an R&D intensity of 3% of GDP (Barcelona objectives) than for other EU countries. However, this structure is not a permanent fixture. Over time it could change by means of higher R&D spending. The government is taking action to increase R&D intensity.

[3] *Technisch Weekblad*, March 2007.

[4] See H.P.G. Erken and M.L. Ruiter, *Determinanten van de private R&D uitgaven in internationaal perspectief* [Determinants of private R&D expenditure from an international perspective], Ministry of Economic Affairs, 2005.

Innovation is needed to increase productivity, especially as labour shortages increase, because shortages on the labour market tend to drive up wages and therefore have the potential to damage the Netherlands' competitiveness. Consequently, the new Dutch government's innovation policy has three general priorities:

1. SME innovation offensive: small and medium-sized enterprises do not always have the time, resources or basis needed to maximise their tremendous potential for innovation activity. The SME offensive therefore encompasses a number of new initiatives and funding increases:

› The Netherlands Bureau for Economic Policy Analysis' impact assessment (February 2007) shows that the use of **innovation vouchers** in the pilot projects carried out in 2004 and 2005 generated additional research contracts. The 2006 voucher project will be evaluated in the latter half of 2007. In view of the positive experiences with the vouchers thus far, the government has decided to broaden their application in order to promote exchange between SMEs and knowledge institutes.

› On the basis of the experiences gained from the nine pilot projects launched in 2005 and 2006, an **Innovation Performance Contracts** (IPC) scheme was introduced on 1 January 2007. The scheme aims to help groups of small and medium-sized enterprises to collectively execute their own multi-annual innovation plan.

› The **R&D tax incentives under the Research and Development (Incentives) Act** (**WBSO**) will be tailored to SMEs: measures will include broadening the target group (also services), expanding the definition of the term 'starter' and extending the first tax bracket.

› The government intends to examine whether it is necessary for small companies always to be bound by the same rules as large companies ("what's sauce for the goose is not necessarily sauce for the gander").

In addition, the following instruments are available to innovative SMEs:

› The **Challenger Facility** provides credit to SMEs for innovative but risky projects that do not fit in with any of the themes of the innovation programmes.

› There are currently six **Small Business Innovation Research** (SBIR) pilot projects in progress.

› A total of 113 starters in the technology sector have been launched or are about to launch with funding from the **Knowledge Exploitation Grant Scheme** (SKE).

2. Innovation programmes for social challenges are under way, aimed at good water management, renewable energy, public safety, a clean living environment, good health care and high-quality education. Innovation can play an important role in dealing with issues that affect society. It even kills two birds with one stone, enhancing competitiveness while tackling social issues. The Innovation Platform is currently drawing up an innovation programme aimed at tackling social challenges in collaboration with the new inter-ministerial Knowledge and Innovation Programme Department. The initial focus will be on energy, water, care, education, safety and agricultural innovation.

3. Key areas approach in innovation policy: The Netherlands is maintaining the course set by the Innovation Platform with regard to the key areas approach. One of the aims is to achieve and maintain international excellence in specific areas (more focus and mass) and to drive up private R&D investment. This should significantly strengthen the appeal of the Netherlands to foreign investors looking to make knowledge investments.

Five innovation programmes are currently running in the key areas:

› *Point One* (June 2006): aimed at embedded systems and nano-electronics.
› *Food & Nutrition Delta* (September 2006): aimed at healthy and convenient food and nutrition with a high added value.
› *Water Technology*: aimed at water treatment technology.
› *High-Tech Automotive Systems* (June 2007): aimed at vehicle efficiency (reduced consumption and emissions) and at encouraging motorists to alter their driving behaviour to increase safety and fuel efficiency.
› *Maritime Innovation Programme* (July 2007): aimed at the maritime manufacturing industry and the offshore industry.

It may be possible to launch a number of new programmes in 2008 based on the results of exploratory studies. These could include innovation programmes in relation to the areas of chemicals, life sciences & health, materials, and/or ICT and other services.

In addition to the three general priorities outlined above, there are also the following generic innovation instruments:

› With some 15,000 applications and a total budget of 425 million in 2007, the Research and Development (Incentives) Act (**WBSO**) is the largest technology incentive scheme in the Netherlands. It has been decided to increase structural funding for this instrument by an amount increasing to 115 million as of 2011.

- The **Launching Customer** (LC) plan of action, set up in 2006, aims to increase government awareness of how to support innovation in the private sector through procurement and tendering policy. The plan will be implemented in 2007 and 2008.
- The Dutch House of Representatives has passed a bill **amending the Patents Act**, now under consideration by the Senate. The changes are mainly intended to provide greater legal certainty by abolishing entirely untested patents and to increase access to the patent system by lowering the threshold costs.
- The Ministry of Economic Affairs' Department of Foreign Investment in the Netherlands (DBIN) works closely with science and technology attachés, the Agency for International Business and Cooperation (EVD), the regions, SenterNovem and knowledge clusters in the Netherlands to **attract knowledge-intensive investments to the Netherlands**.
- Together with regional development companies and large municipalities, DBIN runs an **Investor Development** (ID) programme. The purpose of the programme is to embed foreign investors that have established an office in the Netherlands, nurture the business climate, identify problems, and draw attention to planned new knowledge-intensive investments.

Slovakia

Ján Mikolaj

Deputy Prime Minister
and Minister for Education

Ján Mikolaj

Science and Technology Policy in Slovakia by 2015

MAIN OBJECTIVE OF THE SLOVAK SCIENCE AND TECHNOLOGY POLICY BY THE YEAR 2015

To create conditions for the development of science and technology and more expeditious introduction of the results of research and development in practice requires to take a number of measures throughout the system of Slovak science and technology that will take account of the specifics of their domestic development on the one hand, and the objectives and aims of the Lisbon Strategy in the area of science and technology, on the other. The relevant objectives and aims of the long-term plan will be harmonised and interlinked so as to enable science and technology to respond flexibly to the internal (national) and external (international) demands. Their implementation will be continuously monitored, the progress assessed and subsequently they will be updated enabling science and technology to meet the expected mission to be inseparable component of the economic and social development of Slovakia and make a contribution to increasing competitiveness of the Community.

Science and technology as one of the tree pillars of the development of a knowledge based society: ***education – science and technology – innovation*** **must be at the centre of the attention of political and government bodies taking decision of the overall directions of the development of the Slovak Republic, so as to play the role of the decisive development factor for the country.** To this end, the state science and technology policy must set itself such objectives for the development and application of the system of science and technology whose achievement will ensure the expected role of the development factor. **For this reason the main objective of the national science and technology policy by the year 2015 shall include increasing the involvement of science and technology in the overall development of the Slovak**

Republic – a more intense involvement of science and technology in addressing the economic and social problems of Slovakia. The increased involvement of science and technology in the country's development will entail increased contribution of Slovakia to the overall improvement of the competitiveness of the EU.

THE AREA OF HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT

Available human resources are the basic prerequisite for the development of science and technology; they are the prerequisites needed to increase the competitiveness of the Slovak economy, more expeditious modernisation of the whole society, and, ultimately, they are the necessary preconditions for a successful development of the knowledge society in its full range. Indeed, well-educated human resources are the necessary preconditions for the development of the knowledge society, **which is why education as one pillar of the knowledge society will be subject of a special attention of the long-term development and exploitation of science and technology.**

Human resources of research and development are a crucial factor to advance scientific knowledge, technological progress, to improve the quality of life, the prosperity of the European citizens and to contribute to the European competitiveness. It is vital to create an open and sustainable European labour market and **ensure adequate and highly educated human resources in the research and development.**

With a view to ensuring qualified human resources in adequate numbers for the system of science and technology we will have to **boost the interest of young people in working in research and development, which entails to focus the attention on raring and educating potential research and development workers already in primary schools, continue at all types of secondary schools, universities and ensure for both the research and development workers lifelong training.**

Therefore in the education and training for a professional career in research and development the emphasis will be laid on the **development of regional education, with** a view to making science and technology attractive and accessible to pupils and stir their interest for the activities in science and technology already from the upper grades of primary school by suitable adjusted teaching subjects curricula highlighting the contributions of science and technology to increasing the quality of people's life. Equally students will be stimulated for selecting science and technology as their vocation within extracurricular activities.

In higher education the main objective prompted by the needs of the European labour market will be to **flexibly adjust the content of the study programmes to the needs of practice and also create new study programmes.** Furthermore, it will be important to **raise the interest of secondary school students to study in all disciplines of science and technology contained in the study programmes of university study**, as there is a need to ensure continuity of expertise in all disciplines of science and technology.

At the **first two levels of tertiary education** the aim will be to concentrate on attracting students with aptitudes for science and technology and encourage them to continue upgrading their qualification by taking up doctoral study. **PhD study programmes** will be conceived so as to enable PhD students to actively participate in solving research and development projects and gain experience also during the time spent in business organisations of research and development and in the organisations of research and development abroad. **The creation of conditions for mobility of PhD students and young research workers through support programmes,** with the Ministry of Education as the guarantor, is the basic prerequisite for increasing qualifications of young human resources. To encourage the interest of the young generation to remain working in the research and development, **a system will be have to be created that would facilitate PhD graduates to find employment in the research and development.**

Another objective in the field of human resources will be to attract the research and development workers working abroad to return back and work in the Slovak organisations of research and development. It is therefore important to develop a system that will facilitate young researchers returning from research fellowships abroad to reintegrate in the Slovak research and development organisations.

Another objective is to secure permanent qualification advancement for the research and development workers, which implies the creation of a system of upgrading qualification for research and development staff with a view to achieving certain qualification degrees. The lifelong professional training in research and development with gaining of certain qualification degrees will become the basis for the career advancement of an employee in research and development and his or her financial remuneration.

In connection with the professional qualification growth of research and development employees it will be necessary for the universities to involve more actively in the design of training modules for employees of small and medium sized enterprises by means of their research and education centres and centres of technology transfer.

A technology and innovation mobility portal, linked to the mobility portals for research and development workers and part of the mobility centres of the European Research Area **will foster mobility of the Slovak research and development workers within the EU and also within the research and development sectors by introducing new information means for the mobilities offered to research and development workers at national level. This new objective will create the need to put in place a central information portal for science** within the European Research Area. The central information portal will provide also information on the systems of health and social insurance in the Member States of the EU, the introduction of supplementary pensions and the European health insurance cards.

The objective in the area of human resources in the research and development will be not only to ensure the return of the Slovak experts from abroad to the organisations of research and development in Slovakia but also to create conditions to make the **Slovak organisations of research and development attractive for foreign specialists. In this area we will need to create more acceptable conditions for the stay of foreign experts in Slovakia by amending the Act on the stay of aliens in our territory. At the same time, we will have to improve the visa policy for experts from the third countries and lay down the terms and conditions for their activity in Slovak research and development organisations.**

Alongside with the intend to attract human resources from an early school age and from university stage and hence reverse the trends of aging of the research and development community, conditions **will** need to be **created also for the research and development workers to remain active in the research and development. Conditions will be created particularly to retain middle generation of researchers as the main driving force, so that they, upon achieving the relevant scientific qualification degrees** remained working in the research and development, also with regard to the requirements of the newly emerging disciplines and groups of disciplines of science and technology. These conditions will be secured by creating reorientation support programmes that will help to flexibly address the problem of the need to reorient researchers for the work in a newly created science or technology discipline.

In this respect the priority objective will be to create sufficient material security for the qualified research and development staff and enhance the status of the employee of research and development in the public opinion which is important also in directing and increasing funds to support science and technology. A more positive perception of research and development and the significance of the activities carried out by their employees will secure also the objectives in the area of popularisation of science and technology.

Back in 2000 the European Commission declared the objective to improve the position and the role of women in the research and development. Its current efforts are directed at the EU Member States encouraging women working in research and development to promote their professional growth and to assert themselves in the leadership positions. **The objective in this area will be to improve the conditions for the assertion of women in the research and development.**

THE SUPPORT OF SCIENCE AND TECHNOLOGY

The support of science and technology is the most important systemic priority. It is implemented by means of two forms, direct and indirect support. As a rule, attention in this respect used to be focused on direct support, but owing to the need to ensure increased share of business resources for the development of science and technology, in accordance with the Lisbon Strategy, it will be necessary to focus also on the area of indirect support for science and technology and establish incentives for the business sector.

Direct support of science and technology

To ensure the implementation of the objectives and goals of the development of science and technology by 2015, a total expenditure on science and technology will be required at 1.8% of the GDP in 2015.

One important priority in the direct support of science and technology will be to raise the participation of the business resources in the support of science and technology so as to reach a **2/3 proportion of these resources in the overall support of science and technology** in 2015. Therefore in order to ensure increased participation of business resources it will be necessary to create incentives of indirect support for business entities.

The trend of setting the increase in the total expenditures for science and technology by the year 2015, including the increase in the expenditures from the state budget, business sources and foreign sources, must be based on the fact the overall expenditure on science and technology in 2015 will comprise 1.8 % of the GDP, and that the share of expenditures from the business sources in 2015 will reach the value of 2/3 of the overall expenditures. The following table gives the information on the estimated expenditures on science and technology in relevant budget years from the state budget, from business sources and from foreign sources by the year 2015.

Table 1 › **Estimated trends of increased intensity of expenditures on science and technology from the state budget, from business sources, and from foreign sources by the year 2015 (in % of GDP)**

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015
TE	0.68	0.82	0.96	1.10	1.24	1.38	1.52	1.66	1.800
SB	0.39	0.412	0.434	0.456	0.478	0.500	0.522	0.544	0.566
BS	0.25	0.36	0.47	0.58	0.69	0.80	0.91	1.02	1.13
FS	0.04	0.048	0.056	0.064	0.072	0.080	0.088	0.096	0.104

Abbreviations: **TE** total expenditures on science and technology; **SB** expenditures from the state budget; **BS** expenditures from business sources; **FS** expenditures from foreign sources

Explanation for the table: In the estimation of the growth trends in expenditure on science and technology from TE, SB, BS and FS we draw on the fact that the expenditure on science and technology from the SB in 2007 has been budgeted at around 7 billion SKK (the data of the Ministry of Finance of the SR) and on the fact that the shares of expenditures of SB, BS and FS in 2007 remain at the level of the year 2005, i.e. the expenditure of the **SB will be 57% of the TE,** the expenditure from **BS will be 36.6% of the TE** and **FS will make up 6.4% of the TE.** If the expenditure of the SB at 7 billion SKK makes up 57 % of the TE, then the BS (which are 36.6% of the TE) are 4. 49 billion SKK and the FS (which are 6.4% of the TE) are 0.79 billion SKK. Based on the above, **then TE (as SB+BS+FS) is 12.28 billion SKK, which is 0.68% of the GDP.**

The expenditure in 2007 from the SB (7 Billion SKK) makes up 0.39% **of the GDP**, the **expenditure from the BS** makes up 0.25% **of the GDP** and the **expenditure from the FS** makes up 0.04% **of the GDP**.

If we estimate that **in 2015 the TE will amount to around 1.8% of the GDP,** the **expenditure** from the **SB should make up around 1/3 of the TE,** the **expenditure**

from BS should amount to 2/3 of the TE (the Lisbon Strategy target), **and** the **expenditure from FS will also grow** (in 2015 they will be around 0.104% of the GDP: FS = TE - /SB +BS/), then we can estimate the growth trend of TE, SB, BS and FS (in % of the GDP) in the years 2008 to 2014.

In the years 2007-2013 (in addition to the already existing support, from 2004, of human resources in research and development from the European Social Fund) another source of public funding will participate in the support of research and development in the Slovak Republic, namely the European Regional Development Fund. The means from this fund will be provided under the **Operational Programme "Research and Development"**. The support provided under this operational programme will contribute, to a substantial extent, to the modernisation and revitalisation of research and development technical infrastructure.

Table 2 › **Estimated allocations of expenditure from the ERDF for the support of research and development in the SR under the Operational Programme "Research and Development" (in billion SKK /with the exchange rate approximately 33.50 SKK/1 EUR) and the co-financing allocations from the resources of the State Budget**

YEAR	2007	2008	2009	2010	2011	2012	2013
ERDF in billion SKK	5.76	5.61	5.40	4.98	5.36	5.91	7.50
2. ERDF in % of GDP	0.32	0.29	0.26	0.22	0.23	0.24	0.29
Contribution at 15% from NR to ERDF	1.02	0.99	0.95	0.88	0.95	1.04	1.32
3.Contribution at 15% from the NR to ERDF v % of GDP	0.06	0.05	0.05	0.04	0.04	0.04	0.05

Abbreviations: **ERDF** resources of the European Regional Development Fund; **NR** national resources from the state budget

Indirect support of science and technology

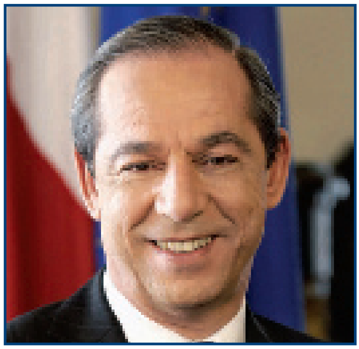
One of the main objectives of the Lisbon Strategy is to bring up the proportion of expenditure of the business sphere to a level of 2/3 of the total expenditure on science and technology. Therefore, the **main objective in indirect support of science and technology will be to introduce tax instruments** the application of which will ensure increased investment by the businesses entities into science and technology.

In the light of the current state in the participation of business sources in the overall support of science and technology, which in 2005 was at circa 37%, **it is necessary**

to put in place indirect instruments that will operate as motivation factors for the private sphere to invest more in the support of research and development, because it is expected (according to Table 1) that the business resources will co-participate at 2/3 in the overall expenditure in 2015. The EU countries implement these incentives most commonly by measures taken in their tax systems. **Hence the main objective in the indirect support of science and technology will be the introduction of tax instruments for the business entities to increase their investment in science and technology.**

Source: Long-term Plan of the National Science and Technology Policy by 2015 (approved by the Slovak Government on 12 September 2007)

Malta



Lawrence Gonzi

Prime Minister

Malta's research and innovation system in transition

Lawrence Gonzi

1. INTRODUCTION

Malta's research capabilities, the research system and the structures for managing that system have undergone considerable change in the last decade and the pace has accelerated in recent years. This is due to a number of factors, with an additional thrust deriving from Malta's accession to the EU in 2004 and the benefits and pressures of EU membership which has led to strong policy initiatives on the part of the Maltese Government, as well as to the country, embarking on a fast learning curve. A number of strategic changes to improve Research and Innovation (R&I) governance and institutional structures have been introduced since 2005 which have given R&I a much-needed higher profile on the national agenda. For the first time, a National Strategic Plan for R&I for 2007-2010, featuring over 65 recommendations and a number of key performance indicators were approved by the Maltese Government in July 2006.

This report outlines the key developments in the national research system and the related governance structures, identifying key achievements and progress in setting policies and goals.

2. HISTORICAL BACKGROUND

There is no comprehensive account of the origins, development and extent of national scientific research activity with the first efforts to launch a science and technology policy dating back to 1989 with the setting up of the Malta Council for Science and Technology (MCST), the first policy advisory body to Government. This constituted the first attempt to support research activity through the setting up of a number of networks in ICT, water, marine sciences, energy, and industrial applications.

These networks and the vision conferences which some of them instituted, were ahead for their time, yet had limited success in securing more public resources for research. The latter was primarily restricted to the University of Malta's limited research budget, the equally limited research funds of the government institutes and laboratories and external funding available through a few bilateral and multilateral agreements.

The main successes of the work carried out in the nineties, related to the work on the National Strategy for Information Technology of October 1998, a comprehensive exercise lasting almost a year, which led to certain policy initiatives being taken in the telecommunications, education and business sectors. Another important milestone was the launch of the first National Science and Technology Policy Document endorsed by the Maltese Government in 1994 detailing a list of priority areas and themes and a number of cross-cutting issues. This was the first time that science and technology had achieved a place on the national agenda.

The first major levers of change emerged with the participation of Maltese researchers in the international cooperation programmes of the EU, including Avicenne and Internal Cooperation (INCO) under the Fourth Framework Programmes. Malta's association to the Fifth Framework Programme highlighted the fact that the country has a highly competent core of researchers who have international links with their peers in other Member States. Indeed, Malta's high per capita participation in FP5 and FP6 is a clear indication that researchers were still able to attract EU funding and to join EU research *consortia* despite constraints of size and lack of critical mass, and limited national funding and support structures. The first efforts to address these concerns culminated in the launch of the first National Research, Technological Development and Innovation (RTDI) Programme for 2003-2004, which was highly over-subscribed, confirming the urgent need for national research funding. The National RTDI Plan and its implementing Programme emerged in response to perceived challenges relating to the Lisbon Agenda together with a growing awareness among policy-makers of the need to address national research priorities and the specific needs and interests of Malta-based researchers.

The National RTDI Programme shall provide financial support for scientific research and development over the whole research and innovation chain, from basic and applied research to near-to-market innovations. The National RTDI Programme is designed in such a way as to encourage an increasing investment in research and innovation activity to comply with the 3% Lisbon and Barcelona targets[1].

[1] http://www.mcst.org.mt

3. STRENGTHENING R&I POLICY STRUCTURES AND GOVERNANCE

Since 2004, the Government has been undergoing a process of deep reflection and re-thinking of national policies relating to science and technology, research and innovation and technological development. The governance of the system of R&D policy instruments has undergone a major transformation in the period 2005-2006 as a result of the Government's request for a review of the research and innovation sector. This review commissioned by Government earlier in 2005, drew on previous studies and put forward a number of important recommendations, which were subsequently taken on board to strengthen the system. This led to the implementation of a number of changes affecting both the structure and organisation of the Research and Innovation policy-making framework together with the orientation, development and implementation of policies.

In October 2005, the Prime Minister of Malta announced a higher profile and a revised and more specific remit for the Malta Council for Science and Technology (MCST), together with stronger links with the Office of the Prime Minister, as part of the national budget measures. This was the first visible change in the process laid out in the National strategy. This included the re-location of responsibility for science and technology policy from the Ministry of Education, Youth and Employment to the Office of the Prime Minister. This has given research and innovation policy a higher profile and priority on the national agenda. MCST, the national advisory body and main funding agency on research and innovation policy now reports directly to the Office of the Prime Minister. MCST's position was further strengthened by the appointment of a high profile Chairman and Board together with a 40 member Advisory Council chaired by the Principal Permanent Secretary of the Maltese civil service. The members of the Council are drawn from the public and private sectors and academia and include representation of Maltese SMEs, and FDIs.

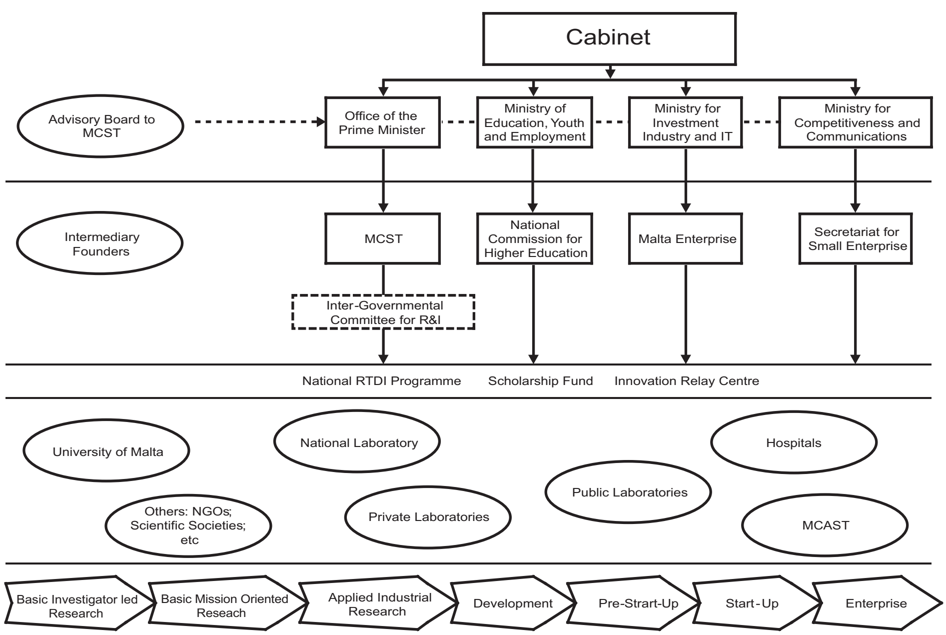
To further reinforce policy coordination and joined-up policies across Ministries, the Maltese Government set up an Intra-Governmental Committee for Research and Innovation in 2006. Through this Committee, it is expected that the research and innovation policy process will receive a more coherent and consolidated management at national level.

The operational objectives of this Committee have been set out as follows:

› to formulate joined-up policies on Research and Innovation;
› to attain congruency of Research and Innovation aims;
› to act as a communication and information sharing fora on Research and Innovation activity.

The structure and mechanisms for the improved co-ordination of R&D policy instruments with policy instruments outside the R&D domain has thus been put in place. The National Strategic Plan for Research and Innovation 2007-2010 approved by the Maltese Government in 2006, has also been based on a broad consultation process and close collaboration between MCST and the key players in the innovation system, including Malta Enterprise, the University of Malta, the line Ministries and public agencies and research entities. This has helped to forge important links between the players and to identify the need for strengthening policy and research capacities at all levels. The Plan specifies a number of shared competencies relating primarily to promoting business R&I, where prime responsibility rests with MCST, Malta Enterprise and the Secretariat for SMEs within the Ministry for Competitiveness and Communications, to meet the newly set R&I strategic objectives within their respective portfolios. Specifically, they are seen to be accountable within their respective portfolios, for meeting the strategic principles of this plan and also to work together in bringing all relevant actors to take-on the strategy and draw maximum benefits from it (such as, through evaluating appropriate incentive schemes to promote R&I).

Diagram 01 › **Below depicts the currente institutional framework for R&I Malta**



MCST was thus assigned a new, more prominent role to ensure more coordinated and coherent policy approaches in research and innovation across Ministries and agencies to harness synergies and avoid duplication of effort. The new remit of MCST includes acting as a catalyst in defining and facilitating the role of research and innovation activity as a support to Ministerial policies and sectoral strategies. In this context, MCST is responsible for addressing research and innovation policy gaps and opportunities which arise at the interface between different Ministries. A key new aspect of its remit is the responsibility to prioritise and orient national RTDI investments, public and where possible private, to sectors and niche areas with high business potential and relevance to meet pressing economic and social needs.

4. NEW APPROACHES IN FORMULATING R&I POLICY

As a result of these changes, there is evidence of new orientations and trends in policy with the introduction of a broader range of measures, direct and indirect as part of the National Strategic Plan for Research and Innovation 2007-2010, approved by the Maltese Government in 2006. The Strategic Plan combines both perceived challenges and stakeholder demand as it has taken into account the heavy over-subscription of the first call for proposals under the National RTDI Programme in 2004. The Plan reflects a number of new policy directions, in particular the drive to leverage State R&I funding to address on the one hand, national priorities relating to water, energy and the environment, whilst on the other hand focusing on a select number of value-added economic sectors in order to obtain value-added R&I. The definition of these priorities was based on an open consultation process which was carried out by MCST between October 2005 and June 2006 involving the public and private sectors and academia.

In total, nine thematic consultation sessions were held with experts from the University of Malta, the public and private sectors on ICT, Biotechnology, Energy, Transport, Tourism, Masonry and Construction, Electronics, Nanotechnology, Materials and Manufacturing and Environment. The thematic consultations involved a discussion on the priorities within the sector, ongoing strategy processes and policy developments and types of measures suited to the sector. The information obtained through these consultations was structured according to thematic area to provide a detailed sector-specific policy context, reflecting on existing national capacities and competencies.
In particular, the key findings which were compiled and presented in Appendix C

of the Strategic Plan highlighted the "lack of an underlying policy in the majority of these sectors, with the exception of ICT and to a lesser degree energy." The Key Findings document further notes that, "even in ICT and energy, there is as yet no clear and well-defined research and innovation strategy". The findings have provided an important input to the prioritisation of measures and themes.

This marks a new approach to research and innovation policy with an emphasis on vision development, priority-setting, sharing of competencies across Ministries and other agencies and the setting of short to medium-term targets and performance indicators. Horizon scanning has been introduced as an important tool in the re-definition of priorities by MCST in consultation with the appropriate stakeholders. This is to be carried out every three years, based on a minimum ten year time horizon.

Attention to complementarities and interactions between policies and measures is being catered for through MCST's new coordinating and overviewing role from within the Office of the Prime Minister to ensure joined-up approaches to R&I governance and measures. The new R&I Plan also specifies that although MCST is the key entity responsible for catalysing and overseeing implementation of the Plan, key functions are to be shared with Malta Enterprise and the Secretariat for SMEs within the Ministry for Competitiveness and Communications (MCMP).

The new Plan is informed by policy developments within the EU, particularly through information made available through the Scientific and Technical Research Committee (CREST) and the policy experiences of other Member States, in particular, small new Member States like Estonia, Slovenia and Cyprus. Sources such as the European Innovation Trendchart, ERAWATCH and the World Economic Forum rankings also provide important benchmarking insights. The references included in the Plan indicate this transnational policy learning process.

4. NEW POLICY ORIENTATIONS: NATIONAL STRATEGIC PLAN FOR R&I (2007-2010)

The new national Strategic Plan for R&I provides the roadmap for a long-term vision for the development of the sector which requires the launch of work simultaneously and ambitiously on a number of fronts. The Plan combines a mix of both the traditional supply-side measures, which involve increasing the resources made available to institutions carrying out research and generating new knowledge. The Plan has introduced changes in R&D policy on a number of levels, in terms of both policy rationales and approaches, through the targeting of particular priority areas and a strong business orientation.

The Plan has made more extensive use of indicators and benchmarks in making the case to Government for a significant boost in national funding for R&I up to 2010. The Plan draws on various studies and reports, both commissioned in Malta and international studies and defines a number of performance targets. The Plan recommends the use of future tools in particular horizon scanning and close collaboration with the National Statistics Office for the improvement of R&I indicators. Significant progress has been registered in 2006 in the development of R&I indicators as a result of the efforts of Malta Enterprise.

The National Strategic Plan for R&I (2007-2010) sets out a vision for "Research and Innovation at the heart of the Maltese economy to spur value-added growth and wealth."

The Vision is underpinned by the following strategic objectives:

› to leverage state R&I finances / funding to address pressing national issues relating to water, energy and the environment;
› to focus public resources, energies and abilities towards a select number of value-added economic sectors in order to obtain value-added R&I;
› to put in place the appropriate supporting and enabling environment for SMEs to innovate;
› to facilitate the establishment of an enabling platform that will allow Maltese enterprises in partnership with overseas institutions and business to enhance imported know-how and technology for exportation in the Southern Mediterranean region;
› to establish the appropriate mechanism for a business to academia nexus and an intellectual property framework for public funded research;
› to develop a National Pro-Innovation Culture supportive of Invention, Risk-taking and Entrepreneurship.

The National Strategic Plan for R&I (2007-2010) sets a number of targets based on performance indicators relating to:

› the SET Human Capital Base;
› Future R&I Capacity;
› R&I Progress and Performance;

- Industry-Academia Collaboration;
- Current R&I Capacity;
- Imported Know-How;
- Growth and Wealth Creation;
- Funding Sources for R&I in business, higher education and Government.

These have been introduced in order to allow for "effective health checking of the R&I landscape in Malta".

5. THE R&I POLICY MIX

The Plan is innovative in its emphasis on demand-side measures aimed at generating the demand for R&I products, processes and services and thereby enhancing the private sector's role in R&I. These thrusts are of course in line with the EU Lisbon Agenda and the target to increase R&D investments to 3% of GDP, with private sector spend accounting for 2%. In 2004, based on the EU Community Innovation Survey, Malta registered a substantial improvement in terms of the business expenditure on R&D which increased from 0.08% to 0.35%. Further efforts are required to ensure that this positive upward trend continues and work is currently underway to promote innovative public procurement. This collaborative initiative on the part of MCST with the Ministry of Finance is set to increase public service awareness of the potentially important role played by public procurement in generating the demand for more innovative products, processes and services and investments in R&I activity to meet this demand.

A related activity is the improvement of the process of capturing the extent of R&I activity underway both through a more accurate understanding of what constitutes R&I and by providing the tools for timely and effective capture of data. MCST in collaboration with the National Statistics Office and the Malta Federation of Industries is working on an initiative to improve the accuracy and timeliness of R&I statistics through the introduction of an on-line facility for submission of data by the private sector. Efforts are also being made to improve the level of competencies and expertise in R&I management throughout the public sector through appropriate training activity. It is envisaged that these measures together with the Plan's recommendation that a number of public agencies include R&I as one of their cost centres and dedicate 0.25% to R&I by 2008, will contribute to a major drive to increase and improve the public sector spend on R&I.

On the supply-side, it is clear that Malta needs to invest more strongly in its human capital base in R&I. This entails a range of measures on a number of levels starting from primary education. MCST is embarking on a major drive in 2007 to promote science popularisation and thereby attracting more young people to take up careers in science and technology. A dedicated strategy for science popularisation is being developed which will include ongoing dissemination activities as well efforts to improve primary level teaching of S&T. Further up the education chain, a number of new measures to improve research and training opportunities for young researchers are being launched targeting both academic and industry-oriented research. Closer collaboration between MCST and the University of Malta to ensure appropriate protection of intellectual property generated through these and other collaborative projects is underway. MCST is also working closely with the Government's Intellectual Property Office to promote awareness of developments in patenting and to encourage local patenting activity.

A range of measures are being introduced to promote R&D in the private sector. Here investments are being focused on four key priority areas: ICT, environment / energy, biotechnologies / health and value-added manufacturing. As outlined in the National R&I Plan, platforms of strategic importance will be set up in each of the four priority areas bringing together public and private sector players. More defined plans for these sectors will be developed in the coming year specifying niche areas to be targeted. Seed capital funding initiatives are currently being explored to ensure the availability of resources for taking forward the proposals generated. MCST will continue to support these initiatives through the National R&I Programme. These efforts will also be supported through the Euro-Mediterranean Initiative for Technology and Innovation (EuroMedITI),which is exploring similar and parallel areas for R&I investments within the wider Euro-Med market.

To sum up, the main changes to Malta's R&I Policy in recent years thus relate to a number of thrusts:

› more systematic approaches to policy formulation including open consultation processes and foresight approaches;
› less emphasis on research per se and more focus on research as the means to development and innovation;
› a strong business-orientation to R&D Policy balanced with due attention to national government priorities, such as energy, environment and water;

- shift from public R&D investments in any area to the targeting of four key sectors in order to generate critical mass: Energy and Environment, Health/Biotech, Value-Added Manufacturing and ICT, in an effort to focus on niche areas of existing strength and emerging opportunities;
- more joined-up inter-ministerial approaches to allow for greater coherence;
- extension of scope to address a broader range of measures, both direct and indirect.

6. CURRENT CHALLENGES

One of the key challenges being faced is the need to move to implementation of the Plan's recommendations. The start-up of new measures is currently underway but requires a focus of efforts to identify appropriate good practices in EU Member States for their design and implementation tailored to the Maltese context. The measures include the dedication of a substantial proportion of EU Structural Funds for R&I (2007-2013) with the introduction of new research funding and scholarships and fellowship schemes targeting the four areas of national priority (environment and energy, ICT, biotechnology / health and value-added manufacturing). Other measures include public procurement for R&I, R&I Planning in key government and public entities and the introduction of on-line capture of R&I indicators. A major initiative underway includes the further development of the Euro-Mediterranean Institute for Technology and Innovation.[2] The design and implementation of each of these measures and initiatives entails its own particular challenges but they share a common set of needs including improved investments in R&I skills among policy-makers (another recommendation of the Plan), shared competencies and more in-depth dialogue between the relevant public entities, the leveraging of public funds and reducing bureaucratic time lags in accessing national and EU funds.

Malta has continued with its commitment and drive to develop and bring improved coherence to R&I governance and institutional structures through a gradual strengthening of MCST's oversight role within the Office of the Prime Minister. This has been complemented by efforts to boost the country's funding for R&I in order to move closer towards achieving its targeted goal of investing 0.75% of GDP in research and innovation by 2010.

Malta is building on the significant changes in innovation governance that were affected in the past two years. With the Office of the Prime Minister taking the leading

[2] http://www.mcst.org.mt/events/20060302/EuroMedITI%20

role in spearheading science and technology policy, research and innovation have been given a higher profile on the national agenda. The Intra-Governmental Committee on R&I has been actively involved in 2006-2007 in consultations on implementing the guidelines and recommendations contained in the National Strategic Plan in order to create an enabling national R&I framework. This has afforded for a more structured dialogue on innovation issues and is promoting more joined-up approaches to policy initiatives across ministries. Moreover, closer working relations have been set up between MCST and the National Commission for Higher Education (NCHE), on identifying needs in strategic planning skills in higher education in view of the on-going reform in the Education System.

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The Future of Science & Technology in Europe

United Kingdom

Ian Pearson

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Science and Technology Policy in the United Kingdom

Ian Pearson

SUMMARY

The UK has a strong reputation for world-class research. Although the UK represents only 1% of the global population, it produces some 9% of the world's scientific publications, and on the most recent figures received 13% of the scientific citations. A recent survey puts four of the UK's Universities (Oxford, Cambridge, Imperial and University College London) in the world's top ten.[1] The strength of the UK research base is a major national asset.

As for the private sector, the latest figures show a 9% increase in R&D expenditure by the UK's top 850 investors in research in 2006 to a total figure of £ 20.9 bn (€26.26 bn).[2] In particular, UK R&D is particularly strong in pharmaceuticals and aerospace and contains a growing software and telecommunications sector. There are 75 UK–owned companies in the Global 1250, making it the third largest country group. These companies have a total R&D expenditure of some £14 bn (€19.6 bn).

In performance terms, the UK has a strong and innovative financial services sector which makes a significant contribution to the economy, though its role in research may have been understated due to long standing problems over accounting for R&D expenditure in the services sector.

The overall framework for UK science policy was established in the Government's ten year *Science and Innovation Investment Framework 2004-2014*,[3] which set out a long term ambition for public and private investment in R&D to reach 2.5% of UK GDP by 2014. The Framework sets the goal for the UK to be a key knowledge hub in the global process of discovery and also to be a world leader in turning that knowledge into new products and services. This framework has been subsequently enhanced by further steps to strengthen the UK's innovation ecosystem

[1] Times Higher Education Supplement 9 November 2007
[2] The 2007 R&D Scoreboard (see http://www.innovation.gov.uk/rd_scoreboard/default.asp)
[3] Science and Innovation Investment Framework 2004-2014 (see http://www.hm-treasury.gov.uk/spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm)

Funding of the UK research system is undertaken on a dual basis. Universities are funded through the Higher Education Funding Council for England (HEFCE) and its equivalents in Scotland and Wales (university funding in Northern Ireland comes from the Department for Employment and Learning in the Devolved Administration). Total funding of the UK university and further education system for 2007/8 (including expenditure on teaching and research) is some £ 8bn (€11.2 bn). Research is also funded though the ring fenced Science Budget, which includes the funding of the seven UK Research Councils. The Science Budget was £1.3bn/€1.82bn in 1997. It has more than doubled to £3.4bn/€4.76 bn and will be £4.6bn/€6.44 bn by 2010-11, over three times the 1997 figure.

The Department for Innovation, Universities and Skills (DIUS) was established in June 2007. This brings together policy on skills, higher Education, science and innovation and offers a major opportunity to deliver an integrated approach to these key drivers of economic growth. DIUS will be responsible for driving forward delivery of the Government's long-term vision. In the months ahead DIUS will publish a detailed strategy for Science and Innovation, which will incorporate plans for implementation of the Review. And from 2008 DIUS will publish an annual Innovation Report, to co-ordinate and report on innovation activity across Government.

The business-led Technology Strategy Board (TSB) has a key role in supporting business R&D and innovation, and identifying investment priorities in emerging areas of technology which have the potential to drive future economic growth. On 1 November 2006 the Government announced that the TSB would become an executive Non Departmental Public Body (NDPB), giving it greater independence. The new body was launched on 1 July with financial support amounting to £1bn (€1.4 bn) over the next three years and will take on a wider remit for promoting growth and increased business investment in R&D and innovation across all sectors of the UK economy, from manufacturing to the creative industries. It will alert Government to areas where barriers exist to the exploitation of new technologies, and may be asked to put forward recommendations as to how they can be removed, but responsibility for the overall direction of innovation policy will remain with Ministers.

CURRENT OBJECTIVES[4]

In collaboration with its partners in the science base the Government aims to build the UK science, research and innovation system in coming years to deliver:

[4] For annual reports on the implementation of the Investment Framework see http://www.dti.gov.uk/science/science-funding/framework/page9306.html

World class research at the UK's strongest centres of excellence:

- Maintain overall ranking as second to the USA on research excellence, and current lead against the rest of the OECD; close gap with leading two nations where current UK performance is third or lower; and maintain UK lead in productivity
- Retain and build sufficient world class centres of research excellence, departments as well as broadly based leading universities, to support growth in its share of internationally mobile R&D investment and highly skilled people

Greater responsiveness of the publicly-funded research base to the needs of the economy and public services:

- Research Councils' programmes to be more strongly influenced by and delivered in partnership with end users of research
- Continue to improve UK performance in knowledge transfer and commercialisation from universities and public labs towards world leading benchmarks

Increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent:

- Increase business investment in R&D as a share of GDP from 1¼ per cent towards goal of 1.7 per cent over the decade
- Narrow the gap in business R&D intensity and business innovation performance between the UK and leading EU and US performance in each sector, reflecting the size distribution of companies in the UK

A strong supply of scientists, engineers and technologists by achieving a step change in:

- The quality of science teachers and lecturers in every school, college and university, ensuring national targets for teacher training are met
- The results for students studying science GCSE level (i.e. secondary school)
- The numbers choosing Science, Engineering and Technology (SET) subjects in post-16 education and in higher education
- The proportion of better qualified students pursuing R&D careers
- The proportion of minority ethic and women participants in higher education

Sustainable and financially robust universities and public laboratories across the UK:

- Ensure sustainability in research funding accompanied by demonstration by universities and public laboratories of robust financial management to achieve sustainable levels of research activity and investment

Confidence and increased awareness across UK society in scientific research and its innovative applications:

- Demonstrate improvement against a variety of measures, such as trends in public attitudes, public confidence, media coverage, and acknowledgement and responsiveness to public concerns by policy-makers and scientists

To achieve these ambitions, the 2004 Spending Review allocated over £1 bn (€1.4 bn) in additional funding for the research base up to 2007-08, including funding to enable Research Councils to cover a greater share of the full economic costs of research and continued dedicated capital funding for the renewal of university infrastructure. The CSR settlement announced for the science budget in Budget 2007 continues the Government's record of sustained and rising investment in the research base, and will see the Science Budget increasing by 2.7 per cent in real terms over the CSR period from £5.4 bn (€7.56 bn) now to £6.3 bn (€8,82 bn) in 2010-11.

SAINSBURY REVIEW[5]

Government policy in this area has recently been reviewed by Lord Sainsbury, the former Minister for Science. His report was published in October and concludes that Britain is well placed to benefit from globalisation, but urgently needs to do more to improve its use of science and capacity for innovation. The Government has endorsed the report and accepted its recommendations

In particular, it has announced its commitment to initiatives proposed by Lord Sainsbury in three key areas:

- **Encouraging more children to experience the excitement of science** by doubling the number of science clubs and boosting investment in the training of specialist science teachers for the nation's schools;

[5] http://www.hm-treasury.gov.uk/independent_reviews/sainsbury_review/sainsbury_index.cfm

- Delivering **a new package of support for technology and innovation** in business, led by the Technology Strategy Board, to help UK firms and universities to work together to develop their best ideas;
- Using government research to **foster the leading technology businesses of the future** by directing Whitehall departments to allocate a share of their R&D spending to early-stage, hi-tech companies.

More children experiencing the excitement of science

The Government is launching a new drive to improve the teaching and learning of science in schools. Despite significant progress in improving school science in recent years there is a need to do more to address the decline in the number of students taking A-level physics and to boost the recruitment and retention of qualified science teachers. The Government will therefore:

- Offer a financial incentive of **£5000 (€7000) to every teacher who completes an accredited physics, chemistry or mathematics specialist course**;
- Provide **targeted training bursaries for schools** where teachers are most in need of updating their skills (£200/€280 per teacher training day, up to a total of 7500 training days per year);
- Invest a further £8 mn/€11.2 m over the next three years, on top of the £2.5m/€3.5 m already invested this year, to **double the number of science and engineering clubs in schools**, to 500 school clubs by April 2009, towards the Sainsbury ambition to set up a club in every school within the next five years.
- To celebrate young peoples' achievement in science, the relevant Government departments along with a range of other partners including the learned societies, science based industries and the after school clubs network to **raise the profile of National Science and Engineering Week**. A **National Science Competition** will be established building on the current successful competitions to showcase young peoples achievements across ages and disciplines.

A new package of support for technology and innovation in business[6]

The TSB will develop and lead a programme worth £1 bn/€1.4 bn over three years to provide business with a coherent package of technology and innovation support, helping companies to turn good ideas into new products and services.

[6] Information on TSB activities can be found at http://www.dti.gov.uk/innovation/

This will bring together funding from Technology Strategy Board (TSB), research councils and regional development agencies (RDAs) to build competitive advantage for business. The Research Councils will commit at least £120m/€168 m, and the Regional Development Agencies (RDAs) commit £180m/€252 m, over the next three years for joint projects.

Working closely with partners, the Technology Strategy Board (TSB) will support a wider range of technology priorities. The TSB's programme will:

- **Extend support** for business to a wider range of sectors, including the service and creative industries;
- **Create new partnerships** between business and the public sector to develop technological solutions to major societal challenges, including health care for ageing populations, low environmental impact buildings, and low carbon transport;
- **Double the number of Knowledge Transfer Partnerships (KTPs)**, to get more highly qualified science and technology graduates working with businesses to develop new products, services, and processes. The KTP programme involved the employment or one or more high calibre Associates (recently qualified specialists) to work on a project central to the needs of the partner businesses.

The TSB is funding the research and development of leading edge projects that meet today's needs, such as:

- Testing new ways of using bacteria to make vaccines which can be taken by mouth, to help the development of vaccines to tackle serious illnesses such as influenza and HIV;
- Developing the next generation of metal detectors to revolutionise airport security systems, using new electromagnetic scanning techniques to find and identify threats.

The new strategy for the TSB will build on existing successes:

- Helping small companies like ReNeuron to work with other companies and a university to develop viable stem cell therapies to treat serious diseases such as diabetes, Alzheimer's disease, Parkinson's disease and strokes;
- Working with bigger companies, such as collaborating with Airbus UK to bring together the best UK researchers and industry to develop the aircraft wing of the future.

- Getting companies the skills they need through Knowledge Transfer Partnerships, such as an engineering graduate from Queen's University Belfast who was able to work with Canyon Europe Ltd., a plastics manufacturing firm, to identify improvements in the design of their products for the European market. This led to the creation of a new R&D laboratory and helped the company to obtain new business from multinational clients.

Fostering the leading technology companies of the future

The Government will make more effective use of its own procurement to support innovation. The Small Business Research Initiative (SBRI) will be reformed to require all government departments to spend a proportion of their extra-mural R&D investment with SMEs, and to publicise R&D priorities contracts more widely. This will provide support worth around £60 mn/€84m per year to early-stage, high-tech companies by the end of the next spending period.

R&D IN THE PUBLIC SECTOR

The ambitions relating to research excellence and sustainability for UK science and innovation were outlined in the ten-year framework. Good progress is being made, with the UK maintaining the excellence of its scientific research in the face of increasing competition and remaining second only to the US in research quality as measured by citations. In particular the fourth independent annual report on the performance of the UK research base revealed continued improvement from an already strong position[7]. The UK has increased its share of highly cited papers to 13.3 per cent. The UK has also sustained a more consistent performance across the range of scientific disciplines than most other countries and retains its lead in the G8 on productivity measures.

It is also important that public sector R&D should have an impact, whether through the commercialisation of research results, the improvement of human capital, the incorporation of such results in the policy making process or the improvement of the quality of life in the UK. A recent study undertaken by the UK Research Councils[8] examined 18 cases in which this could be shown to have happened. The studies covered the breadth of the Research Councils' research portfolio and examples included the Centre for Surrealism, the Lasers for Science Facility, the Applied Genomics LINK programme and the Engineering Doctorates programme. A good example of profitable impact and benefit

[7] http://www.berr.gov.uk/files/file40538.pdf
[8] http://www.rcuk.ac.uk/cmsweb/downloads/rcuk/publications/impacts.pdf

to UK society is the Medical Research Council's investment in DNA technology. Outcomes include the Southern Blot method which underpinned the sequencing of the human genome, and the development of DNA fingerprinting technology. Direct impacts include the creation of two major spin-outs, Oxford Gene Technology and Cellmark Diagnostics, one of which has a $160 million market capitalisation. Wider benefits include a contribution to the $2 billion global biochip market. DNA has revolutionised forensics and may have saved the UK £47 mn/€65.8 mn per year through faster identification of serial rapists.

PRIVATE SECTOR R&D

In an increasingly knowledge-driven global economy, the countries that thrive will be those who invest in the knowledge and skills required to support the development of innovative new products and services. The UK is home to many world leading innovative companies, but overall levels of business R&D investment remain low compared to other leading industrialised nations, and some indicators of innovation activity also suggest scope for improvement. This is largely due to the UK's industrial mix. UK companies generally perform well in their sectors, but the UK lacks large R&D-intensive companies in some key sectors such as motor vehicles, IT, and electronics. Nevertheless, raising levels of business innovation and investment in R&D remain a key priority under the ten-year framework.

In 2005 £13.4 bn/18.76 bn was spent on total R&D performed in UK businesses. In real terms this was a 3 per cent increase on 2004 (5 per cent increase in cash terms):[9]

- in real terms civil Business Expenditure on R&D (BERD) increased by 2 percent from 2004 to 2005, while defence BERD rose by 8 per cent;
- BERD as a proportion of GDP was 1.08 per cent in 2005, arresting the decline seen in recent years; and
- overseas funding of BERD increased in 2005 by 21 per cent in real terms to £3.6 bn/€5.04 bn. This represents 27 per cent of the total R&D spend in UK businesses.

It is important to note that due to time lags this data (the most recent available) cannot fully reflect the impacts of the policies set out in the ten-year framework. However, there is some evidence that the UK's wider innovation performance, which is harder to measure than R&D, but includes the effect of things like design and business model innovation, may be rather better than the R&D statistics suggest.

[9] http://www.statistics.gov.uk/pdfdir/erd1106.pdf

The Government's strategy for supporting business R&D investment in the UK is based around four priorities:

› maintaining or growing R&D in sectors where the UK is strong;
› attracting more R&D investment to the UK from abroad;
› increasing R&D intensity in firms or sectors that are lagging behind their peers; and
› creating new R&D intensive sectors through the creation and growth of R&D intensive SMEs.

In support of this strategy the TSB has supported eight Collaborative R&D competitions announced to date with two new competitions announced in the last twelve months (£50 mn/€70 mn in November 2006 and £100 mn/€140 mn in April 2007). Over 600 collaborative R&D projects are currently being supported with a combined business and Government investment of over £900 mn/€1.26 bn. The TSB has also progressed two pilot Innovation Platforms with the aim of stimulating business investment in R&D and innovation through linkages to public procurement activity.

To provide greater incentive for business investment in R&D, the Government introduced R&D tax credits for SMEs in 2000 and for large companies in 2002. To date, over 23,000 claims have been received, equivalent to over £1.8 bn/€2.52 bn in support to business. Building on the success of the scheme, increased rates of relief were announced in the 2007 Budget (relief can be offset against profits in the company's corporation tax return). The large companies rate will rise to 130 per cent of qualifying R&D expenditure and, subject to State Aid approval, the SME rate will rise to 175 %. The cash credit currently available to loss making SMEs will stay broadly unchanged.

Another notable recent initiative is the establishment of the Energy Technology Institute (ETI).[10] This is intended to deliver a step change in the funding, strategic direction and outcome of UK energy science and technology and will be fully operational in 2008. It will be a 50:50 public/private partnership, aiming to raise £100 mn/€140 bn per year for UK-based energy research, design and development over ten years. The Institute will provide funding for universities, SMEs and other firms, and international collaborations to accelerate the development and movement of promising technologies from the laboratories to commercial application.

"Transforming Government Procurement", published in January 2007,[11] outlined a new vision for Government procurement and the regime required to achieve it,

[10] Information on the ETI's activities can be found at http://www.dti.gov.uk/science/science-funding/eti/
[11] http://www.hm-treasury.gov.uk/documents/enterprise_and_productivity/public_services_productivity/ent_services_procurement.cfm

based on a more professional Government procurement service, supported by a small, high calibre Office of Government Commerce (OGC). This vision includes better linking of future procurement opportunities with the TSB. The Sustainable Procurement Action Plan, published in March 2007, also identified ways of harnessing public sector purchasing power to make innovative and sustainable solutions more widely available and affordable to others and to help to deliver a low carbon economy.

Creative industries are important contributors to innovation and the strategic understanding and exploitation of technology and innovation by the Creative Industries will be vital to their future growth and success. Collaboration and the exchange of knowledge, ideas and opportunities across the Creative Industries and within sub-sectors is a key need and the TSB is active in this area to foster collaboration between universities and business and collaboration for commercial opportunities.

The services sectors have grown to become a major component of the economy, accounting for over 75 per cent of the UK's GDP by early 2007. However, the drivers of innovation in services are not recognised as readily as, for instance, manufacturing investment in research and development. In the light of an increasingly service orientated economy, a project on Innovation in Services was launched by the Department for Business, Enterprise and Regulatory Reform in summer 2007. This aims to deepen understanding of innovation in service sectors and to assess whether any Government actions should be taken either to encourage and facilitate innovation in service sectors or to reduce barriers to such innovation. The project will work with a small number of business-led sector innovation groups as well as joining up with DIUS, the TSB, and other key stakeholders from Government and the knowledge community. It aims to generate recommendations to Government by early 2008.

HUMAN RESOURCES IN R&D

The ten-year Framework highlighted the importance of a strong supply of scientists, engineers and technologists to the long-term health of the science base and the wider UK economy, and set clear ambitions to achieve a step change at all stages in the education system.

In pursuit of the targets established there, HEFCE continues to monitor the position of STEM subjects and others of strategic importance. Its October 2006 progress report[12] noted that the position appeared to have stabilised in respect of STEM subjects at

[12] http://www.hefce.ac.uk/aboutus/sis/

universities (recent applications figures confirm a stabilising or increasing trend). HEFCE awarded around £11.5 mn/€16.1 mn from its Strategic Development Fund to projects to increase and widen participation in engineering, chemistry, physics and mathematics, with subject associations and other partners contributing a further £0.7 mn/€0.98mn.

HEFCE also announced additional funding recognising the high costs of some science subjects. From 2007/08, £75 mn/€105 mn over 3 years will help maintain provision in subjects including chemistry, physics, chemical engineering and mineral, metallurgy and materials engineering.

In addition to "traditional" education approaches, the Government has been addressing the issue of skills across the workforce through the Leitch Review of Skills[13]. This recommended re-balancing HE priorities to include the whole adult workforce and HEFCE has been asked to support an additional 5000 employer co-funded student places in 2008-09 with further growth of at least 5000 additional places year-on-year in each year up to 2010-11.

On the important topic of researcher careers and ensuring that researchers have the skills which make them employable in the wider economy, Research Councils UK (RCUK- the umbrella body of the seven UK Research Councils) published its Research Careers and Diversity Strategy in January 2007[14]. A working group of representatives of the main funding bodies, Universities UK (the representative organisation for UK Universities) and selected representatives of the research sector has established a draft set of principles for *A Concordat to Support the Career Management of Researchers*, designed to replace the 1996 Concordat on the Contract Research Staff Career Management. This will provide a clear, high level, statement of expectations and responsibilities of research funders and institutions with respect to the management of researchers. The draft was published in July 2007 for consultation[15].

The UK GRAD programme, funded by the Research Councils, has been a key vehicle for promoting good practice in the delivery of skills training and building capacity for researcher training within universities, including in transferable skills such as research management and enterprise skills. The contract for supporting skills development of researchers which will replace the current UK GRAD contract from January 2008 will support the higher education sector to develop their provisions for research staff as well as research students.

[13] http://www.hm-treasury.gov.uk/independent_reviews/leitch_review/review_leitch_index.cfm
[14] http://www.rcuk.ac.uk/rescareer/strategy.htm
[15] On this and on the UK GRAD programme generally, see http://www.grad.ac.uk/cms/ShowPage/Home_page/Policy/National_policy/Researcher_careers__including_the_RCI/p!eigmpfk

EUROPEAN DIMENSION

I have focused on domestic UK policy initiatives in this piece. No national science system exists in a vacuum, however, and it is vital for Europe that we build on what has already been achieved to strengthen and advance the European Research Area. The European dimension is already central to the UK science base The UK attracts a large and increasing number of EU researchers (some 12000 students from other EU countries enrolled for doctoral studies in the UK last year). A recently published study commissioned by the Government Office for Science shows that the number of UK collaborative scientific papers with France and Germany increased by about 50% between1996-2000 and 2001-05 and their impact improved to reach a par with UK/US collaborations[16]. This indicates that European collaboration can bring enhanced quality to research and underlines the benefits which we can all gain from an effective ERA. The UK therefore fully supports the Portuguese Presidency in its wish to see S&T issues take a high profile in the advancement of the Lisbon Agenda, following on from the conclusions of the Hampton Court summit and the Aho Report.

[16] http://www.berr.gov.uk/files/file40396.pdf

Estonia

Tõnis Lukas

Minister of Education and Research

Towards knowledge-based Estonia

Tõnis Lukas

HUMAN RESOURCES FOR S&T

Estonian RD&I strategy "Knowledge-based Estonia 2007-2013" sees the future Estonia as a knowledge-based society. The role of human resources for developing new knowledge is crucial. For a transfer to a knowledge-based society, both the public sector as well as the private sector need much more researchers and engineers than they have at the moment.

The proportion of employees involved in research and development in Estonia is around 5 researchers and engineers per 1000 employees and has to increase to 8 by 2013. Considering the current growth rate, such increase in the number of RD&I workers is difficult to obtain. Our main priorities include increasing the number of researchers and engineers, linking the students' research areas to the needs of enterprises, improving the system of in-service training and the mobility between education and research institutions and enterprises. The intensity of RD&I can only grow significantly in conjunction with the growing number and quality of employees, thus, it is indispensable to invest in people. Estonia shows a tendency for growth regarding the number of researchers.

It should be mentioned that the increase of the number of researchers is mainly related to private sector, the number of researchers working in public sector has not really changed in the last years. One of the reasons for this situation is that despite the general growth of the funding of research and development, wages in public sector did not increase very much. The wages of Estonian researchers are higher than those of Latvian, Polish and Slovakian colleagues, but are still 2/3 lower than in Hungary and Czech Republic. One positive change is the fact that most of all, there are 25-35-year-old scientists and engineers in Estonia.

The number of 35-45-year-old scientists and engineers has decreased, as they probably have left to other fields.

The RD&I strategy includes a number of measures to encourage the development of education, research and innovation, emphasising the development of human resources. Human resource development activities are not sufficient on their own – R&D specialists also require an attractive working environment and working conditions supportive of top-level basic research and applied research. Deficiencies of the physical infrastructure and inadequate equipment are major problems (the proportion of upgraded and new RD&I infrastructures in 2004 was less than 20%, our aim is to reach 80% by 2013).

Popularising of Education and Research

In order to maintain the pool of researchers and teaching staff and supply the businesses and public sector with top specialists on a level comparable with developed countries, Estonia needs larger numbers of doctoral-level researchers and engineers. Special attention will be paid to talented young people, trying to discover them and bring them to research already at their school-age. In order to draw students' attention to science and technology, a set of measures has already been developed and implemented in basic schools and upper secondary schools. We support, for instance, the centres of technology and nature as well as research societies of school students, science competitions of specific subjects and implement additional scholarships for basic school and upper secondary school students in the fields of natural sciences and engineering. Research, research education and innovation are popularised in the society, as well as the scientific conception of the world and basic ethical values are promoted (including the support for science associations, The Gifted and Talented Development Centre of Tartu University, which is dealing with additional teaching of talented pupils and organising of science competitions, also the Estonian Science Centre AHHAA, the Tallinn Technology and Science Centre, and others which introduce research and development to young people). The Science bus *"Suur Vanker"* ('Big Dipper'), which demonstrates interesting physical experiments, has had the biggest success and visited one-third of all schools in the country. Positive feedback was received from both pupils and parents, proving that the initiative had a positive impact on how people view physics. The science bus and its team, which is composed of physics students from the University of Tartu, got the *Descartes Prize for Science Communication* in 2006.

Doctoral studies

In order to ensure the high quality and sustainability of the Estonian research, the scope of Doctoral studies will be considerably expanded (the number of state-commissioned PhD students will be increased, the possibilities will be created for foreign students to come to Estonia and to promote the studies of Estonian PhD students abroad), the support measures for Doctoral studies (including Doctoral grants and social benefits for PhD students) will be ensured and Doctoral studies and Doctoral schools will be integrated with research and development carried out in the centres of excellence and the centres of competence. In Estonia, nine Doctoral Schools were established, financed by the European Social Fund. Doctoral Schools are financed from ESF's measure 1.1 with total volume of 81 million kroons (i.e all Doctoral Schools in the period of 2005-2008). In 2006, the financing volume was 29 million kroons. The supporting of Doctoral Schools from ESF instruments will also continue in the new period of structural funds.

One of the objectives of Estonian higher education strategy is linking higher education to RD&I systems. The indicators of implementation include, for example, the number of doctoral theses defended per year, the share of foreign doctoral and master students in the key areas defined by the state, and the number of graduates in exact and natural sciences, and technology. A variety of measures will be developed and implemented to improve the efficiency and quality of doctoral studies, support the internationalisation, and the innovation and development capacity of the society.

In order to improve the efficiency and quality of doctoral studies "The System of ensuring the quality, performance and sustainability of Estonian doctoral studies" (2005-2008), a project has been launched in the framework of the measure 1.1 of National Development Plan. Despite the measures that have been taken in use, the number of doctoral candidates increases tenaciously.

STUDY YEAR	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006
The number of graduates from Doctoral studies	82	105	138	119	143

Compared to other EU countries, the number of graduates of natural and technical sciences is considerably smaller in Estonia, and this is one of the greatest problems for us. During 1997-2006 the number of students of natural sciences has increased from 8% to 10%, the number of students of technical sciences has decreased from 16% to 13%. As the total number of students has increased abruptly, the number of study places in the field of natural and exact sciences has also increased 2,3 times; in the field of technology, production and construction the number of study places has increased 1,7 times. 26% of those students pay for their studies (their study places are not state-commissioned). The percentage of graduates is a bit smaller than the percentage of students: 9.4% in natural sciences and 9.9% in technical sciences.

Mobility

The request for high qualified personnel is increasing at international level, while the scientific employment in public S&T sector is expanding very slowly compared to the private one. Universities and other research institutions will be encouraged to bring foreign researchers, and Estonian researchers working abroad to Estonia (including the development and implementation of repatriation scheme, collecting data about the Estonian researchers abroad, and creating communication channels to keep in touch with them.) In 2006, Estonia was engaged in the programme "Strategic Development Installation Grant" of European Molecular Biology Organisation (EMBO), which aims to encourage foreign researchers and highly qualified Estonian researchers to return to Estonia. In 2007/2008 a new national programme for researchers' mobility is opened. Comparing to the current situation the volume of post-doctoral grants will be remarkably increased and additional opportunities for supporting the activities mentioned before is created.

Supporting excellence

The number of articles published by Estonian researchers, and the frequency of citation has considerably increased over the past few years. In 2006, the scientific articles of Estonian researchers made up 0.07% of the total number of high quality publications in the world, and their citation frequency was the highest among the former socialist countries. The average impact (January 1995–September 2006) of the publications of Estonian researchers was 7.5, almost twice lower than that of Switzerland. To increase excellence, additional investments will be made through the centres of excellence in internationally competitive R&D areas, capable of world level research, which help to achieve the goals of the Lisbon Strategy. Promoting the centres of excellence will create favourable conditions for world level research (in terms of both human and material resources) and ensure the high quality of Estonian research.

Promoting career opportunities

Top specialists need motivation to be engaged in research and development, and this motivation consists of competitive wages, development prospects and attractive working environment reflected by modern infrastructure. The creation and modernisation of R&D and higher education infrastructure will help to recruit (foreign) top specialists, reversing the "brain drain" by bringing foreign students, teachers and specialists into Estonia. Measures will be taken to promote the careers of top researchers, and permanent positions (tenure) will be established for excellent researchers and top-level university teachers. Administrative and legal aspects of mobility should be worked out to enable mutual recognition and comparability of the content and quality of studies, international co-operation and particularly mobility of students, teachers and researchers.

Cooperation and networks (incl businesses)

Qualified workers are a measure of knowledge-based society and their knowledge, skills and experience will guarantee the society's development and competitiveness. Investments in training qualified human resource, in R&D infrastructure and innovation capability of businesses will also create a favourable environment for knowledge and technology-intensive foreign investment, which is one of the main objectives of Estonia's R&D and innovation strategy and the NSRF. The career models and development opportunities of RD&I personnel should be addressed systematically, the transfer of people and knowledge between educational and research institutions and enterprises should be encouraged and the stimuli should be created for students and researchers to start their own business.

International cooperation

Estonian organisations were engaged in 325 projects of the Sixth Framework Programme (FP6) of the EU (with 372 partners) and received 33,12 million euros additional money for research activities. The proportion of successful programmes was higher in the information society technologies programme, and the sustainable development programmes “Life Sciences” and “Citizens and Governance in a Knowledge-based Society”. Estonia is involved in the coordination of 19 projects. Although the Sixth Framework Programme was closed in 2006, a number of projects are still running. The Seventh Framework Programme and European Research Council will give opportunities for researchers, as the key areas of Estonia’s R&D (biotechnologies, ICT, materials technologies) are subset of the themes of the framework programme.

PRIVATE INVESTMENT ON R&D

Most analyses carried out for assessment of the Estonian innovation system as well as the international evaluations of different R&D fields have revealed among the main weaknesses of R&D the short-term planning and financing of research and development. Developments in the creation and application of new knowledge have generated the need for more efficient collaboration both within and between different research sectors, but also between basic and applied research. R&D sector in Estonia needs remarkable resources for fast development.

The development of human resources means mainly supporting the activities of higher education institutions, as the researchers and engineers who will go to work to research institutions and private enterprises are trained in higher education institutions. Many (new) researchers and engineers should go to work in the private sector. Together with increasing the intensity of research and development, its quality and efficient management has to be ensured and cooperation encouraged.
New measures should be prepared for supporting traditional industry, which are oriented towards the growth of technological innovation and productivity of enterprises, the development of human capital and supporting the recruitment of development personnel, and implementing professional design as a competitive advantage. The development of cooperation networks and clusters based on regional or sector-based initiative should be promoted. The main principles here are the individualized approach to the needs of different kinds on enterprises, promoting cooperation and joint projects of enterprises, and internationalization. Consideration should be given to the more important bottlenecks in all development phases of enterprises. Special attention must be paid to increasing the demand

of enterprises for development and cooperation with universities, supporting the start-up and growth of new innovative enterprises and increasing the development capacity of enterprises.

The consistent growth of R&D expenditures in the business sector is for certain one of the positive tendencies in the field of Estonian R&D.

PUBLIC FUNDING OF S&T

In 2005, the total expenditure on R&D was 0.94% of GDP (compared with 0.88% in 2004), with business sector investments making up 46% of the total R&D expenditure (compared with 39% in 2004). The 2006 budget focused on creating favourable conditions for the sustainable development of the research and development system, enhancing the quality and efficiency of R&D, improving the base of knowledge, and developing human resources.

Estonian RD&I strategy 2007–2013 "Knowledge-based Estonia" focuses on sustainable development of the society by means of research and development, and innovation. It contributes to achievement of the goals of Estonia's long-term development strategy "Sustainable Estonia 21" as well as the Lisbon strategy (the strategy for growth and jobs). As for general indicators of implementation of the strategy, the total expenditure on research and development is planned to be increased to 1.5% of GDP by 2008, to 1.9% by 2010 and to 3% of GDP by 2014, of which the business sector research and development investments cover more than a half (1.6% of GDP).

In 2006, financing instruments were arranged for R&D (the targeted financing of research fields and development institutions, grant financing of the Estonian Science Foundation), and the evaluation of research and development institutions, as well as the application and processing procedures for registration in the register of Estonian research and development institutions through the Estonian Research Information System (ERIS) were introduced. ERIS offers a wide range of opportunities for state agencies and state-financed institutions to check and process the information submitted, providing support for the decision process, and supplying information on processing stages and feedback on the applications. In 2006, preparations were made to introduce processing state programmes in ERIS.

Strategy and operational programme

Starting from 2007, the use of Estonian own budgetary resources and EU structural funds will be subjected to joint planning to facilitate the parallel and complementary development of the policies that define the social and economic development of Estonia. Measures for promoting research and development held a prominent place in the Estonian action plan for economic growth and employment 2005-2007 for the implementation of the Lisbon Strategy. The assessment of the action plan, published by the European Commission, pointed out the impressive growth in R&D investments both in public and private sectors.

Focuses and key technologies

R&D measures will be thematically focused in areas where Estonia has the potential to become competitive at the international level. Estonian RD&I strategy 2007-2013 "Knowledge-based Estonia" supports the R&D with internationally competitive high quality, creation of preconditions for the RD&I system to grow and be oriented towards efficiency and innovation projects creating high economic added value.

The strategic key technologies in supporting research and development, and innovation are information and communication technologies, biotechnologies and material technologies as these technologies are at the frontier of modern R&D, they are rapidly developing and increase the added value and productivity in various fields of life. The key technologies have a deep impact on economic sectors, replace or improve existing technologies and give stimulus to the development of new technologies. The implementation of key technologies has a profound effect on productivity growth and it strongly influences all aspects of society's functioning.

National programmes

In cooperation between the Ministry of Education and Research and the Ministry of Economic Affairs and Communications, thematic R&D programmes will be launched in areas where Estonia has the potential to achieve results in global frontier research that has also business potential and value-added for in the development of a number of fields – the priority fields of the national RD&I strategy stated above. The thematic R&D programmes will have specific topical focuses within the priority fields. The topics will be chosen in cooperation of the relevant actors (including related ministries, R&D institutions and entrepreneurs), based on the analysis of the current R&D situation and future perspectives (if possible, based on the foresight) of the priority field. The criteria for choosing the topical focuses include: the research conducted on the topic must be of high level and relevant to the socio-economic development, the topic must be clearly focused within this thematic field, and it must create cooperation between universities, business sector and the state. The aims of the socio-economic research and development programmes are to conduct necessary research for the development and implementation of public policy, to attract (and bring to Estonia, if necessary) researchers and entrepreneurs, to facilitate the usage of products and services with high added value and to implement new technologies in order to raise the quality of life of Estonian people.

The Future of Science & Technology in Europe

Bulgaria

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Bulgaria in the era of knowledge

1st of January 2007 marked the ending of the most ambitious political, economic and cultural project in the modern history of Bulgaria. It is hardly to remember another national endeavor that have gathered such a sound efforts and enduring consensus through all these years.

POPULATION OF 7.7 MILLION (2005)

Between 2002 and 2006, Bulgaria enjoyed an average GDP growth rate of 5.12 %. The country's GDP per capita reached 29.8 % of the EU25 average in 2004, up from 26.7 % in 2000. The labour market situation also improved during the last few years as the unemployment rate decreased from 18.1% in 2002 to 10.9 % in 2004.

In the last years the main features of the national economic environment were:

› Finalization of the privatization processes of the main production funds; major banks and financial institutions and of the market and infrastructural objects;
› Conclusion of the product; technological and service restructuring of the economy;
› Increasing the share of the modern technological sectors in the macroeconomic indicators for the country;
› Real export-orientation of the economy;
› Improving the conditions for starting up new businesses

Along with these processes the exchange rate was stabilized; the inflation was brought to reasonable levels; stable money supply and rebuilt credit and financial markets; keeping reasonable budget deficit.

Bulgaria's gross expenditure on research and development (GERD) as a percentage of GDP has an average level of 0.5 % of GDP. According to the National Innovation Strategy of 2004, Bulgaria aims to achieve 1 % GERD as a percentage of GDP by 2013.

Industry merely contributed 26.8 % to GERD in 2003, slightly up from 24.8 % in 2002 – a far cry from the Barcelona goal of a two-thirds share of private sector contributions. The large share of public R&D funding highlights the general dominance of the state sector in science, research and innovation.

Science and Technology policy

In conformity with the European tendencies during the last several years new strategies and instruments that regulate the development of science and innovations have been developed.

1. **National Reform Program (2007-2009)[1],** which aims to systemize the efforts of the state administration, the non-governmental sector and the social partners for reforming the Bulgarian economy in order to achieve high and stable rate of economic growth and increase employment in the country. (Upon the preparation of the program as a starting point the Integrated guidelines for growth and employment recommended by the European Council upon the formulation of policies and measures for achievement of the targets of the renovated Lisbon strategy were used.)
2. **National Strategic Reference Framework for the Period 2007-2013 (NSRF)[2]** – the strategic document for the EU structural funds that has been negotiated with the European Commission (EC). It was developed on the basis of the National Development Plan (NDP)[3] 2007-2013 and it is a strategic platform for reasoning and coordination of the financial assistance under the EU structural funds.
3. **Operative Programs[4],** which substantiate on operative level and execute the NSRF strategy in the thematic fields for interventions comprised by them.

Science and innovations policy is realized by the Ministry of Education and Science and by the Ministry of Economy and Energy through their basic instruments – National Science Fund and the National Innovation Fund.

Likewise other governmental institutions – the Ministry of Agriculture and Food Supply; Ministry of Foreign Affairs, the Parliament, the Ministry of Economy and Energy (outside the grant for the Innovation Fund activities); National fund within the Ministry of Finance -support implementation of these policies. They operate with own budgets and execute certain activities in the field of research. (Fig. 1 in Annex 1 shows the consolidated State Budget distribution as per the budgets of the separate entities).

Furthermore, some sectoral governmental bodies such as State Agency for Information and Communication Technologies; Ministry of Ecology; Ministry of State

[1] http://www.aeaf.minfin.bg/en/documents/NRP/summary en.pdf
[2] http://www.eufunds.bg/docs/
[3] http://www.aeaf.minfin.bg/en/documents/NDP Tan06 en.pdf
[4] http://www.eufunds.bg/?cat=42

Policy for Disasters and Accidents are commissioning targeted and highly specific research surveys and projects to specialized research organizations and/or universities.

And though the research policy is pursued exclusively by the MES, a coherent and coordinated approach is implemented.

The basic trends for development of the national research and innovation policy are:

- Modernization of research system based on the targets set in the Integrated guidelines of the EU for growth and jobs[5].
- Increase of the national expenditures for research;
- Effective utilization of Structural funds promoting research and innovation activity of the academic structures;
- Transforming the higher schools into modern research and innovation centers;
- Integration of the Bulgarian scientists in the common European research area;
- Improvement of the age profile of the research potential;
- Implementation of an attractive social package for young researchers;
- Creation of a dynamic career development model;
- Development of highly technological economic sectors, able to absorb scientific products, technologies and services;
- Creation of an effective mechanism for promoting of both the innovations and usage of information and communication technologies.

These trends are included in the Governmental program for 2005-2009.

Research policy is being formulated on the basis of annual programs and it is focused in the following fundamental activities:

- dynamic participation in European and Trans-European scientific programs;
- intensive bilateral, regional and trans regional cooperation;
- mutual commitment and complementarity between the instruments that stimulate the development of research and innovations;
- development of a system of indicators measuring research activity and effectiveness as well as monitoring on their grounds
- utilization of the project funding as an instrument for enlargement of the scientific problematics, for concentration of resources; specialization of research and creation of a new generation of scientists.

[5] COM (2005) 141

After the publication of the Green paper on the European research area, Bulgaria, together with other EU member states, initiated national consultation with the research community; university professors; employers and large public, the basic concept and principles laid in the document. The result from the public debate (analyses is due until mid of November 2007) in parallel with the commencing foresight programme, delineate the frame of National Strategy for Research and Development.

Main policy stakeholders

The Ministry of Education and Science (MES) and the Ministry of Economy and Energy (MEE) are the main policy-making and executive bodies in the area public S&T and innovation policy. Their functions are complemented by several executive agencies and advisory bodies. Depending on the policy field, other sectoral ministries are formally responsible for research activities within their respective areas of competence.

The **MES** defines the national priorities in the field of education and science policy; it is responsible for the design and implementation of the policy measures in this area. Since 2003, the MES is supported by the **National Council for Scientific Research** (NCSR). The NCSR is an advisory body in the formulation of the national research policy and research strategic issues. It gives recommendations on the issues concerning implementation of Bulgaria's S&T strategy and is a driving force in launching initiatives in areas that are essential to knowledge development and value creation. The NCSR is an arena for discussions both within the research system and with the users and the public regarding choices of direction and challenges in the world of research.

The second major institutional innovation within the realm of the MES that was introduced in 2003 was the founding of the **National Science Fund** (NSF). The Fund implements the ministry's programmes promoting scientific research and supports international cooperation. This is the only specialized organization for funding national research and development programmes and projects.

Set up in 2001 with a primary aim to promote top-quality research in response to the social-economic needs of the country, today NSF is the only existing research funding agency in Bulgaria that base its activities on competitive spirit and excellence, is proud to be full member of the European Science foundation, as since 2003, having bilateral and multilateral collaborations and contacts all over the world. NSF activities correspond to the European trends for creating a new dynamic of research and defining new instruments for increased investment in R&D.

The NSF organizational objectives are designed to support our strategic goals which are the Fund to become more accessible and transparent; more integrated and efficient, more competent and important arena for cooperation. In its way to achieving these objectives, the short-term highest priority is given to:

- Carrying out long-term budget planning
- Simplification and standardization application procedures by introducing fully electronic application submission and processing

The **MEE**'s responsibility within the S&T system is to develop policies to foster economic growth and competitiveness, and to implement the national innovation policy concerning the business sector. On a strategic level, the economic policies of the Council of Ministers in general, and the MEE in particular are strongly influenced by the **Council for Economic Growth** (**CEG**) – a high level advisory body, composed of representatives of government and the business sector. It provides a discussion forum for economic issues and important feedback and advice from the business community concerning proposed policy measures and the development of policy agendas.

MEE is also supported by an advisory body, the **National Innovation Council** (NIC). The main instrument in Bulgaria's innovation strategy is the **National Innovation Fund** (NIF). The NIF finances market-oriented applied research on a competitive basis and aims to establish links between research institutes, universities, industry and SMEs.

Main research actors

The main knowledge creating institutions in the Bulgarian innovation system are the universities and the non-university research institutes, most notably those within the Bulgarian Academy of Sciences (BAS); the National Centre of Agrarian Sciences (NCAS) and specialized national public health centres.

Today in the country there are 51 **higher educational establishments** with 13 000 researchers, of which 37 state supported and 14 private ones.

The research landscape comprises of 82 structural units of the **Bulgarian Academy of Science** with about 3 600 researchers, which do research in a broad range of scientific disciplines, including social sciences and the humanities. This is the main horizontal research organization.

The second large horizontal research institution is the **National Centre of Agrarian Sciences** NCAS, operating under the authority of the Ministry of Agriculture and Food supply. The NCAS runs 40 institutes in the area of agriculture, fishery and forestry with 1 800 researchers.

In addition, a number of state institutes are linked to different executive agencies and/or ministries in order to provide specific scientific services.

Also, actors in the research landscape are specialized non-governmental organizations and innovation small and medium-sized enterprises (SME's).

The National Scientific Policy within the European Context

The short and long-term development of science in Bulgaria is inevitably connected with the European Union and with its new basic policies and trends.

These policies were developed through the Lisbon strategy of Europe and they aim at:

- *Raising the expenses for scientific and innovation activity till 2010 up to 3% on the average from the Gross Domestic Product (GDP). The share of the private funding is expected to grow up to two-thirds from the total expenditures (a target fixed in Barcelona).*
- *Removing the barriers for mobility of the researchers, protection of the scientific talent in Europe and attracting scientists from third countries.*
- *Building new research infrastructures, their binding into a network through high-speed communication technologies and granting wide access for their exploitation for scientists from Europe and world-wide;*
- *Encouraging private investments in scientific researches and innovations through creation of favorable business environment as well as introduction of attractive direct and indirect stimuli;*
- *Creation of voluntary networks of national and joint research programmes under freely chosen targets and development of a system for an open method for the national policies coordination.*

The specific reflections of these targets are a number of actions that had a proved positive effect on the national research policy development:

- Action Plan for the period 2006-2007 for the achievement of the Barcelona target, accepted by Decision No. 38 of the Council of Ministers. The document content summarizes the actions of the national institutions in support of the scientific and innovation policies and shapes the future policy aim for research development introducing new competition scheme for:

- Building up modern and competitive research environment;
- Improvement of the age structure of the academic institutions;
- Limitation of the 'brain drain' phenomena and conversion it into a dynamic 'circulation of scientists' more skilled and knowledgeable;
- Supporting the construction of bridge structures between the industry and academia;
- Upgrading of research infrastructure in priority fields of strategic importance for the country.

PUBLIC RESOURCES FOR SCIENCE

R&D funding is an important prerequisite for achieving qualitative and competitive results. During the last few years there is 20-25 mln.levs yearly increase of the absolute value of the budget expenditures for science.

The public resources for science are mainly distributed on an institutional basis. For the last two years the share of programme and project based funding is constantly growing ensuring better concentration of resources for high-competitive and excellent research groups and networks and pooling implementation of large joint research programmes.

There is continuous intensification of the instruments that support research and innovation activity in the universities in the country as an input to the EU agenda for modernization of higher education intuitions as key actors in the "knowledge triangle" concept.[6]

The research and innovation funding is operated by the National Science Fund and Innovation Fund through specialized programs. Some specific activities are performed by other sectoral ministries and agencies through targeted research programmes focused on emerging political or social issues of national importance.

The ultimate goal is to provide support for building up inter-institutional scientific groups that can be competitive in Europe based on: targeted research programmes; centers for research and innovation competence; development of research activity in the universities; modernization of research infrastructure and creation of modern research and information complexes and internationalization of research.

[6] COM(2006)0208 " Delivering on the modernization agenda for universities – Education, research and innovation" and COM (2003) 0226 'The role of universities in Europe of knowledge"

Our aim is to tackle the major problems, common as well for the rest 26 EU Member states and laid in the Green paper. It outlines the strategic components of the European research are – **integrated institutional landscape; competent research potential; large-scale and modern research infrastructures and effective transfer of knowledge.**

The activities of the Fund can be structured in following action lines:

› **Targeted research programmes,** which support integrated research schemes in priority thematic areas in line with the European research framework programmes priorities and are carried out by a consortium of minimum three different research-performing institutions implementing common strategic research agenda;

› **Support for development of centers of research competence** aiming at pooling the existing research potential and resources. Actually there are 33 Centers of competence supported both by targeted national research programmes and utilization of other funding instruments.

› **Promotion of scientific research in Universities aiming** high quality scientific research in the public higher education institutions and supporting:
• Interinstitutional integration with other higher education institutions and universities, scientific organizations, small and medium-sized enterprises, university hospitals and national centres;
• Effective international scientific cooperation and encouragement of participation of university scientists and units in building up of a European university space;
• Intensification of the relation "science-industry" by means of implementation of joint scientific research projects (SRP) with companies, small and medium-sized enterprises;

› Support for creation of long-lasting and effective partnerships between the academia and research sectors and mounting the absorptive capacity of the industry for research and innovative products, technologies and services;

› **Internationalization of research** – various competitions under bilateral, tri and multilateral programs with different partner countries from European Union and third countries such as Germany, France, Greece, Romania, Slovenia, Macedonia, China, India, etc. These programmes have special impetus on the research mobility and transfer of knowledge.

As a future step we envisage the development of **Integrated research and technological institutes supporting implementation of large-scale research programmes;** providing a new way of realizing public-private partnerships and focusing on key strategic projects for the country that have high downstream knowledge and industrial potential.

PRIVATE EXPENDITURES FOR SCIENTIFIC ACTIVITY DURING 2006

Contemporary scientific research demands more and more resources. In order that the targets of the renovated Lisbon strategy are met it is especially important to direct our attention towards increasing the share of the private investment for science and innovation. This is a key problem for the development of the scientific and innovative system and in a large degree it is an indicator for the competitiveness of the economy as a whole.

There are two ways of influence:

- Introducing indirect financial stimuli or incentives;
- Creation of **favorite normative environment** through indirect stimuli

The fact is that the small and medium business and the industry usually buy scientific production, which in most of the cases is imported and thus they do not invest additional resources for research activity on national level.

There also is an insufficient active relationship between the academic structures and the business sector.

During 2006 new schemes stimulating the science-business relation were introduced by:

- **voucher scheme for companies,** effected through the National Scientific Program for small and medium-sized enterprises whose basic aim is the presentation of specific scientific services and products that are necessary for improvement of the company's activity and for building of special priorities so that the respective company can realize its production. Irrespective of the fact that the scheme is a good practice for creation of good relationships between academy and business, its popularity among the private sector as well as its more effective assimilation by the business is still insufficient;
- open access for companies' structures to the competitive schemes of the Scientific Research Fund upon specific conditions. Only in 5% of the funded projects there was a declared participation of a company's structure as a partner in the project without obligation for financial participation – instead there was only contribution "in kind";

- **pilot scheme for elaboration of doctoral labor jointly by a scientific organization or an university and a company's structure** aiming to build a real public and private partnership and stable bridge relationships between the two sectors.
- **Special scheme in support of applied research projects and technological pre-competitive surveys** where the main beneficiaries are SME's which to develop the research component of their activities.

Specific measures in the Operative Programme "Development of the Competitiveness of Bulgarian economy" are envisaged:

- ***Support for increase of the employment of researchers in the enterprises.***
- ***Creation of a new infrastructure and strengthening of the existing pro-innovative infrastructure.***
- ***Support for renovation of the equipment intended for application aims*** – The scientific organizations will be supported in order to obtain and/or renovate the existing application equipment on condition that there exist a clear demand by the business in the specific scientific sphere as well as proven necessity of such equipment and potential for wide application of the expected RDA results in the national economy.

Human Resources

An important factor for the generation and transformation of knowledge in innovation products are the human resources occupied with research and development activity.

One more time the reports show high educational level for Bulgaria in comparison not only with the newly accepted EU Member-States but in comparison with the highly developed European countries as well. It is primarily due to the great number of students who graduated the schools for higher education. In 2003 the percentage of the university graduates in active age in Bulgaria is (21,7%) and it corresponds to the average level for the 25 EU Member States, which is (21,9%). At the same time for the period 2000-2004 the percentage of the young people in Bulgaria from 20 to 24 years of age, who have graduated at least their secondary education (in 2000 – 74.9% , in 2004 – 76 %) is approximately equal to the number for EU25 (in 2000 -76.4%, in 2004 –76.6%).

The number of the newly obtained educational and scientific "Doctor" degree of 1000 people from the population in Bulgaria (**8.3**) in the age group 20-29 in the scientific and technological fields is lower than the average percentage for EU25 (**12.2**).

Regarding the human capital, which is bound up in the creation and usage of the scientific knowledge, there is a drop in Bulgaria during the last decade.

The knowledge economy requires strong science and more highly qualified specialists. According to the European innovation scoreboard the share of the scientists in the enterprises is low in contrast to their percentage in the state research institutions. This shows disproportion, which is to be gradually overcome by the help of the new national schemes.

In this respect the basic instruments of the National Science Fund may be summarized as follows:

- **Fellowships for postdoctoral training in foreign scientific organizations and obligatory work in a Bulgarian scientific organization.**
- **Upgrading research potential in Universities – aiming at renewal of the scientific potential by means of attraction of young people who will participate jointly with habilitated persons in the scientific research.**
- **The pilot scheme for scholarships for young scientists, who are elaborating doctor's theses within the national company structure aimed at building of a real public and private partnership and of steady bridge relationships between the two sectors.**
- **Support of New and Already Started Doctoral Programmes and a Program for Development of Post-Graduate and Post-Doctoral Training, funded through the new instruments of the European Community – Operative Programme for Development of Human Resources.**

Future steps will be introduced through additional support schemes for young Scientists realization on the Labor market, and reintegration grants for young scientists who work abroad.

INTERNATIONALIZATION OF THE BULGARIAN SCIENCE

The incorporation of Bulgaria to the Community Framework Programmes practically broke up the existing frame for execution of scientific programmes and revealed new opportunities for work under scientific projects, access to contemporary scientific appliances etc.

If we carefully analyze our participation in the Framework Programme we can outline the following trends:

1. Following our official integration to the Programme there is a considerable growth of the attracted resources per years. (For 2006 the data are not final due to the EC delay of the estimation and contracts.) The membership dues for participation in the Programme were completely restored. Bulgaria takes part in more than 350 scientific projects, networks and coordinating activities.
2. The distribution according to the attracted finances between the various institutions is comparatively balanced:

Our participation in the thematic priorities shows availability of quality potential in the field of the information and communication technologies where the presence of the companies in successful projects is the greatest. There was a satisfactory presentation of the university and scientific structures in the thematic Programmes entitled 'Steady Growth and Environment' and 'Quality and Safety of Foods' (Fig. 3 – in Annex 1)

The participation in the other international scientific programmes was quite successful. The Bulgarian scientists have especially satisfactory presentation in the COST Programme. Since our integration in the Programme we participate in more than 150 activities. The distribution as per the various organizations is also balanced. During the last two years nongovernmental organizations are also included. (Fig. 4, Annex 1)

The cooperation and partnerships of the Bulgarian research organizations and universities with the Joint Research Centers of the European Commission is also quite satisfactory.

The Bulgarian position in the special Programme of NATO entitled 'Security Through Knowledge' is successful. This Programme is directed towards support of the international cooperation between scientists from the The Euro-Atlantic Partnership Council Member-States. Through the instruments of the Programme joint scientific projects are being realized as well as experts' visits, summer schools, specialized scientific seminars and scholarships for reintegration of scientists. For the period 2002-2006 over 60 projects with Bulgarian participation were supported, primarily from the institutes of the Bulgarian Academy of Sciences and over 500 scientists and experts have been guests as lecturers within the frames of the specialized scientific schools and seminars funded under the Programme.

Current analyses of the Bulgarian participation in various research programme show that there is:

› good quality research potential in some thematic areas;

› open access to the existing research base and favorable conditions for cooperation and durable partnerships.
› flexible institutional landscape adaptive towards diverse programmes and instruments.

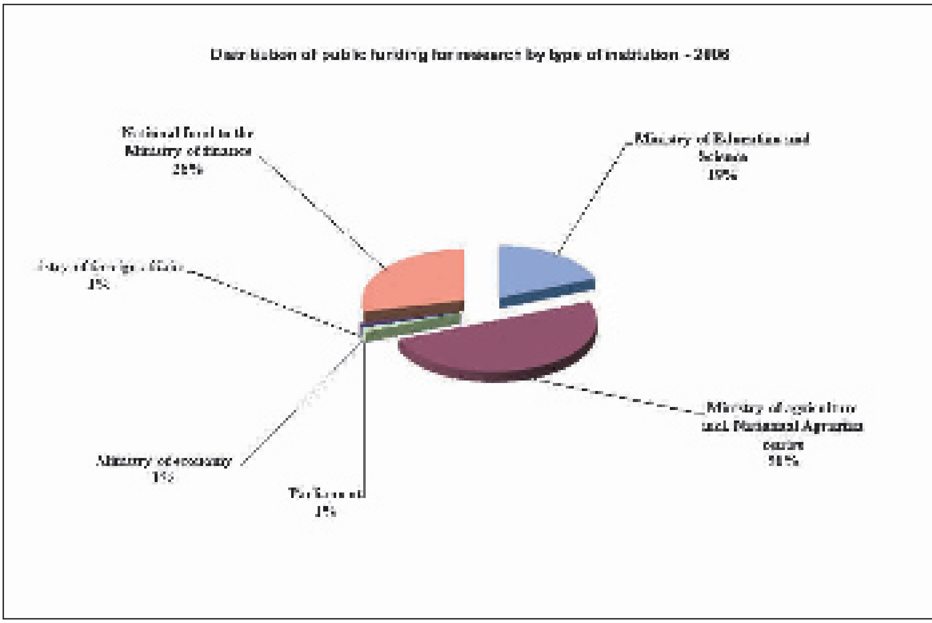
FUTURE ACTIVITIES

Future steps in national research policy can be summarized as follows:

› Increasing the investments in research and innovation;
› Development and adoption of National strategy for research and development which to outline the priority directions for future coherent and coordinated governmental actions;
› Support for development of active milieu that encourages effective research and innovative processes (through legislative and fiscal measures);
› Creation and development of national centers in priority areas of strategic importance and significance for the country and national economy aiming at introducing a new form for collaboration; effective utilization and concentration of research potential and facilities. Such areas where Bulgaria has competitive advantages for development; traditionally good research potential and manufacturing experience are: **Information and communication technologies; genetics; proteomics and innovative medicine; plant and animal genetics and biotechnology; precise engineering; development and application of modern technologies in traditional and nuclear energy and for energy efficiency, and nanotechnology and microelectronics;**
› Modernization and upgrading of national research infrastructure;
› Effective utilization of Structural funds for research and innovation activities of the academic institutions;
› Implementation of independent evaluation of the effectiveness and quality of the research activities in the public research organizations and binding the outputs with the volume of resources;
› Joint research schemes between universities and research organizations;
› Development of new a generation of young researchers, more skilled and knowledgeable;
› Increasing the absorption capacity of the national economy and support for doing applied research in economic sectors with high potential for realization.

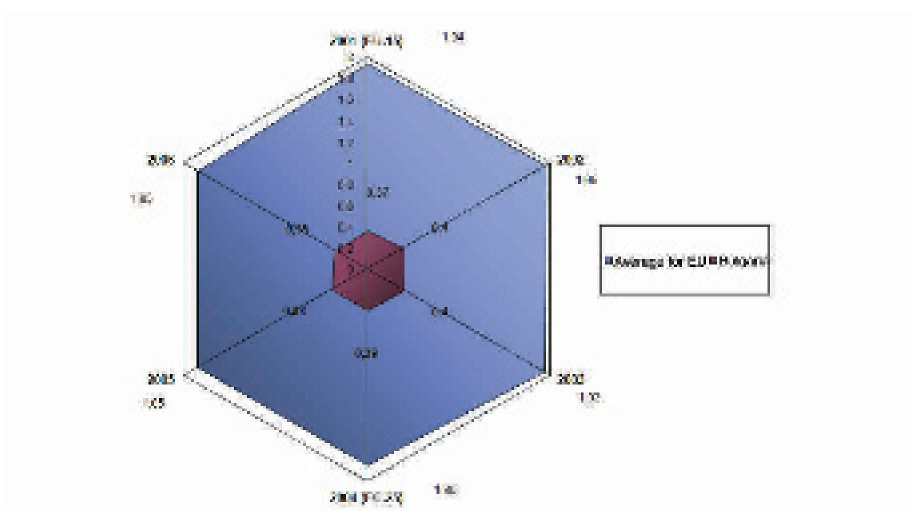
ANNEX 1

Figure 1 › **Distribution of the consolidated state budget for research by types of institutions**



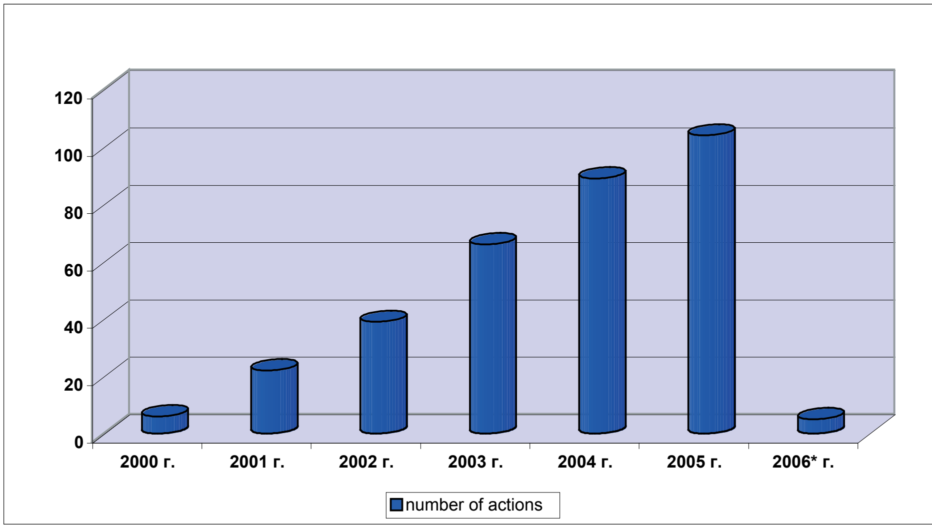
Source: Law for the State Budget of Republic of Bulgaria for 2006 .

Figure 2 › **Public Expenditures for R&D as a % from the Gross Domestic Product**



Source: NSI and Law for the State Budget of the republic of Bulgaria for 2006

Figure 3 › **Dynamics of the participation in COST – Shares of Bulgarian Teams**



Source: Scientific Research Fund

The Future of Science & Technology in Europe

Austria

Johannes Hahn

Federal Minister for Science and Research

Science and Technology Policy in Austria

Johannes Hahn

Over the last years, Austria has successfully managed to achieve a continuous rise of its research and development rate. In their global estimate for 2007, Statistik Austria forecast an R&D-intensity of 2.54% of the GDP, which amounts to an 8.1% growth compared to 2006. In total, €6.83 billion are expected to be invested in research and development in 2007.

The new federal government that came into office in 2007 has reaffirmed the national goal to reach the 3% benchmark by 2010. The general economic upswing and recent GDP growth are challenging this ambition. However, success remains within reach.

By raising **public R&D intensity** in annual steps of 10% until 2010, Austria intends to generate a substantial leverage effect for the growth of **private investment in research and development**. Our objective is to guarantee the share of private investment on a fairly high level and to seek to advance it.

National public investment thus provides the precondition for an overall European boost of investment in research and development.

We develop our research policies in an ever changing world. Therefore, we feel the need to strive for the best policy mix that fosters investment decisions of the private sector. Thus, Austria is constantly making efforts to reassess and optimise investment conditions, e.g. with a view to:

› providing stronger support to high tech through R&D
› creating favourable conditions for private investment, e.g. through more favourable legal requirements for donations
› the impact assessment of previous support activities, including R&D-related tax incentives

It should be our common European concern to encourage private investment in **basic research** constantly. Basic research has sustainable effects and enables Europe to be a leader in innovation. Investment into basic research thus is of long-term interest to Europe's economy.

Research institutions and infrastructure are two particular target areas for public investment: The *Institute of Science and Technology Austria (I.S.T. Austria)* is the new Austrian centre of highest level research with a focus on basic research and a PhD programme designed to meet international excellence standards.

Austria supports common European investments into large-scale projects in the field of infrastructures, as called for by the European Commission's Green Paper on the European Research Area. In February 2007, Austria signed the first Memorandum of Understanding for the FAIR project (Facility for Antiproton and Ion Research). With its estimated construction costs of €1.19 billion, FAIR is the most comprehensive among the 35 large-scale infrastructure projects on the ESFRI "list of opportunities". In order to generate pan-European support for common investment into large-scale infrastructures, we strongly believe that such projects need to be regionally balanced and fully accessible also to smaller member states.

With a view to increasing common optimisation efforts for public research programmes, we feel that voluntary guidelines could gather European experience in successful programme assessment, as practised, amongst others, in the framework of the ERA-nets.

We explicitly welcome a continued exchange of experience and the common work for the six dimensions of the European Research Area, as presented in the Green Paper.

We need many discussions and a structured exchange of views with all stakeholders, also on the national level, to establish the Lisbon goals and the creation of the ERA as our common agenda sustainably. I am therefore launching a national research dialogue and have invited the Austrian science and research community to embark on a year of intense co-operation on the Austrian research and innovation strategy. In this process, the results of the EU discussions on the Green Paper and the further development of the European Research Area will be of utmost importance.

In the field of **human resources**, we see two inter-dependent challenges: a lack of (particularly female) researchers in some fields (1) and mobility restrictions (2) that are inherent in the system and need to be overcome. For the mobility of researchers we would prefer the focus to be on exchange (*brain circulation)* rather than unilateral loss and benefit (*brain drain / gain*).

Austria attaches great importance to setting up a large pool of well-qualified people, from which a peak of excellence may emerge. Peak and depth depend on each other.

The pedagogic training of future teachers, and the right choice and planning of curricula for bachelor programmes, especially in the sciences, have also been particular challenges:

Even though Austria, more recently, ranged among those member states with the highest growth rates of graduates in mathematics and sciences, after decades of EU-wide decline, the overall graduate rate in these studies continues to be a source of concern.

Measures should both start early and be well-targeted: to women, to young talents, particularly to traditionally less well-educated parts of society (e.g. people with migration backgrounds). Children's curiosity for research can be cultivated at a fairly young age. Austrian initiatives such as the *Children's University (Kinderuniversität)* may serve as examples for early stimulation of the exploratory spirit.

A wide range of instruments offers tailor made support to target groups, examples of which are scholarships and doctoral colleges where young people with potential receive comprehensive tutoring from a group of internationally renowned researchers.

Other focal areas that need additional attention are the further education of researchers and the reintegration of the rich experience of researchers at the end of their careers via consulting and mentoring schemes.

The recently published *Rocard Report* offers a number of interesting ideas for a science-oriented education in schools. Austria welcomes these ideas, while at the same time emphasising national competence in education policies. We would not support any transfer of co-ordinating responsibilities from the member states to the European Commission.

In this field, voluntary instruments may generate important momentum for a European spirit of quality:

The *European Researchers Charter* and the *Code of Conduct for the Employment of Researchers* are important instruments for the creation of a European Research Area. They help to establish a culture at European research institutions where quality standards become self-binding.

At the same time, they contribute to reducing obstacles to mobility, such as the widespread practice of researcher careers that are restricted to only one institution.

On the basis of all these merits, I signed the Charter on behalf of my ministry on 10 March 2007.

In some contexts, even the mere implementation of existing agreements would signify an important step forward.

For doctoral studies, we might recall the good practices collected by the *European University Association* within the framework of the *Bologna process*, but also the agreements reached in the *Bologna Communiqués* by ministers, including the *Ten Salzburg Principles*.

Eventually, we have to find the innovation agents most important for Europe world-wide, generate favourable conditions for transnational co-operation, and open-up the European Research Area to the world.

Austria uses its scientific-technical co-operation (*WTZ*) to create the basis for an exchange of researchers, for *brain circulation*. Most recent examples are agreements with Macedonia and India.

Austria is in the process of amending the legal working requirements for third country citizens: Researchers and their families will be granted privileged access to the Labour Market in Austria.

Finally, the transferability of social security is an emerging European topic which – with a view to the Lisbon strategy for growth and employment – does affect researchers as it does other key areas. There is need for a more comprehensive approach to this topic.

Romania

Anton Anton

President of the National Authority for Scientific Research

Anton Anton

Science and Technology Policy in Romania

TO HAVE A VISION FOR THE FUTURE,
ONE SHOULD KNOW HIS PAST

Once upon a time Romanian scientific and technological system was organized according to the dream of self sufficiency and the power to find an answer to any question. That was before December 1989. According to statistical data, 148 513 people (from which 55 957 with high level education) were involved in research, development and innovation activities.

Several elements were defining that period and were representing the "philosophy" of that era: a certain feudalism of research, which meant that the Romanian research was supposed to produce everything, while being isolated from the international scientific community; the assimilation, copying of existing equipment and machineries and their presentation as research activity was actually an important part of the "RTDI" activities; the oversized national institutes, as a result of centralization and of destruction of the company's research; ignoring the socio-human, economic, linguistic areas, considered as "non-productive" research.

During 1990-2004, in the general economic context, the Romanian scientific and technological system survived with an "emergency" budget represented by a 0.1-0.2% PIB. There were times of exploratory organizational models and struggles to find out the best development ways, corresponding to the national realities. The big inherited R&D institutes reshaped into flexible and efficient organizations and the universities became more visible and stronger in the field of scientific research and technological development.

For the first time multiannual funding scheme was applied during the first National Plan for Research, Development and Innovation for the period 1998-2006.

The evolution of the financial support, based now on competition, forced the human resources to readapt to the new conditions.

During the year 2005, a time for a profound analysis of the Romanian RTDI system and a milestone in the RTDI development, statistical data are used according to European statistical procedures; instruments and institutions strong and weak points have been analyzed and the necessity of an investment system for research have been underlined.

From administrative side, the Research department into the Ministry of Education and Research was modified and developed into the National Authority for Scientific Research (ANCS) headed by a President in charge of science policies, financial and administrative issues related to RTDI.

ANCS launched the Progamme Research of Excellence (CEEX), with the main aim to structure and consolidate the Romanian Area of Research, and thus, to ensure the preparation of the RTDI community in Romania for a more rapid and efficient integration in the European Research Area. It is worth mentioning that since 1998, Romania is associated to the European Framework Programmes, so one can say that scientific research, technological development and innovation represented a domain where Romania has been integrated in the European family long before 1st of January 2007.

The circumstances imposed a new and strategic vision and approach. In 2006, it is for the first time that a National Research, Development and Innovation Strategy 2007-2013 was approved by national law.

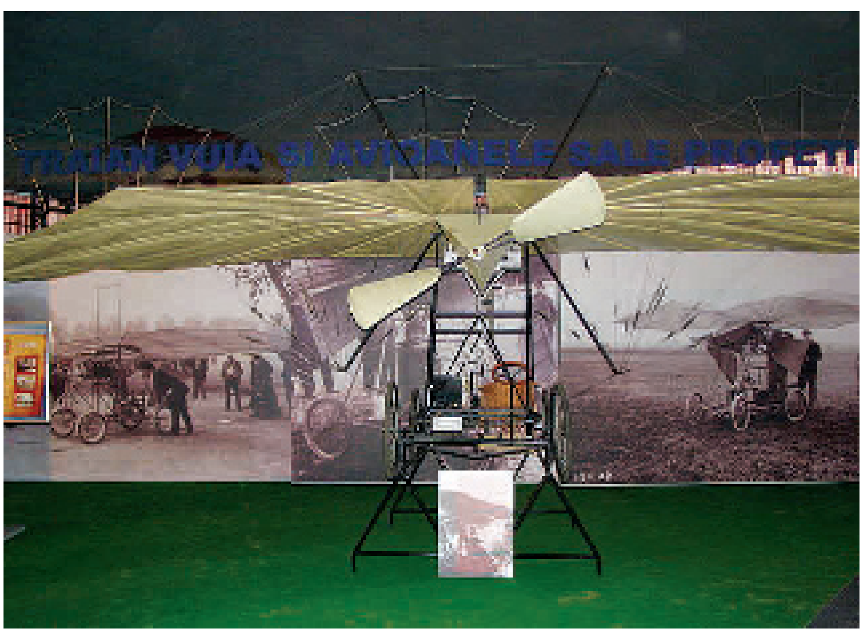
Based on the Strategy, ANCS implements the second National Plan for Research, Development and Innovation for the period 2007-2013 (PN II), oriented to develop science and technology in order to increase the economic competitiveness.

Under those circumstances, the major objectives for Romania are represented by the achievement of a dynamic and competitive economical environment which should be able to assimilate and to develop high level technological areas, and should respond to the strategic demands of the long term development, in the context of the evolution at global level of the knowledge based economy.

CURRENT SITUATION – AN OVERVIEW

ONLY HEALTHY IDEAS CAN FLY ALL OVER THE WORLD

ANCS constantly and strongly promotes RDTI as high priority policy domain, with a clear view to increase the capacity of the Romanian RDTI system to support the achievement of Lisbon strategy objectives related to sustainable economic growth and competitivity.

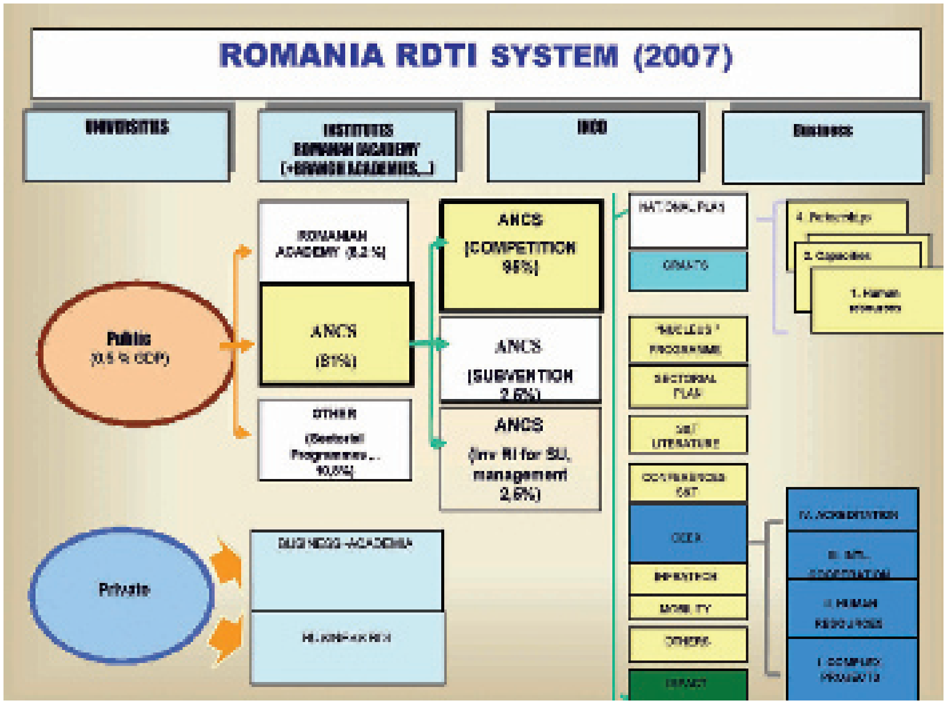


The flight device conceived and tested by the Romanian engineer Traian Vuia

At the present moment the main instruments for implementing RDTI policy priorities are:

› the national RTDI programmes, coordinated by ANCS:
  - CEEX, running for 2005-2008.
    The main objective is to support the participation to the EU Framework Programmes for Research, FP6 and FP7. Its proficiency was already confirmed by 512 FP6 projects with Romanian participation, which were selected for financing;
  - The National Plan for Research, Development and Innovation (PNII), 2007-2013.
    With the aim of implementing the National Strategy for RTDI, PNII is the main instrument of the RTDI public funding, representing 85% of it. For the first calls in 2007, more than 5500 proposals have been submitted.
  - the Programme IMPACT, running for the period 2006-2010.
    It is dedicated to the preparation of RDTI projects for future financing from structural funds during 2007-2013. The programme supports the costs for consultancy services needed for preparation of consolidated projects' dossiers, including support documents (e.g. feasibility studies) that will accompany the applications. Up to now 248 projects were selected;
  - the Programme of grants for scientific research, initiated since 1996, which supports the formation of scientific careers;
  - the Nucleus research programmes, launched in 2003, as programmes of the national R&D institutes, reflecting their research strategy, in relation to specific sectoral development strategies;
  - the INFRATECH programme, launched in 2004, for the development of specialized infrastructures for technology transfer and innovation.
  - the sectoral R&D plans, launched in 2004, aiming to cover R&D objectives related to sectoral technological development and financed by ministries coordinating the respective sectors.

An overview of the system is presented below:



One of the reference components of the consolidation policies of the Romanian Research Area is represented by the improvement in the operational structure of quality and performances of the activities and institutions from RDTI system, especially through financial support mechanism granted solely on competition bases, and through the market based rules for optimization of state owned research institutions.

The Romanian research landscape comprises 18 national R&D institutes under the coordination of ANCS and 26 under the coordination of other ministries, 65 basic and advanced research institutes and centers under the coordination of the Romanian Academy, 25 institutes and centers and 91 stations of research and production under the coordination of the Academy of Agricultural and Forestry Sciences, 23 research centers and institutes (12 hospitals) under the umbrella of the Academy of Medical Sciences, 56 public and more than 18 private universities and other RDTI units organized as public and private sector, including industrial companies with S&T laboratories (about 5% of S&T activity) – around 400 entities with RTDI as main activity .

Situation of national research-development institutes-2006

COORDINATING GOVERNMENT ORGANISM	NUMBER OF COORDINATED INCD	TOTAL NUMBER OF R&D PERSONNEL OF INCD
National Authority for Scientific Research	18	2587
Ministry of Economy and Commerce	8	867
Ministry of Agriculture, Woods and Rural Development	6	965
Ministry of Waters and Environment Protection	3	363
Ministry of Transports, Public Works and Tourism	3	345
Ministry of Communications and Information Technology	2	124
Ministry of Labor and Social Solidarity and Family	2	129
Ministry of Public Health	2	270
TOTAL	**44**	**5650**

Source: White Book of Research-Development and Inovation in Romania – National R&D Institutes, ANCS, 2006

HUMAN RESOURCES FOR S&T

EXCELLENCE IS AN ART WON BY TRAINING AND HABITUATION

In 2006, the RTDI system in Romania comprised 42220 people (f.t.e); the researchers represented 30122 employees, with 0.5% PIB dedicated to RTDI activities; the scientific production, in published scientific articles per 1 million inhabitants is 8 times smaller than EU 15, the number of high-tech patents for 1 million inhabitants is 0.13 for Romania.

With a 21.6 million inhabitants, in 2005 Romania had 108 475 high level education graduates, representing 3.19 % from the 20-29 years population sector. This represents an investment which should definitively be exploited and developed for the benefit of the whole society.

Human resources, one of the main elements of the Research for Excellence Programme, launched in 2005, had a dedicated component for young researchers meant to attract young people for a scientific career and to consolidate their careers. It is for the first time that a financial scheme is dedicated to the post-doc research activity and to the reintegration of Romanian scientists from abroad. More than 400 proposals have been submitted in 2005-2006. The programme acknowledged the research manager and supported this distinctive activity through specialized training.

All these constitute premises for a special movement of the young researchers, a decreasing of the average age for RTDI personnel.

In PN II the human resources are placed on an important position, being one of the six components of the National Plan: out of a total of 15 000 million lei from the state budget, 1 350 million lei are allocated for "Human resources".

The core purpose of the Human resources component is to ensure a clear research career through projects.

The "Human Resources" programme not only covers a large range of activities (training and specialization of researchers by doctoral' and post-doctoral' training programmes, projects for the integration of foreign researchers into the Romanian RDI system, research schools with international scientific performances, domestic and international mobility for researchers, training in the field of management of research and innovation, awarding outstanding results in research), but also offers substantial financial support for their effective achievement. The 2007 competition brought more than 1 200 proposals.

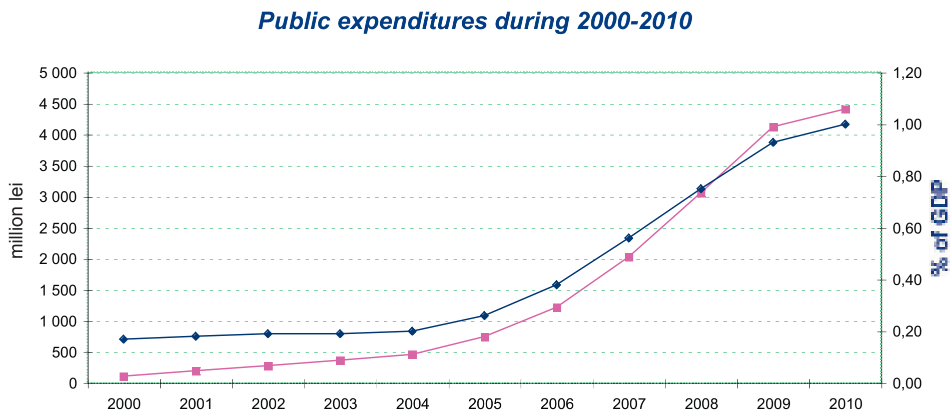
Several positive effects are expected, following the implementation of this programme: increasing the number of PhD candidates and postdoctoral researchers, increasing the attractiveness of the research career, especially for eminent academic graduates, attracting performing Romanian researchers from abroad, setting up excellence centers around scientific personalities internationally known and recognized, increasing researchers' national and international mobility, stimulating the setting up of excellence centers, improving the management of RDI units.

PUBLIC FUNDING IN S&T

THE ONLY WAY TO FIND THE LIMITS OF THE POSSIBLE
IS BY GOING BEYOND THEM TO THE IMPOSSIBLE.

The turning point, as mentioned before, in 2005, represented by the Programme Research of Excellence (CEEX) 2005-2008, was an effective instrument to directly support and accelerate the preparation of the Romanian RTDI community to become part of ERA. CEEX is composed of four modules covering all areas of scientific research: technological excellence, developing of human resources, international visibility and recognition, and research infrastructures. For the first time the individual projects benefit from significant budgets (appreciatively 400 000 euro/project, for a 3 years duration), more than ten times the previous projects values.

The Romanian RTDI system is continuing now its development on the right tracks: the financial support is based only on open competition and there is no prejudice and no distinction made for what concerns the type of participants: only the excellence matters! It is worth to be emphasized that the public funding system offers now to potential actors, a whole range of programmes and activities, with important financial dimension. But they have to demonstrate not only their scientific capability, but also existing capacities, a solid plan, based on existing realities.



The public expenditures, after facing a 'survival' period, have significantly increased and it is expected to continuously growing to reach the 1% of the GDP in 2010.

PRIVATE INVESTMENT IN S&T

IT IS NOT SO IMPORTANT WHO STARTS THE GAME BUT WHO FINISHES IT

In order to strengthen research-industry cooperation, especially in high technology fields, starting with 2005, ANCS also launched a vast action for promoting technology platforms at national level, in correlation with the European ones. Currently ANCS monitors 21 national platforms in fields such as: hydrogen and fuel cells, water management, maritime transport, future manufacturing, nanoelectronics, nanomedicine, innovative medicines, sustainable chemistry, plants genomics and biotechnology, aeronautics.

Also, up to now, the development of 23 technology transfer and innovation centres (9 incubators, 10 technology transfer centres, 4 technology information centres) and 4 RTDI parks (located in Arad, Bucharest, Craiova, Cluj-Napoca, Deva, Ia i, Râmnicu-Vâlcea, Timi oara, Tulcea), was authorized and financially supported through the INFRATECH Programme.

The “Innovation” programme of the new PNII aims to contribute and support the innovation capacity of enterprises, through partnerships with the scientific world. As a consequence of such a “risk-sharing” financial scheme, more private investment is attracted for the RTDI.

Private investments in the Romanian RTDI area reveals a continuously developing and surprisingly new dimension: although the RD&I activities developed in the private system are not so “visible” as the public ones, the 2006 statistics shows that there are more than 14 000 employees working in private companies, involved in research, development, high-tech and IT activities.

Instead of conclusions

Through time we have learned that science knows no borders and acts as a torch bringing light, hope and prosperity to our life, as no problem can stand the assault of sustained thinking. It is time to break through the barriers that have held us back for such a long time: Romania is a valuable partner and offers its contribution to boost economic growth, create more and better jobs and ensure lasting prosperity in Europe.

The Future of Science & Technology in Europe

Finland

Mauri Pekkarinen

Minister of Ttrade and Industry

Mauri Pekkarinen

Broad-based innovation policy as a response to new challenges: the future of science, technology and innovation in Finland

1. INTRODUCTION

The goal of the Government of Finland is to promote economic growth and social well-being by improving productivity and employment. This will require a better availability of labour, increasing competence and innovativeness, and the reformation of the economic and administrative structures. The national strategy of Finland is strongly based on scientific research, technological development and innovation, and on the successful actions, instruments and implementation processes in the key policy areas. These policy domains include education, S&T and innovation policies. During the past decade, public and private stakeholders of the national innovation system have increased in partnership their investments in creating and exploiting new knowledge, technology and skills. At the same time, there is a growing need for more advanced policy instruments with more extended impacts on the economy and society.

To meet these challenges, the Government will carry out efforts that aim at renewing the structures and procedures of the national innovation system and increasing resources in R&D and innovation. The ultimate objective is to offer innovators the best operating environment in the World. Improvements in economic productivity and competitiveness will require more effective broad-based policy actions. In this context, special attention will be focused on policies in relation to education, R&D and innovation. Apart from technological innovations, the Government will underscore the importance of social innovations, such as those of marketing and organisational innovations. That's why the Government is currently drafting a national innovation strategy. This article will take a closer look at the recent developments in the crucial elements of this strategy – R&D financing and human resources – and describe some of the essential features of the forthcoming new policy domain, i.e. broad-based innovation policy.

2. VOLUME AND FINANCING OF RESEARCH AND DEVELOPMENT ACTIVITIES

The share of R&D funding of gross domestic product

In light of international comparisons, the financing of research and development (R&D) in Finland has developed very favourably. Investment in R&D by both the private and public sectors is among the highest in both the EU and OECD areas. National investment has increased continuously for the past three decades, both in terms of quantity and as a share of gross domestic product (GDP). The GDP share of R&D funding (i.e. R&D intensity) in accordance with the Lisbon Strategy did already reach 3% in Finland in 1999. In 2005, the volume of R&D expenditure in Finland was almost 5.5 billion, i.e. approximately 3.5 per cent of GDP. Preliminary information concerning 2006 indicates that growth of the volume of R&D funding is continuing. However, GDP seems to have grown faster than R&D funding at such a rate that, in 2006, the R&D intensity will probably decrease to 3.4 per cent. The government goal is to raise the R&D intensity to four per cent by 2011. In order to attain this goal, public research and innovation funding will be increased by 5 per cent a year between 2008 and 2011. The goal is included in the decision on state spending limits for 2008-2011 made by the government in May 2007.

R&D expenditure and funding

Overview

Currently, companies account for 71 per cent of R&D expenditure in Finland. The higher education sector accounts for approximately 19 per cent of expenditure and the public sector (i.e. government R&D institutes) for 10 per cent. As the companies' share of the total R&D expenditure has increased, the share of the public sector, in particular, has diminished over the past 15 years.

The private sector also finances the bulk of R&D activities. Its share of R&D funding in the 21st century has been approximately 70 percent, while the public sector's share has been approximately 26 percent. Foreign sources only account for approximately 3 per cent of total R&D funding. Companies finance 95 per cent of their own R&D while the public sector only covers 3.7 per cent of it (in 2004); it needs to be emphasised here that the share of the public sector is clearly below the OECD average.

Table › **R&D expenditure by sector**

[million euro]

YEAR	ENTERPRISES		PUBLIC SECTOR		HIGHER EDUCATION SECTOR		TOTAL	R&D INTENSITY
	MEUR	%	MEUR	%	MEUR	%	MEUR	%
1991	975	57	358	21	378	22	1711	2.0
1996	1657	66	395	16	452	18	2504	2.5
2001	3284	71	501	11	834	18	4619	3.4
2006*	4058	71	565	10	1113	19	5736	3.4

Source: Statistics Finland, Science and Technology Statistics

* *Estimate*

Private sector perspectives

In international comparisons, the Finnish business sector appears to be very R&D-intensive. Over the last 15 years, the R&D activity of the business sector has been growing strongly and steadily. From 1991 to 2006, the share of R&D expenditure by companies of the total R&D expenditure increased by approximately 14 percentage points. During the same period, in terms of GDP, the companies' share increased from approximately 1.2 to approximately 2.4 per cent.

Within the private sector, the share of funding by manufacturing industry decreased from 82 per cent in 1998 to less than 80 per cent in 2004. This derives from the strong growth of R&D in the knowledge-intensive services and the moderate growth of R&D in sectors other than the electronics industry. The share of the electronics industry of the total volume of R&D expenditure in the industrial sector increased by 10 percentage points between 1998 and 2004, reaching 71 per cent in 2004. In addition, one company, Nokia Group, accounts for a lion's share of the R&D within the sector. The shares of the two traditional pillars of Finnish industry – the wood processing industry and the metal industry – decreased, amounting in total to no more than 16 per cent of the entire industrial volume of research expenditure in 2004.

R&D is very much concentrated in large companies. The R&D operations of small companies with less than 10 employees are very limited and their growth modest (in 1998–2004, even nominal growth remained under seven per cent). Slow growth is not so much a sign of access to R&D funding being difficult, but rather reveals that the number of R&D-oriented start-up companies remains low. The actual problems in the capital management of these companies lie in the fact that risk capital investors avoid investing in start-up companies. Public investors have to provide 90 per cent of financing in this particular area of innovation funding.

According to the Statistics Finland estimate published in January 2007, private sector R&D expenditure in 2006 increased by approximately 4.9 per cent on the previous year. According to a Confederation of Finnish Industries survey, the R&D expenditure of Finnish companies abroad increased, but somewhat slower than domestic R&D expenditure. According to the estimates of Finnish business life, companies' R&D expenditure will continue to grow in 2007. Positive developments can be observed, particularly in the chemical industry and the technology industry, whereas in the forest industry no signs of revival of R&D activity can be detected as yet. The Statistics Finland estimate, on the other hand, seems to indicate that R&D activity has also increased favourably in the service sector.

It is also worth noting that the Confederation of Finnish Industries estimated that companies would spend over 66 per cent of their R&D expenditure in Finland. This is about the same amount as in 2005-2006, and as much as 6 percentage points more than at the beginning of the 21st century. As far as the R&D activity of Finnish companies is concerned, it would seem that Finland has maintained its position as a competitive and favourable environment for innovation. The growth of R&D expenditure has also increased the number of R&D staff in companies while, in 2003-2005, it remained almost unchanged.

Public sector perspectives

In spite of the fact that the relative share of public sector investment in the volume and funding of research has decreased, **when calculated in euros, public sector investment in R&D has increased significantly.** State R&D funding almost doubled in 1996-2006. During this period, in real terms, public funding for R&D grew every year except for three. We should note in particular that, at the end of the 1990s, when the state was otherwise cutting expenditure, it still increased R&D funding. Taken alone, the general increase of 1997–1999 meant a real increase in state investment in R&D of more than one fifth. The proportion of R&D funding of state expenditure increased over ten years by 1.2 percentage points. Since 2002, the share of state expenditure has been 4.5 per cent.

In 2007, in the state budget, EUR 1.73 billion will be allocated for appropriations and allocation authorisations for R&D activities, representing an increase of EUR 50 million and nominal growth of three per cent from the previous year. As in previous years, the share of R&D of state expenditure, excluding state debt servicing costs, is 4.5 per cent. In Finland, at 1.03 per cent, the proportion of public R&D funding of gross domestic product in 2005 was the highest among the EU Member States. However, mostly due to remarkable rates of growth of GDP, it is more than likely that the figure will decrease below the level of one per cent in 2007.

Table › **The development of total state expenditure* and R&D funding in 1996-2006.**

YEAR	MEUR		SHARE OF R&D OF STATE EXPENDITURE, %	REAL CHANGE, %	
	EXPENSES	R&D FUNDING		EXPENSES	R&D FUNDING
1996	28 658	938.8	3.3	-2.5	-1.7
1997	27 831	1 183.9	4.3	-3.6	23.4
2001	29 672	1 352.4	4.6	2.1	0.7
2004	33 939	1 535.1	4.5	2.8	3.1
2006	37 344	1 680.0	4.5	3.6	2.7

Source: Statistics Finland, Science and Technology Statistics

Since the latter half of the 1990s, the most characteristic feature of *public sector* research funding has been a **strong focus on competitive funding**, its share of state research funding growing within ten years from 25 per cent to 42 per cent in 2005. The financing volume of financing organisations has grown significantly during the same period, as can be seen from the following:

Table › **Targeting of research funding in the state budget at current prices in 1991-2005** (MEUR)

	1991	1995	1996	2000	2005
Academy of Finland	75.6	77.1	84.4	153.8	223.5
Tekes	156.5	243.9	246.2	390.8	448.4
Total	*232.1*	*321.0*	*330.6*	*544.6*	*671.9*
Universities	226.3	220.4	258.6	346.4	416.7
Research institutes	209.9	194.6	196.1	215.8	259.4
Other research funding	131.5	158.0	153.4	189.1	248.7
All in total	**799.7**	**894.0**	**938.8**	**1295.9**	**1596.7**

Source: Statistics Finland, Science and Technology Statistics

The Academy of Finland is an organisation which provides funding for basic scientific research and Tekes (Finnish Funding Agency for Technology and Innovation) is an organisation which provides funding for applied technical research and innovation activities. In the state budget of 2007, their share of public R&D funding is 45.1 per cent. As the share of financing organisations has grown, the share of government R&D institutes in particular has decreased.

* Total expenditure, excluding debt servicing costs

In Finland, the development of the basic funding of universities rests on the Higher Education Development Act, which guarantees a certain real increase in basic funding for universities in 2005–2007. The problem is that the **operative basic funding of universities has hardly increased at all**, since they are being forced to use most of the statutory increase on rents and other real estate expenses. The modest increase in the basic funding of research institutes operating under various ministries, on the other hand, is largely explained by the **endeavour to make research institutes increase the quantity and share of external R&D funding**. Within ten years, the share of external R&D funding has indeed grown at an average annual rate of eight per cent, reaching 44 per cent of total funding in 2006. Still, only two of the twenty research institutes – the Technical Research Centre of Finland (VTT) and the Finnish Environment Institute (SYKE) – have reached above average levels. In order to develop outside funding, it has been deemed necessary, for instance, to develop the calculation of costs at research institutes and to raise the tax exemption limit of corporate donations for institutes of higher education.

3. DEVELOPMENT OF HUMAN RESOURCES

The rapid growth in the volume of research in Finland has also set challenges for researcher training in order to guarantee that the education level of research staff remains high as operations expand. So far, we have succeeded well. Key measures for achieving this have included the development of graduate schools, the emphasis given to new doctoral theses in the basic funding of universities, and the linking of PhD training to Academy of Finland research funding that has continued for long. At the same time, insufficient attention has been paid to investment in post-doctoral research careers. This development has not matched the requirements of increased R&D activity and presents a major challenge for the research system as a whole, as well as for the financing organisations.

The table below, demonstrating **the development in the number of university degrees,** shows steady and strong growth in the number of university degrees, postgraduate students and doctoral degrees between 1991 and 2006. The annual number of doctoral degrees more than doubled in Finland in the 1990s, and this growth has continued in the early 21st century. In 2006, the number of doctoral degrees totalled 1,409. Women accounted for 47 per cent of these degrees in 2006, as compared to 33 per cent in the early 1990s.

Table › **University degrees: postgraduate studies**

	1991	1995	2000	2005	2006
Higher university degrees	8 410	9 819	11 515	12 920	13 128
Postgraduate students, total	11 839	15 927	20 537	22 145	21 899
Licentiate degrees	604	793	748	533	489
Doctoral degrees	524	765	1 156	1 422	1 409

Source: Ministry of Education, KOTA database

The Finnish **graduate school system**, established in 1995 with the financing of the Ministry of Education, universities and the Academy of Finland, has gradually expanded and the number of schools has doubled from the original. At the beginning of 2006, the system comprised 124 graduate schools, where slightly over 4,000 postgraduate students are working on their doctoral dissertations full-time. Most of the graduate schools are networked projects jointly run by several universities. The graduate schools are tasked with providing systematic education and guidance for the postgraduate students enrolled in them. In graduate schools, students study full-time and receive salary.

The graduate schools have made postgraduate education more systematic and efficient. The key objectives are to assure the quality of graduate education and shorten the time it takes doctoral students to write their dissertations, thus lowering the age at which doctoral candidates defend their theses, in order to educate high-level professional researchers and experts. With a view to more international doctoral education, the aim is to increase the share of foreign doctoral students in the graduate schools to 20 per cent on average by 2012.

In 2004, almost 13,000 PhDs were involved in working life in Finland, representing approximately 0.5 per cent of the workforce. Employment prospects are bright for those with a doctoral degree, and in international comparisons, the Finnish unemployment rate for PhDs is among the lowest (2.2% in 2004; unemployment rate of the entire work force in Finland was 7.7% in Dec 2004). Most doctors (85%) work in the public sector. The general unemployment rate in Finland in December 2006 was 6.4 per cent.

In 2005, a total of over 77,000 personnel worked in R&D positions, representing an increase of only one per cent on the previous year. On a longer-term perspective, however, we can see that the number of R&D personnel has grown very favourably in Finland for quite some time. From the point of view of both R&D investments and the number of R&D personnel, the late 1990s was a period of rapid growth. At the beginning of the current decade, growth was slower, but over the past two years the resources allocated to R&D have again begun to grow favourably. After a couple of years of decline, the number of R&D personnel in corporations is also growing again. More than half of research personnel work in companies and about a third – over 26,000 in all – are women. In the public sector and the higher education sector, women account for almost half of research staff, but in companies their share is only slightly over a fifth.

Table › **Research and development staff by sector**

	1995	2000	2005
Corporate sector	24 243	38 169	40 802
Public sector	8 902	10 096	10 680
Higher education sector	14 721	20 548	25 793
Total	47 866	68 813	77 275

Source: Statistics Finland, Science and Technology Statistics

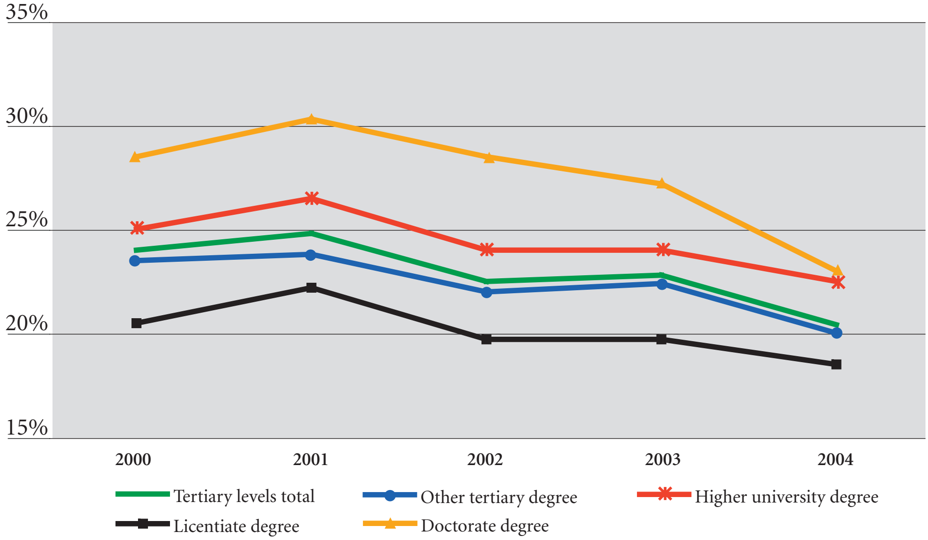
Mobility of the highly educated

In recent years, a third theme has arisen alongside questions on the need for highly educated employees and the placement of graduates, namely, their mobility on the labour market. From the point of view of the national innovation system, the mobility of the highly educated is a key channel for the dissemination of knowledge and expertise. The transfer of employees from one workplace to another is the most efficient way of spreading the knowledge possessed by a person – so-called tacit knowledge and expertise – from one place to another.

The mobility of the highly educated[1] increased favourably in Finland after the economic depression of the 1990s, but has begun to decline again since the turn of the 21st century. In 2004, slightly over 20 per cent of the highly educated changed jobs, almost three per cent less than in 2000. The drop in the mobility rate was highest among the most highly educated, i.e. those with doctoral degrees (from 28% to 23%). In the Finnish labour market, the higher the educational level, the greater the mobility rate, generally. The mobility rate differs greatly from one field of science to another.

[1] The term, 'highly educated' refers to a person with at least a lower degree in higher education and, in this context, mobility refers to a change of job or becoming employed as compared to the year before.

Figure › **Rates of mobility according to education level in 2000-2004**



In the EU Member States, R&D co-operation and researcher visits to foreign universities increased significantly in the 1990s. Efforts have been made to enhance international mobility further through measures implemented simultaneously in the EU and its member states concerning, for instance, the labour markets, taxation, immigration regulations, work permit questions, and the establishment of internationally acknowledged research environments.

Finland has also taken separate steps in order to become a more attractive place for highly educated foreigners and to attract as many as possible who have moved away to return. The goal is to strengthen the foundations of expertise and reform modes of operation in Finland.

In Finland, the share of foreigners in professions requiring high-level expertise is one of the lowest in the EU15 area. The share of foreign R&D staff is also among the lowest of all EU15 states. In addition, at the beginning of the 21st century, the share of foreign students in researcher education programmes in Finland was among the lowest of the EU15 states (approx. 6%). Growth in the number of foreign students in Finland would be a positive factor, but it would be equally important to have more of them stay and work in Finland after graduation.

A key goal is to enhance the international mobility of researchers. The means of doing so have been examined from the point of view of the advancement of researcher careers and the development of graduate education. According to studies, it would seem important to support researchers during the phase in which they are becoming independent, and to develop the career ladder at universities in a way that promotes research careers. Accordingly, an action plan for the promotion of graduate education and research careers has been drawn up for 2007–2011. In addition, a taskforce has been set up to prepare a four-step research career model.

In accordance with the government programme, a national strategy will be created for the internationalisation of higher education in order to increase the international mobility of students, teachers and researchers. Commissioned education directed at foreign students will be facilitated, and a trial will be launched allowing universities and polytechnics to apply for the right to charge fees for participation in specified MSc programmes from students coming from outside the EU/ETA area. This trial will also include a scholarship system for foreign students of limited means.

A public financing programme, the Finland Distinguished Professor Programme (FiDiPro), has been established in order to recruit foreign researchers to Finland, offering distinguished professor-level positions for a fixed term. The programme aims to strengthen Finland's scientific and technological expertise and to internationalise the Finnish research system, bring added value to the national innovation system, and support the profiling of research in universities and government R&D institutes.

4. SCIENCE AND TECHNOLOGY ALONE ARE NOT ENOUGH: TOWARDS BROAD-BASED INNOVATION POLICY

The government aims to increase public R&D funding sufficiently to raise the GDP share of private and public research funding to four per cent by the end of this decade. Of course, increasing research funding is not an end in itself. With a view to the realisation of the science, technology and innovation policy objectives, it is essential that research funding be provided on a long-term basis and its development is predictable. The purpose of public funding is to increase the benefits deriving from investment. Public funding also encourages companies to increase their research investments and strengthen their innovation activities. In Finland, the concern remains that large investments in R&D do not materialise sufficiently in the form of new innovations, businesses, jobs, or increased exports. It would be especially necessary to develop R&D and innovation activities in the service sector, which has a weak productivity rate.

Thus, when targeting financing, in addition to implementing content-related goals, it would also be important to reduce the fragmentation of R&D activities and other weaknesses. Accordingly, the measures in accordance with the government decision in principle concerning the structural development of the public research system – particularly the centres of expertise, structural reform of sectoral research, and more efficient strategic guidance – were emphasised in the implementation of the science, technology and innovation policy. The internationalisation of science and technology is the over-arching feature of all development measures.

The structural development of **institutes of higher education** aims at strengthening their quality, effectiveness and internationalisation. Universities and polytechnics are being encouraged to develop their own focus areas. Some polytechnics have become united, and the preparation of a few university consortiums is underway. In accordance with the government programme, a new innovation university of research and education will be established as a joint venture by three institutes of higher education. Project funding has been provided for universities and polytechnics, for instance, for the purpose of strengthening business expertise, entrepreneurship and internationalisation in their teaching. Universities will be given more financial power in connection with the reform of the Universities Act. They can become collective or juridical persons under public law or foundations under civil law. In addition, their management and decision-making systems will undergo a reform by the spring of 2009. The legislation concerning inventions made in institutes of higher education was reformed in the spring of 2006. A new law will make the recognition and exploitation of inventions developed in institutes of higher education more efficient by clarifying the related rights and compensation procedures. Furthermore, the legislation was changed to enable universities to establish limited companies which can apply research results for commercial purposes.

Special attention is being paid to the fact that the **financing structure of research organisations** (direct budget funding and competitive funding) is in balance and rests on a sustainable foundation with a view to the stable management of the basic tasks and long-term development of the knowledge base. These principles apply to the use of both existing and new funding, the need for which is already a widely accepted fact in Finland.

Strategic Centres of Excellence in Science, Technology and Innovation will be established for areas of expertise which are crucial to the future of the national economy and society. Such areas include energy, the environment, metal products and mechanical engineering, the forest cluster, health and welfare, and the information and communications industry and services. The operation of these centres will be based on the strong commitment of companies, universities, research institutes and financing organisations. Moreover, the national strategy includes proposals for the development of comprehensive national infrastructures and their enhanced use. The first centre of expertise, the Forest Cluster Ltd., was established in the summer of 2007.

Preparations for the establishment of strategic centres of expertise have taken place in close co-operation with the **Centre of Expertise Programme (CoE).** During the new programme period 2007–2013, the CoE programme focus will be on the development of nationally significant centres of expertise and internationally competitive centres of expertise. In addition, a regional centre of expertise programme will strengthen the innovation environments of small and medium sized rural areas in particular and support their networking with stronger rural areas within the innovation system. The innovation strategies of large rural areas, on the other hand, promote the development of rural innovation environments and support the establishment of centres of expertise. Financing from EU structural funds will be guided towards the development of regional conditions for innovation activity.

The government has decided to reform the governance system of **research performed in sectoral research institutes** (i.e. government R&D institutes), operating under various ministries. An advisory committee has been established for the ministries' new, joint operating model, to guide and develop sectoral research and its exploitation. The field of sectoral research has been divided into four areas: regional and social structures and infrastructures; competencies, work and welfare; sustainable development; and security. Furthermore, the advisory committee has been tasked with the development, for instance, of evaluation and anticipatory methods for policy measures, and the promotion of researcher careers and internationalisation.

The various phases in the development of enterprises and the varying needs related to each of them have not been taken into account in the financing as comprehensively as they should be. However, the public sector has begun to eliminate the discontinuity emerging at the interface of research and innovation funding by means of risk funding, operating between R&D funding and the actions of private capital investors. This phase of the innovation process also entails other areas of development requiring investments, particularly in areas related to business skills and, more generally, willingness to become an entrepreneur.

Alongside increased R&D funding, efforts are being made to improve the efficiency of the way in which the funding is used. In order to make the **evaluation of the impact** of aid measures easier, a database of public research funding and economic subsidies has been set up. This database, covering all business subsidies since 2000, provides a foundation for evaluating the impact of subsidies independent of the provider of the subsidy and with the required research reliability.

In addition to the above, there are many other factors related to the operation of the innovation system, for the development of which the public sector is expected to bear responsibility in Finland. Such measures include closer co-operation and interaction between public innovation organisations, including the development of joint service models, more efficient productisation and commercialisation measures, and the promotion of innovation readiness and creativity – for instance, by supporting the innovativeness of work organisations, promoting entrepreneurship, improving the clarity and predictability of the regulatory environment, the operation of markets, and the development of public sector acquisitions.

In my opinion, it is important that the development of the science and technology policy be closely linked with the innovation policy, since in this way it can be guaranteed that the results of scientific and technological development will benefit society as extensively as possible. Furthermore, it is important that the concept of innovation be not confined only to, say, technological innovations. Accordingly, the Finnish Government has decided to draw up a **national innovation strategy**, whose preparation has been launched from the viewpoint of broad-based innovation policy. The basic principle lies in there being a specific, recognisable role for most areas of political life within the innovation activities and policy, and that the governance measures of public authorities are linked more comprehensively as part of the innovation policy.

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Germany

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Innovation: A Source of Future Prosperity

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INNOVATION: A SOURCE OF FUTURE PROSPERITY

On the 50th anniversary of the signing of the Treaties of Rome, which was celebrated in Berlin on 25 March 2007, the heads of state and government of the European Union stated: “Europe’s wealth lies in the knowledge and ability of its people; that is the key to growth, employment and social cohesion.” Putting people and their skills at the focus of progress is a truly European idea. Therefore, the European Union’s Lisbon Strategy, which aims at making Europe the most dynamic knowledge-based region in the world by 2010, is closely linked to greater financial and conceptual efforts in the fields of education, science and research.

Europe is paving the way for more innovation and establishing a future-oriented foundation for greater attractiveness in the international competition for talent in science and research.

One element of the Lisbon Strategy is that the Member States invest 3 percent of GDP in research and development by 2010. Germany supports this aim. We also know, however, that this objective presupposes extraordinary efforts. In 2008, about 2.7 percent of GDP will be invested in research and development in Germany. This is possible because the Federal Government has increased the research budget by an additional 6.5 billion Euro so far during this legislative period. Further increases will be necessary in 2009. Industry has already followed suit and considerably increased its investment in research and development. Industry expenditure has risen by 8 percent over the period 2005 to 2007, from 38 to almost 42 billion Euro. All in all, the European Union has been lagging behind its own target in recent years. We must therefore use the remaining time to achieve a considerable increase – up to the 3 percent target. In addition to investment, conceptual strategies are needed for science and industry to become natural partners in the processes strengthening innovativeness.

THE HIGH-TECH STRATEGY FOR GERMANY

In autumn 2006, we presented the High-tech Strategy for Germany, which is a new concept for a modern innovation policy. The strengths of basic research are to be better used in Germany in processes of transformation. It is our objective to translate good ideas as rapidly as possible into marketable products, services and processes.

To implement our objectives, we will become active in and coordinate five central, cross-cutting areas: (1) science/industry interface, (2) private commitment to R&D and innovation, (3) dissemination of technologies, (4) internationalization of research, development and innovation, and (5) promotion of talent. The measures in each of these fields of action aim at simplifying and shortening the path from ideas to innovation.

We have identified 17 fields of innovation, among them nanotechnologies, biotechnologies, optical technologies, microtechnologies as well as information and communication technologies. They are considered drivers of innovation worldwide. They facilitate a great variety of applications and they change many branches of industry. However, what is even more important for an export-oriented country like Germany is the integration of these basic technologies into fields of application, such as automotive and mechanical engineering, which are the basis of our economic strength, or environment and energy technology, which are required for solving urgent problems of the future.

The following three examples of innovation strategies will illustrate the High-tech Strategy for Germany:

The German **automotive industry** is a key industry and holds a global leadership position with its innovativeness and willingness to innovate. Up until the year 2015, we expect an average annual growth in this industry of almost three percent. About one job in seven in Germany depends directly or indirectly on automotive construction. Almost 30 percent of all researchers and developers are working in the automotive industry. In future too, we want Germany to build the best cars. At the same time, we want to live up to our responsibility regarding the climate. We will therefore develop new technologies in Germany which considerably reduce the average CO_2 emissions of new passenger cars.

The successful and the failed terrorist attacks in Europe have made clear how fragile the global security situation is. **Security research** is therefore another important field of innovation in the High-tech Strategy. The aim is to protect people's freedom also by means of suitable high technology. We need a whole set of strategies for action in order to be able to respond quickly to threats or hazards caused by terrorism, sabotage, organized crime, the impact of natural disasters or severe accidents. In addition to prevention, innovative technologies for a rapid and comprehensive response in the case of crisis will play a particularly important role. We can, for example, considerably mitigate the consequences of attacks and IT incidents as well as of natural disasters. New security solutions for communication networks, industrial facilities, buildings, supply and logistics systems can make our society more robust against disasters and less attractive for attackers.

In 2005, the volume of turnover of the market for security technology products and services amounted to ten billion Euro in Germany alone; the field of IT security alone accounted for 3.6 billion Euro – with high growth rates. IT security in particular is becoming increasingly important.

Information and communication technologies (ICT) proliferate in all spheres of life and work. ICT are the technological basis for the information and knowledge society as well as for ever new services in industry (E-business, E-commerce), public administration (E-government), the health sector and private life.

Electronics – including micro- and nanoelectronics –, communication technology, telecommunication, IT services, IT businesses and IT trade generate ten percent of GDP on OECD average with a strong upward trend. ICT also catalyze growth in many other industries. As part of the High-tech Strategy, we want to consolidate and enhance Germany's technological leadership position in the ICT sector. The competitiveness of production and labour in Germany is to be secured and increased by means of ICT, in particular in mechanical and facility engineering, the automotive industry and the telecommunications market. The High-tech Strategy is to accelerate technology developments and processes which have a particularly strong leveraging effect on the economy.

HIGH-TECH STRATEGY FOR CLIMATE PROTECTION

In the field of climate protection, we also rely on the opportunities offered by modern innovation policy and are creating modern framework conditions. Under the "High-tech Strategy for Climate Protection", we seek to encourage targeted solutions for the challenges posed by climate change. In a joint effort between science, industry and politics, we have developed this strategy in summer 2007. It focuses the strengths of the German research and innovation potential on climate protection and takes up all the topics which contribute to climate protection, are expected to lead to technological break-throughs in the near future and provide opportunities on the market and for exports. We believe it is important that the path from ideas to specific, marketable products should be as short as possible.

We want to make targeted efforts to shape and make use of technological change and growing markets also for products, processes and services which are relevant for the climate. In order to do so, the High-tech Strategy for Climate Protection will bring research and industry even closer together. We want them to jointly develop innovative technological solutions for climate protection.

Over the coming ten years, the Federal Ministry of Education and Research alone will provide an additional one billion Euro for the High-tech Strategy for Climate Protection. Industry has already committed itself to participating by providing at least two billion Euro.

RESEARCH BONUS

We also want to create closer networks between research and small and medium-sized enterprises (SMEs) in order to better use the full innovation potential. Often, SMEs have only restricted access, or no access at all, to scientific findings and solutions proposed by research. This prevents SMEs from introducing their experience on the market and from contributing their ideas for solutions to the innovation process. This is why we have introduced the Research Bonus. It mobilizes additional potential for cooperation with SMEs in institutions of higher education and public research institutions. The Research Bonus provides public research with the necessary incentives to further enhance their competences in the field of knowledge and technology transfer. Science can thus contribute to developing ideas from practice further as well as to a rapid translation of results from research and development into innovations.

LEADING-EDGE CLUSTERS

Many examples show how intensively science and industry are jointly searching for innovative solutions even today. These synergy effects become particularly visible in so-called clusters. We have therefore launched a leading-edge cluster competition to set new trends under the motto of “Strengthening Strengths!”. It provides scientific institutions and companies with incentives to make even better use of their cooperation potential. The aim is to provide targeted support for efficient clusters from science and industry on their way to achieving an international leadership position. When selecting the strategy concepts, we therefore take into account the creativity and innovativeness of the cluster's approach as well as its current development status.

THE INDUSTRY-SCIENCE RESEARCH ALLIANCE

A group of advisors consisting of leading representatives from industry and science flanks the High-tech Strategy so that these initiatives can live up to the actual demands. Each member of the "Industry-Science Research Alliance" is a promoter for one or several of the 17 innovation and five cross-cutting fields of the High-tech Strategy. The promoters develop recommendations for the Federal Government. Knowledge and expertise in research and innovation will be networked more closely by the work of the Research Alliance. Growth opportunities are identified in a dialogue between science, industry and politics. In this way, we are creating conditions in Germany under which more ideas are implemented in practice and Germany can assume a leadership position on the most important future markets.

So we have set the right course. However, we can only fully use the potential of this policy if all stakeholders join forces and industry assumes its share of responsibility in the area of R&D investment.

Furthermore, we must not lose sight of the above-mentioned source of Europe's wealth, i.e. the knowledge and skills of both men and women in Europe. We must therefore invest much more in education, training and continuing training. Qualifications are the drivers of innovation. Europe must become attractive for the most talented scientists, for highly qualified professionals and experts from all over the world. In recent years, we have initiated many projects in Germany to turn our country into an internationally attractive hotbed of talent.

HIGHER EDUCATION PACT

Future-oriented research needs highly qualified scientists, researchers and professionals in companies. These young people are trained at our institutions of higher education. For this reason, the Federal Government and the *Länder* have concluded a Higher Education Pact. This Pact is an explicit commitment to the German higher education system. Due to age groups with high birth rates, we expect a run on institutions of higher education in the next few years. The Higher Education Pact guarantees all these young men and women a study place. At the same time, we want to improve conditions for studies still further in order to make it possible for everyone to pursue studies which are oriented to the highest international standards.

INITIATIVE FOR EXCELLENCE

This is why we have initiated the Initiative for Excellence, which is already bearing fruit: A body of international experts has identified nine elite universities in two selection rounds: RWTH Aachen University, Berlin Free University, Albert Ludwig University Freiburg, Georg August University Göttingen, Ruprecht Karl University Heidelberg, Karlsruhe University, Konstanz University, Ludwig Maximilian University Munich, Munich Technical University. These universities have presented future-oriented concepts in the area of post-graduate research schools, excellence clusters and new future-oriented concepts for the university as a whole. These beacons are giving international visibility to German cutting-edge research.

RWTH Aachen University and the Research Centre Jülich have launched a special collaboration in their "Jülich Aachen Research Alliance" JARA. JARA pools cutting-edge research. To begin with, the university and the research centre, with a combined annual budget of over 900 million Euro, will bring together their research areas for brain research, simulation sciences and information technologies. The three sections will be given a management structure based on a partnership and they will develop their research aims and decide on staff and investment together.

The Karlsruhe Institute for Technology (KIT) is taking concrete shape. The merger of the University and the Research Centre Karlsruhe, a member of the renowned Hermann von Helmholtz Association of German Research Centres, combines the strengths of both partners. They are initially planning to cooperate in micro- and nanotechnology, scientific computing with a focus on grid computing as well as materials research for the energy sector. The KIT is a unique, future-oriented model in Germany which will radiate far beyond Germany.

As an elite university, Munich University was able to conclude a future-oriented cooperation agreement with the renowned American University of Berkeley.
Other universities have also indicated their interest in closer cooperation.

These examples have also called into action all the universities which were less successful in the Initiative for Excellence. Many institutions of higher education have developed their own concepts for the future.

We know that all these instruments and initiatives will only be really successful if we see a change of mentality in our country. People in Germany must become more interested in research and science, and the work of researchers and scientists must be given greater recognition. We will only be able to better use Germany's potential and the European Union's potential if we are successful in this field. Initiatives such as "Science in Dialogue", which promote exchanges between science and the general public, or the Science Years, which are dedicated to a new topic each year – for example the humanities in 2007 and mathematics in 2008 – are making an important contribution.

However, this is not enough. The Report on Germany's Technological Performance, which was presented in June 2007, predicts a shortage of up to 62,000 engineers and other highly qualified university graduates in Germany every year up until 2014. The number of unemployed engineers has dropped by about 50 percent in the past three years. The unemployment rate among IT experts and scientists is also falling and the number of vacancies is rising. This trend can also be observed among older unemployed people with a corresponding qualification. In addition, Germany's active population will shrink because of demographic change. Furthermore, forecasts predict that there will be a shortage of about 270,000 skilled workers in Germany in 2020 while the demand for workers without formal training will be much lower.

EARLY CHILDHOOD EDUCATION

We must therefore ensure in the long term that we arouse an early interest in science among children and that this enthusiasm for science and technology is then supported in primary school and into secondary school so that again more young men and women choose to study engineering, technology or science subjects.

The "House of Little Researchers" initiative aims to arouse the interest of pre-school children in exciting questions from the field of science and technology by using a playful but intensive approach. This initiative was launched in late October 2006 by industry, science and politics in Berlin and became a nation-wide project in 2007. Arousing curiosity, jointly discovering new things and understanding causal relations are the objectives of the "House of Little Researchers".

Early childhood education is the key to developing individual interests and skills. Studies have shown that three- to six-year-olds are particularly receptive and capable of learning. They have a natural interest in making discoveries, and they have no reservations vis-à-vis science and technology. The "House of Little Researchers" initiative wants to make use of this opportunity by supporting nursery school teachers in their work. The programme includes continuing training programmes and workshops as well as teaching and working materials for teaching staff in day-care centres for smaller children, visits of scientists in day-care centres and kindergartens and even a mentor network and a hotline for scientific and didactic questions. Three- to six-year old children in day-care facilities or kindergartens are allowed to find their own answers to everyday science questions by means of simple experiments and to enhance their language, learning and social skills in the process.

YOUNG PROFESSIONALS

The "Girl's Day" is a means of reaching out to young women. On this day, girls and young women can get to know technical occupations because at present we are far from making sufficient use of this potential. Later on, long-term practical placements can contribute to providing young women – and men – with real insight into a technical occupation over a longer period. Drop-out rates at universities can be reduced through early, detailed information about what a study course and / or a related career will bring. At the same time, such long-term placements can also trigger an interest in young people to take up such studies since it has become increasingly clear in recent years that even young people with university entrance qualification opt against studies.

Contrary to this trend, we want to increase the number of graduates to 40 percent and, at the same time, reduce the number of drop-outs. About 35 percent of an age group currently take up studies, but only 20 percent graduate. The change-over to bachelor's and master's programmes has already reduced the drop-out rate at some universities from 50 to 10 percent.

NATIONAL QUALIFICATION INITIATIVE

However, highly qualified professionals with a university degree will not be sufficient to maintain our innovativeness. We also need well-trained skilled workers. This is why we have launched the National Qualification Initiative which pursues the aims of strengthening early childhood education, bringing mathematics and the sciences, the so-called MINT subjects, stronger into the focus, considerably reducing drop-out rates and better integrating migrants by means of better education.

We want to enable all young people in Germany to undergo vocational training. This means that we also have to improve the transition from school to training. To provide better opportunities in particular for those young people who have difficulties in actually completing their training, we want to provide them with a second chance by modularizing vocational training. Furthermore, we want to improve the transfer between vocational training and higher education. Since the demands made on skilled labour are increasing, we want to achieve a greater participation of employees in continuing training. Companies are also called upon to make better use of opportunities provided by continuing training for employees.

Furthermore, it is becoming clear that we will not be able to do without a targeted immigration of skilled labour, neither in Germany nor in Europe as a whole. If we want to be attractive for highly qualified professionals from other parts of the world, we must increase our efforts in providing job perspectives for qualified immigrants. These efforts will continue to be a responsibility of individual EU Member States, and rightly so. They will have to become part and parcel of sustainable innovation strategies.

We have therefore decided to provide easier access to the German labour market for engineers from the new EU Member States in the fields of mechanical engineering and motor manufacturing as well as electrical engineering. At the same time, we want to enable foreign graduates of German institutions of higher education to stay in Germany after graduation and to make their knowledge available to the German market.

STRATEGY FOR INTERNATIONALIZATION

We are living in a world which is more internationally networked than ever before. Scientific progress and technological innovations have made major contributions to globalization. Large companies give their R&D activities a global orientation. The internationalization of production capacities is now followed by an internationalization of development and research capacities. Companies therefore seek to locate their production, research and development activities close to research institutes and higher education institutions in order to solve development problems and take up new ideas. There is a strong international competition for the locations of national and international research institutions. Furthermore, the global map of science has changed. New partners for Germany and Europe have emerged. Challenges, such as demographic change, better health-care or climate change no longer concern individual countries but humanity as a whole, and call for global solutions.

The 7th Research Framework Programme, which was launched at the beginning of the German EU Council Presidency in January 2007, shows that we are determined to do more for research in Europe. The programme is the central platform for the most important research topics and pools European research efforts. The 7th Research Framework Programme is the most comprehensive research funding programme worldwide. Above all, it is an important milestone of successful innovation and research policy in Europe. With a project period of seven years, the 7th Research Framework Programme provides planning security. Its total budget of about 54 billion Euro exceeds the funds of the predecessor programme by about 60 percent annually on average. We are thus well on the way towards strengthening Europe's position in the global competition. Further important elements are the European Research Council and the European Institute of Technology which is to promote innovation alliances between science and industry through a network of excellent innovation alliances.

Education, science and research are the sources of future prosperity – economic and intellectual prosperity alike. The dynamism which has been created in our countries must be consistently strengthened to keep abreast of the international dynamism. Europe as a continent of diversity, also as regards its science systems, needs mobility for a corresponding development of the Bologna process towards transparency and comparability. The aim of all science and research policy strategies must be a consistent promotion of the knowledge and skills of citizens in Europe because this is the key to growth, employment and social cohesion.

Portugal

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A Commitment to Science for the Future of Portugal

Portugal has defined its scientific and technological development as a national priority. The programme of the Portuguese government (2005-2009) includes as one of its main features a Technological Plan for the advancement of science, technology and innovation. As a consequence, the Government's Initiative *A Commitment to Science* considers explicit goals and defines policy measures and instruments for the legislative period 2005-2009:

- Reaching 5.5 researchers (FTE) per thousand active workers (they were 3.5 in Portugal and 5.5 in the EU25 in 2003).
- Increasing from 1.000 to 1.500 new PhD holders per year, also increasing the fraction of PhDs in sciences and engineering.
- Increasing by 50% the internationally referenced scientific production, from 400 to 600 scientific publications per million inhabitants per year.
- Trebling the number of patents registered in the European Patent Office and the US Patent Office (these were respectively 4.1 and 1.3 per million inhabitants).

In order to achieve these results, the following international goals regarding human and financial resources have been adopted:

- Increasing by 50% the number of new graduates in sciences and engineering.
- Doubling public investment in R&D, from 0.5% to 1.0% of the GDP.
- Trebling private investment in R&D, which was only 0.24% of the GDP in 2003.

We recognize that scientific progress is a source of development. Public resources invested under rigorous international assessment policies lead to new knowledge, better advanced training of new human resources for the society, new ideas and processes, which increasingly result in innovation, modernization of institutions, improved quality of living, economic productivity and better employment[1].

[1] European Commission (2004). Increasing human resources for science and technology in Europe. Eds., Gago, J., Ziman, J., Caro, P., Constantinou, C., Davies, G., Parchmannn, I., Rannikmäe, M. and Sjøberg, S.; High Level Group on Human Resources for Science and Technology, European Commission.

Some forty years after John Ziman launched the discussion on *Public Knowledge*[2] and thirty years after his work on *Reliable Knowledge*[3], to appreciate the significance of scientific knowledge one must understand the nature of science as a complex whole. In *Real Science*[4], we are reminded that "science is social", referring to "the whole network of social and epistemic practices where scientific beliefs actually emerge and are sustained".

Our goals require the renovation and expansion of the social basis for scientific and technological development in Portugal. This calls upon strong conviction not only from the scientific and technical professions and of public and private research organizations, but also from students and from the general population. The growing appropriation of scientific and technological culture by society is thus one of the central aspects of our strategy.

We have therefore assumed the following main guiding principles:

› Investing in **knowledge** and in scientific and technical competence, measured at the highest international level;
› Investing in **human resources** for science and technology and in the scientific and technological culture of the population at large;
› Investing in public and private R&D **institutions**, and in their reinforcement, responsibility, organization and networking, together with their integrity;
› Investing in **internationalization**, together with quality and evaluation, following the best international practices;
› Investing in **ideas** and the commercialization of science and technology in an increasing global economy, in a way to foster sustainable growth and strengthening scientific employment through a new generation of science-based firms.

These guiding principles have been associated with increasing public and private investment in S&T, as well as with attracting more human resources for science and technology. This includes raising the public understanding of science and technology and developing science and technology culture, as well as promoting the integrity of scientific institutions. In addition, a profound reform of higher education was completed in 2007, following a systemic evaluation conducted by the OCDE in 2006[5] at the request of the Portuguese government.

[2] Ziman, J. (1968), Public Knowledge: The Social Dimension of Science, Cambridge University Press
[3] Ziman, J. (1978), Reliable Knowledge: an exploration of the grounds for belief in science, Cambridge University Press
[4] Ziman, J. (2000), Real Science: What it is, and what it means, Cambridge University Press
[5] OECD (2007), Reviews of Tertairy Education – Portugal, OECD Education Department.

INVESTING IN KNOWLEDGE BY PROMOTING PUBLIC AND PRIVATE EXPENDITURE ON R&D

For the first time in Portugal, the total public budget for R&D exceeded 1% of GDP in 2008 (it was 0.85% in 2006 and 0.88% in 2007). It grew at 11% per year from 2004 to 2007, while it had grown at 10% a year from 1995 to 2002, among the highest values in Europe. We believe public funding should be consistently allocated to research in a way that can foster the knowledge infrastructure. Analysis has shown that fostering and maintaining excellence of the knowledge infrastructure is also a most effective way for public funding of R&D being able to provide and facilitate resources (including qualified human skills) to firms and to stimulate their own investment in science and technology, as well as to foster the entrepreneurial environment for innovation[6].

In fact, the increase in public investment in R&D in recent years in Portugal is matched by a steep rise in companies' investment in R&D. The business share of the Gross Expenditure on R&D (GERD) grew 71% from 1995 to 2005, in a way that has been associated to a structural reform of the GERD allocation of a magnitude unique in Europe. But it was only from 2005 onwards that business expenditure on R&D exceeded that of higher education institutions, and it is estimated that it has exceeded 500 million euros from 2006 onwards (see evolution of relative share of R&D expenditure per sector in Figure 1).

These changes occurred together with revisiting the tax system for corporate R&D in 2005, in a way that has fostered business expenditure on R&D, as well the employment of research personnel in private corporations.

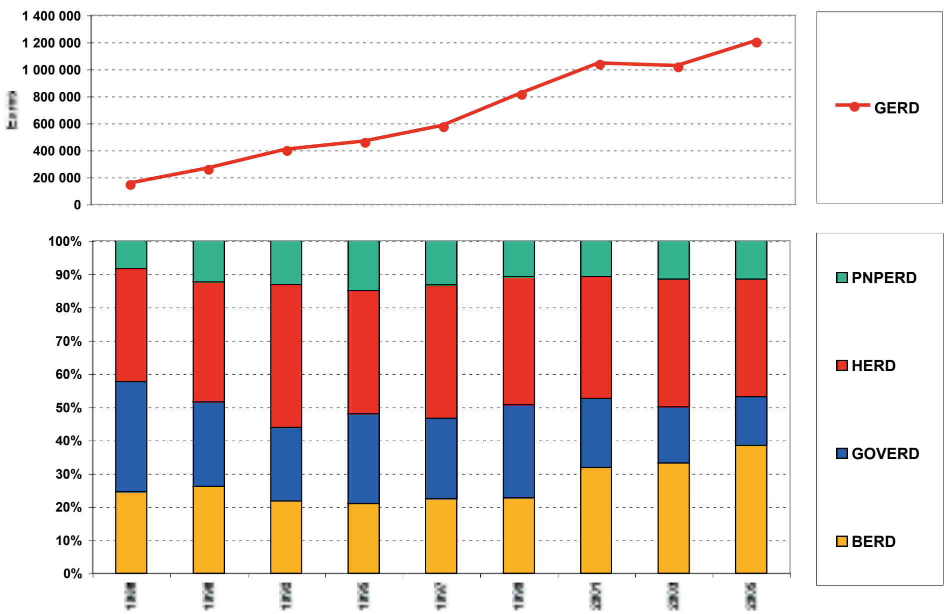
Recent monthly figures for the technological balance of payments showed positive results in 2007 for the first time in Portugal, demonstrating an improvement of technology-based Portuguese exports and the strengthening of the technological capability of Portuguese companies and their international impact. Also, the number of Portuguese patents registered at the European Patent Office and the United States Patent Office increased by 68% and 50% respectively between 2005 and 2006, and the provisional figures for 2007 – up to October – already show a clear trend of continued growth in both systems compared with 2006.

But the key aspect to be noted is that the priority given to the country's rapid scientific and technological development has been accompanied by the active mobilisation of Portugal's scientific community, with visible results in terms of its impact at the international level, including the involvement of researchers from

[6] Conceição, P., Heitor, M.V. (2005), Innovation for All? Learning from the Portuguese path to technical change and the dynamics of innovation. Westport and London: Praeger.

Portuguese institutions in European and international science and technology networks. Scientific output in Portugal increased by 18% over the last two years when measured in terms of the number of scientific publications internationally referenced.

Figure 1 › **Evolution of Gross Expenditure on R&D (GERD) at current prices and relative share of R&D expenditure per performing sector in Portugal for 1988-2005**



Source: IPCTN, S&T National Survey, http://www.estatisticas.gpeari.mctes.pt/

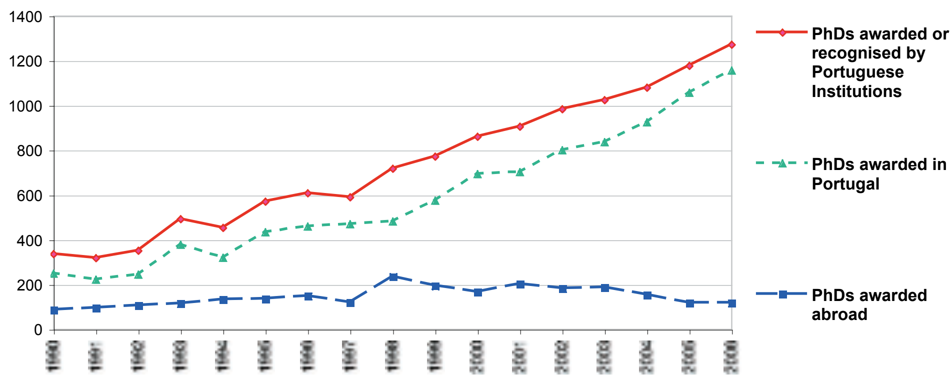
Key: GERD: Gross Expenditure on R&D; PNPERD: Private Non-profit Expenditure on R&D ; HERD: higher Education Expenditure on R&D; GOVERD: Government Expenditure on R&D; BERD: Business Expenditure on R&D

INVESTING IN HUMAN RESOURCES AND IN SCIENTIFIC AND TECHNOLOGICAL CULTURE

The development of the Portuguese Science and Technology academic system is currently based on around 10,000 PhDs working in R&D centres (measured in "full time equivalent" in January 2007). This figure has increased 20% in the last two years. The number of PhD researchers has doubled since 2000. Further, around 20% of the new PhDs awarded since 1990 were awarded or recognised in Portugal in the last two years, and by 2009 Portugal is expected to achieve the target of 1500 new PhDs a year (Figure 2).

The percentage of new PhDs awarded to women recently passed 50%. It should also be noted that the number of new PhDs in the science and technology areas currently accounts for nearly half (47.3%) of all new PhDs, when at the beginning of the 1990s they accounted for only around a third of all the doctorates awarded at that time (31% in 1991).

Figure 2 › **PhDs awarded or recognised by Portuguese universities**



Source: Portuguese statistics for science, technology and higher education, http://www.estatisticas.gpeari.mctes.pt/

Recent OECD data shows that over the past 15 years most OECD economies have experienced a large increase in the number of students in higher education, Figure 3. The absolute number of students in S&T fields shows an overall increase too, but although the proportion of S&T students has steadily decreased during the same period in most OECD countries, Portugal has increased this value in the last decade.

The Government's *Commitment to Science* contributed to these significant results, namely as a consequence of:

› Increased support by the *Fundação para a Ciência e a Tecnologia* (Foundation for Science and Technology, FCT) to promote competitively the Portuguese science base; the total number of research grants increasing steadily in recent years, rising to approximately 5820 grants in 2007, of which 4301 are PhD grants and 1190 are post-doctoral grants. In addition, FCT is currently funding 4940 R&D projects in all fields of science, which provide funding for additional R&D personnel. All R&D projects are awarded by international evaluation panels.

› Promoting scientific employment, through a new programme launched in 2007 to support scientific employment through contractual arrangements for at least new 1000 PhD researchers by 2009.

› Improved immigration law on the conditions of entry and residence of highly qualified technical and scientific personal.

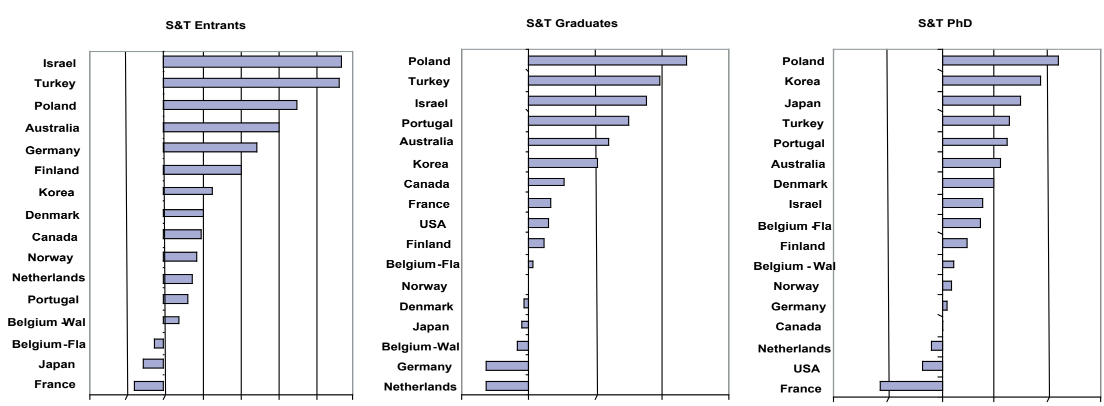
According to recent findings, the increase in the number of students in S&T fields appears to be correlated with the increase in the gross expenditure on S&T per inhabitant, whenever the annual average increase of GERD/inhabitant exceeds 3%. Moreover, the latest available data show that Portugal has also achieved a remarkably high rate of women researchers, particularly in the Government and Higher Education sectors (Figure 4), with increasing share in the total number of researchers for about 41% in 1997 to 45% in 2003.

Moreover, the need to foster public understanding of science and better scientific and technological culture in the society at large is well accepted in Portugal as part of national science policy, where schools and other institutional settings (namely science centres and science museums) have a determinant role in stimulating curiosity and interest for scientific knowledge. The European report on the "Benchmarking the promotion of RTD culture and Public Understanding of Science"[7] acknowledges the leading role of national programs such as *Ciência Viva*, as implemented in Portugal since 1996.

[7] Miller, S., Caro, P., Koulaidis, V., Semir, V., Staveloz, W. and Vargas, R. (2002). Report from the Expert Group Benchmarking the promotion of RTD culture and Public Understanding of Science. http://www.jinnove.com/upload/documentaire/PP-fe-106.pdf

[8] OECD (2006), Evolution of Student Interest in Science and Technology Studies - Policy Report, May 2006, OECD, Global Science Forum, Paris.

Figure 3 › **Average annual change of S&T entrants in higher education, graduates and PhD's for 1993-2003 (Mean normalized regression coefficient)**



Source: OECD (2006)[8]

Public investment in science and technology in recent years has reinforced the activities of *Ciência Viva* and the national and international projection of its work of exceptional public importance in promoting scientific culture. Public funding for the promotion of scientific and technological culture has attained the indicative level of 5% of public S&T investment funding. The following activities undertaken during the last year are particularly noteworthy:

› About 1100 new projects to reinforce experimental teaching of the sciences in primary and secondary schools and to promote scientific and technological culture were approved by *Agência Ciência Viva* (www.cienciaviva.pt) and are being implemented in close cooperation with schools and research centres, corresponding to approximately 14 million euros of public funding in 2007 and 2008.

› The network of *Ciência Viva* Centres has been extended throughout the country, to a total of 16 Science Centres at present, with 6 new Science Centres being inaugurated since 2005 (two of them in 2007). At least 6 more new centres are planned to be added by the end of 2009.

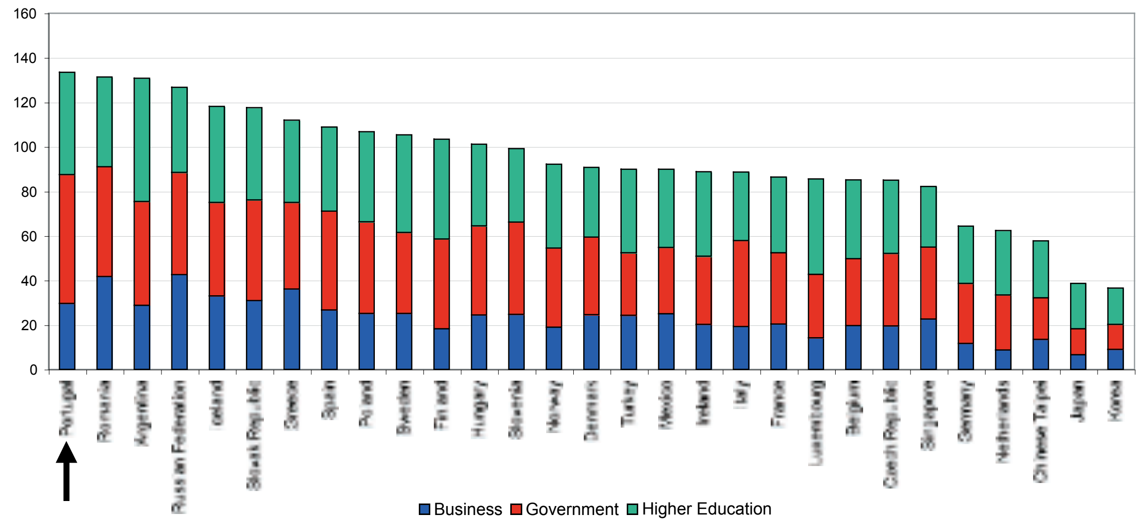
› The European Convention of Science Centres and Museums (ESCITE) brought together to Lisbon in May 2007 over 1000 experts in the public understanding of science. The first Iberian Congress of Science Centres and Museums was also held in Portugal, further strengthening the work of *Agência Ciência Viva* and the international profile of its activities.

› The organisation in 2007, under the aegis of the *Ciência Viva* holiday programme, of 856 placements of secondary school students in around 70 research and higher education institutions, including, for the first time, an exchange between Portugal and Spain involving over 60 students. This programme has involved over 5800 secondary school students since 1997.

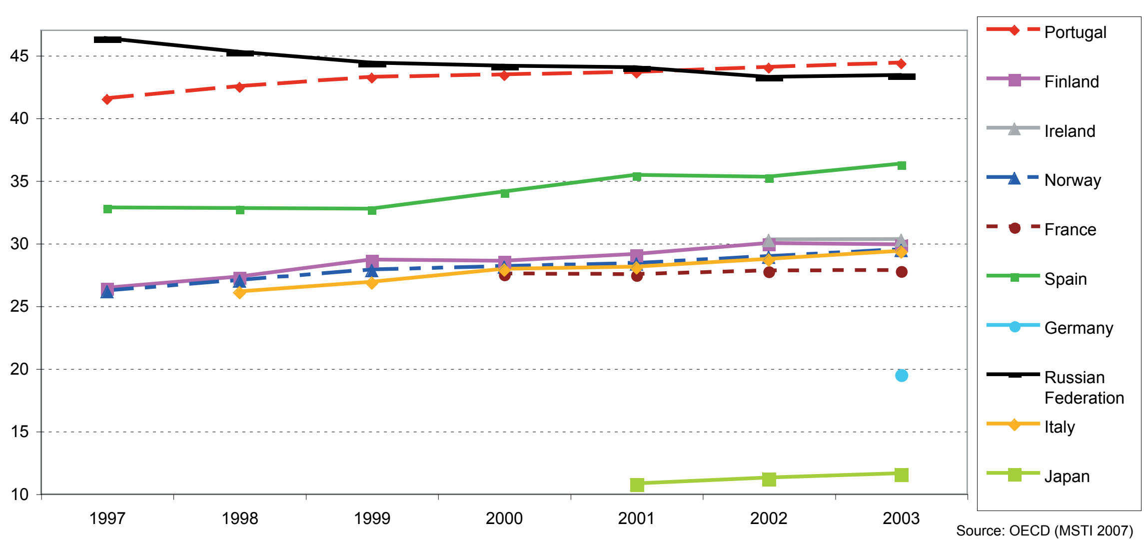
› The public involvement in summer activities in astronomy, biology, geology, or engineering, which this year involved around 136 institutions and over 2300 events around the country.

Figure 4 › **Women researchers as a percentage of total researchers (Headcount, for last year available or 2003)**

a) per performing sector



b)Evolution for 1997-2003



Source: OECD, 2007[9]

[9] OECD (2007), Main Science and Technology Indicators 2007, OECD, Paris.

PROMOTING SCIENTIFIC INSTITUTIONS AND THEIR INTERNATIONALIZATION

While we continuously improve our understanding of knowledge-based economies and the processes that allow learning societies to be sustainable, analysis has systematically shown the combined and evolving role *institutions* play, together with that of *infrastructures* and *incentives*[10].

Over the last decade, science policy towards institutional development in Portugal has been particularly based on two main pillars, namely:

i) strengthening and restructuring the network of research centres throughout the country (namely in universities and related private, non-for profit institutions) through their systematic international evaluation every three years, with direct impact in their funding levels, which has consistently been implemented in Portugal since 1996; and

ii) promoting critical mass across all scientific disciplines by establishing a network of selected "Associated Laboratories" in the form of relatively large research consortia oriented towards thematic networks in a number of a few selected institutions after their international assessment.

By 2007, the network of scientific institutions includes 510 research centres (they were 257 after the evaluation of 1996) and 25 Associated Laboratories (with the first three Laboratories launched in 2001), with an overall level of institutional funding about 71 Million Euros in 2007 (25 Million Euros in 1999).

It is in this context that a revisited approach to institutional development has recently been launched, with particular emphasis on institutional cooperation at national and international levels, as a way of encouraging scientific activity in networks that promote institutional inter-relations. While helping to overcome the effects of the limited size of some research units, developing such science-based networks is intended to encourage the creation and dissemination of new knowledge and stimulate scientific development in a climate of constant change and growing internationalization of the scientific base.

The approach has included the reform of the network of State Laboratories, concerning their mission, structure and activities, as well as the creation of Research Consortia involving scientific and higher education institutions. Six main Consortia are under development, namely in areas of physics and computing, marine sciences, natural risks, biotechnology, space and security.

In this respect, one critically important and emerging institutional issue refers to the training of students and young scientists in order to provide them with core

[10] Conceição, P., Heitor, M. V. and Veloso, F. (2003). "Infrastructures, Incentives and Institutions: Fostering Distributed Knowledge Bases for the Learning Society", Technological Forecasting and Social Change, **70**(7), pp. 583-617.

competencies that help them to become successful researchers and prepare them with the adequate "transferable skills" for the job market outside research and academia[11].

In addition, recognizing scientific knowledge as a "public good" introduces the need to consider new policy dimensions in science and technology policy that are designed and implemented in a way that fosters independent scientific institutions, among which the way in which transnational institutions are organized may provide a useful framework. It is also in this context that major efforts have been undertaken to promote the internationalisation of the Portuguese scientific community.

We know that casual observations have shown that patterns of scientific strength and weakness are strongly influenced by the nature of the societal and technological problems to be solved. In any case, current understanding of the complexities of the knowledge base that underlie future scientific and technological knowledge is very limited, and this led Keith Pavitt to conclude many years ago that "the aim of policy should be to create a broad and productive science base, closely linked to higher (and particularly post-graduate) education, and looking outward both to applications and to developments in other parts of the world."[12]

Under this broad scope, the following actions deserve special mention:

› The installation of the *Iberian International Nanotechnology Laboratory*, INL, created by international treaty between Portugal and Spain signed at the end of 2006, under construction in Braga (northern Portugal). This is the first International Research Laboratory set up in the Iberian Peninsula. It is expected to achieve a reputation as an international institution of excellence with around 200 researchers from all over the world and an annual operating budget of around 30 million euros matched by a similar investment budget funded in equal shares by the two countries.
› The GRID National Initiative for advanced network computing (INGRID) was launched and the IBEROGRID Iberian platform was created to share resources between Spain and Portugal.
› A strategic programme of international partnerships in science, technology and higher education was initiated in 2006 and by September 2007 the first doctoral and advanced studies programmes were officially launched, bringing together several Portuguese universities and leading universities worldwide, including, MIT, Carnegie Mellon University and the University of Texas at Austin. Unprecedented in Portugal, these programmes facilitated the creation in 2007 of effective thematic networks

[11] Ernst, R. (2003), "The Responsibility of Scientists, a European View", Angew. Chem. Int. Ed. 2003, 42, pp. 4434-4439.
[12] Pavitt, K. (1998), "The Social Shaping of the National Science Base," *Research Policy*, 27(8): 793-805.

involving a large set of Portuguese institutions with the objective of stimulating their internationalisation through advanced studies projects and sustainable schemes to stimulate new knowledge and exploit new ideas in collaboration with companies and internationally renowned institutions, as follows:

- The MIT-Portugal Programme, http://www.mitportugal.org/, launched on 11 October 2006 in the field of "engineering systems", attributing special emphasis to the complex processes associated with industrial production systems, sustainable energy systems, bio-engineering systems and transport systems, in which Portuguese and MIT faculty and researchers identified over 30 priority areas for research and development in close cooperation with an industrial affiliation programme.
- The CMU-Portugal Programme, http://www.cmuportugal.org/, was launched in October 2006 with emphasis on information and communication technologies and involving dual professional masters and PhD programmes by Portuguese institutions and Carnegie Mellon University (namely in Software Engineering, Information Networking, Information Security, Human Computer Interaction, entrepreneurship and technological Change, Mathematics and Language Technology.
- Under the University of Texas in Austin - Portugal Programme, launched in March 2007, http://www.utaustinportugal.org/, the following areas were selected:
  i) digital content and multimedia production and distribution;
  ii) advanced computing; and
  iii) science and technology commercialization, including establishing an "university technology enterprise network".
- In addition, a study has also been launched of the potential for collaboration between Portuguese Universities and research laboratories and the University of Harvard, which is expected to enable a new collaborative framework to be launched in 2008 including biomedical research programmes and the development of a new infrastructure for delivering medical information to the general public.

› Co-operation with the *Fraunhofer Gesellschaft* for the establishment in Portugal of the first Fraunhofer Institute in Europe outside Germany. This is an ambitious project focusing on emerging information and communication technologies, such as “Ambient Assisted Living”, to be complemented by the establishment of R&D consortia and co-operative projects involving several Portuguese institutions and Fraunhofer institutes in Germany in other four areas:

i) logistics;

ii) biotechnology;

iii) advanced production systems applied to the automotive industry; and

iv) nanotechnologies.

REFORMING HIGHER EDUCATION

The priority given to the rapid scientific and technological development of Portugal has been matched by a profound reform of higher education, which reflects the current European movement to modernise higher education and, in particular, research universities.

We recognize that higher education systems are under pressure to meet demands imposed by a globalised knowledge-society without compromising quality deliverance. Although most European institutions and their faculty have recognized the need for change, the way institutions are organized, either internally, or through traditional links with society, as well as their own systems of incentives, have contributed to delay reform.

Portugal has reformed its higher education system in 2007, as part of the government' overall strategy of pursuing education, scientific and technological development.

First, the implementation of the Bologna Process was adopted as a driver for reform, namely by:

i) adopting the model of organization of higher education in three cycles, together with the European system of accreditation (ECTS);

ii) introducing rules allowing for a broader access of citizens to life long learning opportunities after secondary school, including the supply of short cycles, with emphasis on polytechnic institutions. Accordingly, for the academic 2007-2008 academic year, around 87% of initial education programmes in Portugal are already organised in line with the Bologna framework for degrees and diplomas.

Second, in order to broaden the access of higher education, structural measures were adopted by government to increase adult intake in higher education. As a result, around 10,850 new students entered higher education in 2006-07, as compared with only 900 adults entering higher education in 2005-06.

Third, the legal reform of the Portuguese higher education system included the following actions in 2007:

› The new legal framework for higher education institutions approved on 10 September 2007, which establishes, *inter alia*, the organisational principles of the higher education system, the autonomy and accountability of institutions, setting up governing Boards with external participation, diversity of organisation and legal status of public institutions (namely as public foundations), establishment of consortia, recognition of research centres as part of University management framework.
› The new legal framework for the evaluation of higher education and the creation of the Higher Education Evaluation and Accreditation Agency in August 2007, both aiming at the ensuring the quality of higher education through the evaluation and accreditation of higher education institutions and their study programmes, along the best international practices in which independent external evaluation is mandatory.
› The creation of conditions to foster the national and international mobility of students and graduates, namely: i) the new "Regulations on Arrangements for Changes of Study Programmes, Transfers and Return to Higher Education", which seek to facilitate the entry of higher education students into Portugal to continue their studies, with rapid and objective recognition of their previous school education and occupational training, and to create simplified arrangements for return to higher education; and ii) the new legal framework for the recognition of foreign higher degrees, which simplifies the system for recognising foreign degrees in Portugal.
› The introduction in September 2007 of a system of student loans with mutual guarantee underwritten by the State, which complements the system of public grants, thereby improving access to higher education for all students.

How to attract and sustain new talents in Portugal and how to ensure universities meet the global challenges of research and international competition for highly qualified human resources? The debate to follow in the coming years requires considering a diversified set of challenges, but also of new opportunities.

As for the organisation of research activities, there is also the need for a better and safer response by the scientific system to the challenges presented. This requires regular review of the network of scientific institutions with the objective of ensuring their reliability and the overall quality of the Portuguese scientific system, according to international standards, in what is expected to be a phase of accelerated growth. It also requires a systematic policy of promoting co-operation between public research institutions and industry and to encourage private R&D investment.

Those are, in brief, the priorities of Portuguese national policy for science and technology.

Ministries' Websites

SLOVENIA
Ministry of Higher Education, Science and Technology
http://www.mvzt.gov.si

FRANCE
Ministry of Higher Education and Research
http://www.recherche.gouv.fr/

CZECH REPUBLIC
Ministry of Education, Youth and Sports
http://www.msmt.cz

SWEDEN
Ministry of Education and Research
http://www.sweden.gov.se/sb/d/2063

SPAIN
Ministry of Education and Science
http://www.mec.es

BELGIUM
Federal Government
http://www.belgium.be

Brussels Capital Region
http://www.bruxelles.irisnet.be

Flemish Government
http://www.vlanderen.be

Government of Wallonia
http://www.wallonie.be

Government of the French Speaking Community
http://www.cfwb.be

Government of the German Speaking Community
http://www.dglive.be

HUNGARY
Ministry of Economy and Transport
http://www.gkm.gov.hu

Ministry of Education and Culture
http://www.okm.gov.hu

POLAND
Ministry of Science and Higher Education
http://www.mnisw.gov.pl

DENMARK
Ministry of Science Technology and Innovation
http://www.vtu.dk

CYPRUS
Minister of Finance
http://www.mof.gov.cy

IRELAND
Department of Enterprise, Trade & Employment,
http://www.entemp.ie/

LITHUANIA
Ministry of Education and Science
www.smm.lt

SWITZERLAND
State Secretariat for Education and Research
http://www.sbf.admin.ch

ICELAND
Ministry of Education, Science and Culture
http://eng.menntamalaraduneyti.is

LIECHTENSTEIN
www.liechtenstein.li/en

NORWAY
Ministry of Education and Research
http://www.regjeringen.no/en/dep/kd/

GREECE
Ministry of Development
General Secretariat for Research & Technology
http://www.gsrt.gr

ITALY
Ministry for Universities and Research
http://www.miur.it

LATVIA
Ministry of Education and Science
http://www.izm.gov.lv

LUXEMBOURG
Ministry of Culture, Higher Education and Research
http://www.mcesr.public.lu

THE NETHERLANDS
Ministry of Economic Affairs
http://www.minez.nl

Ministry of Education, Culture and Science
http://www.minocw.nl

SLOVAKIA
Ministry of Education of the Slovak Republic
http://www.minedu.sk

MALTA
Office of the Prime Minister
http://www.gov.mt

UNITED KINGDOM
Department for Innovation, Universities and Skills
http://www.dius.gov.uk

ESTONIA
Ministry of Education and Research:
http://www.hm.ee

BULGARIA
Ministry of Education and Science
http://www.minedu.government.bg

AUSTRIA
Federal Ministry of Science and Research
http://www.bmwf.gv.at/

ROMANIA
Ministry of Education, Research and Youth
http://www.edu.ro

FINLAND
Ministry of Trade and Industry
http://www.ktm.fi

GERMANY
Federal Ministry of Education and Research
http://www.bmbf.de

PORTUGAL
Ministry of Science, Technology and Higher Education
http://www.mctes.pt