European Union and International Best Practice in Research and Development

2007
# Table of contents

**Introduction** 5  
**Executive summary** 6  
**Part I EU 2010 – the Lisbon strategy** 8  
**Part II EU 2006 – half-way towards Lisbon** 11  
R&D expenditure trends 15  
R&D personnel 21  
Innovation 30  
EU research in a bibliometric mirror 34  
Patents 40  
Background data 43  
**Part III EU best practice in R&D&I governance** 45  
Austria 45  
Belgium 55  
Denmark 63  
**Estonia** 73  
Finland 83  
Ireland 95  
Lithuania 104  
The Netherlands 112  
Slovenia 122  
Sweden 132  
Switzerland 142  
**Part IV International best practice in R&D&I governance** 151  
Israel 151  
USA 159  
R&D and Innovation policies in the South Eastern Asian countries 170  
Japan 172  
China 182  
Korea 187  
Taiwan 192  
Singapore 195  
India 198  
References and source materials 201  
**Abbreviations and Symbols** 202
Introduction

This compilation of materials on European Union and international best practices in research and development (R&D) and innovation systems and their administration has been carried out within the framework of the N/Tacis project 123052 „Creating an effective model of science administration: review of EU best practices and elaboration of policy recommendations with the Ministry of Education and Science of Georgia” financed by the European Commission Delegation to Georgia and Armenia.

The task of the compilation is to provide the Georgian research and higher education community and policy makers a review of selected EU (as well as other international) best practices for R&D policy administration and funding.

The Government of Georgia is determined to invest more in research and development, however given that public funds are always limited; there is an urgent need to develop an effective administration and financing model. Scientific research should contribute to the economic recovery of Georgia. Research is an important step in the overall reform of the educational sector as well as harnessing both research and higher education to the overall innovation processes.

During a transition and restructuring period it would be helpful to look at and consult the R&D&I systems and management practices implemented both in EU and third countries, in order to derive the best knowledge from the existing practices and implement it in the restructuring of research administration in Georgia.

In order to elaborate principles for an integrated science and higher education development, main directions for scientific research and ways to approach the European Research Area it is paramount to bear in mind the abundant international experience. In elaborating a new system, organisation, administration and financing of scientific research it would be especially beneficial to rely on information and experiences of running scientific systems in smaller EU member states. This compilation is an attempt to meet these demands.

Disclaimer

The materials in this compilation have been collected from publicly available sources and reflect the points of view of the project management team.

Please note that the views expressed in this document are purely informative and may not in any circumstances be regarded as stating an official position of the European Commission and cannot give rise to rights or legitimate expectations to the claimant..

The publication of this compilation has been supported by the European Commission Delegation to Georgia and Armenia within the framework of the N/Tacis project 123052 „Creating an effective model of science administration: review of EU best practices and elaboration of policy recommendations with the Ministry of Education and Science of Georgia”.

5
Summary

This compilation of materials on European Union and international best practices in research and development and innovation systems and their administration has been composed from publicly available sources.

Part I EU 2010 – the Lisbon strategy presents a review of a number of strategic EU documents outlining the strategic approach of EU to the development of R&D activities in the way towards a knowledge-based society.

Part II EU 2006 – half way towards Lisbon gives an overview of the R&D situation in Europe in the year 2005 and provides a comparison of EU25 to the R&D development trends in some other highly developed countries (USA, Japan).

Part III EU best practice in R&D&I governance represents the core material of the compilation. It provides a structures review of the R&D systems and administration in smaller EU and EEA countries comparable to Georgia population-wise and with high or very high R&D intensity (Austria, Belgium, Denmark, Finland, Ireland, the Netherlands, Sweden, Switzerland) as well as in some new EU member states (Estonia, Lithuania, Slovenia) with relatively high R&D intensity that could be used as reference countries for Georgia.

Part IV International best practice in R&D&I provides similarly structured information for a number of other non-EU countries. This group of countries is rather heterogeneous including R&D expenditure leaders such as USA, Israel, Japan and Korea; strong emerging R&D countries China, Taiwan, Singapore, and a group of developing countries (Malaysia, India, Thailand and Indonesia) who have undertaken to catch up with the developed countries. Their examples might provide some good insight into the measures taken by different governments in supporting the overall R&D development in a country.

How to make best use of this document

The material has been structured similarly for all the countries under the following topics:

1) basic characteristics of the research system that provides an overall description of the research system in a given country (incl an R&D&I organisational chart)

2) main research policy setting mechanisms that reflect the different levels of R&D policy making and implementation (parliamentary and governmental, ministerial, funding and support agencies, and the organisations that conduct research (universities, public and private research institutes, etc))

3) Research funding systems, including the national public research funding system (when available, a chart of funding flows is enclosed)

4) R&D policy performers – a synopsis of most important actors in a country’s R&D scene (universities, public and private R&D institutions, research and technology organisations, and partnerships.)
5) Strategic development trends and documents that reflect the current situation with regard to long-term R&D goals of a country.

With regards to the research systems and their administration, the following few generalisations can be made from the material:

1. The systems vary a great deal, from very complex ones in some EU countries to quite straightforward ones in several South East-Asian countries
2. The R&D&I systems in EU countries tend to have more layers, be more complex and quite often more network-like involving a great number of support and associated structures. This in turn requires more time and effort in coordination and implementation of various actions.
3. The leading research-intensive countries have maintained a long-term commitment to R&D allocations from the GDP (close or in excess of 3% of their respective GDPs)
4. The leading research-intensive countries have also followed long-term strategic goals set forward in their strategy documents.
5. Successful implementation of long-term R&D&I commitments involves wide-scale stakeholder involvement, continuous dialogue with the business and research communities and society at large.
Part I EU 2010 – the Lisbon strategy

The Lisbon Strategy, also known as the Lisbon Agenda or Lisbon Process, is an action and development plan for the European Union. It was set out by the European Council in Lisbon on March 2000. It broadly aims at making "the EU the world's most dynamic and competitive economy" by the 2010 deadline to be achieved by transforming Europe into the world's largest knowledge-based economy.

The progress of science and technology is crucial:

- To help European companies innovate and stay competitive
- To create more and better jobs in Europe
- And to keep improving the European way of life

Challenges for EU

1) achieving the 3% of R&D expenditure from GDP
2) 2/3 of the total R&D expenditure by BERD
3) Catching up the missing 700,000 R&D workers in Europe: It has been estimated that to fulfil the Lisbon/Barcelona targets an extra 1.2 million researchers are needed over a ten-year-period: 500,000 for renewal of the research labour force (to replace retirees) and 700,000 net new researchers.

Preparation was carried out in relation with the broader reaching Council of Europe, the international organization of the "wider Europe", which also has charge of education in Europe.

Between April and November 2004, Wim Kok headed up a review of the program and presented a report on the Lisbon strategy suggesting how to give new impetus to the process. The Commission used this report to declare the social and environmental aspects of the Lisbon Agenda were no longer a priority and that instead the strategy would be revised to focus on the economic context only.

The Lisbon Strategy intends to deal with the low productivity and stagnation of economic growth in the EU, through the formulation of various policy initiatives to be taken by all EU member states. The broader objectives set out by the Lisbon strategy are to be attained by 2010.

The main fields are economic, social, and environmental renewal and sustainability. The Lisbon Strategy is heavily based on the economic concepts of:

- Innovation as the motor for economic change
- The "learning economy"
- Social and environmental renewal
Under the strategy, a stronger economy will drive job creation in the EU, alongside social and environmental policies that ensure sustainable development and social inclusion, which will themselves drive economic growth even further.

**The EU goal is to approach 3% of GDP for research by 2010.** This is an important part of the "Lisbon strategy", which consists of a Partnership between the European Union and Member States to transform Europe in a vibrant knowledge economy, in order to boost economic growth, create more and better jobs and ensure lasting prosperity in Europe.

*In order to reach the Lisbon goals, it is of paramount importance to increase and improve investment in Research and Development*

**The essence of the problem**

- The EU invests less of its GDP in research and development than its main competitors. The powerful leverage effect of public spending at EU level on private investments in research and development in Europe, of which a strong increase (up to two thirds of the total) is a condition of achieving the objective of raising the overall European research effort to 3% of EU GDP. Today (according to latest official data), this EU overall research effort represents 1.96% of GDP, as against 2.59% for United States, 3.12% for Japan and 2.91% for Korea. The gap between US and EU, in particular, is currently about € 120 billion a year, 80% of it due to the difference in business spending in research and development.
- Europe is weak in translating the results of research into innovative products and services that can boost competitiveness.
- Europe does not have enough scientists and researchers – 5.3 per 1000 workforce compared to 9 per 1000 in the US and 9.7 per 1000 in Japan. Scientists that train here can be tempted to work elsewhere. Good researchers from outside Europe are not attracted here, because of the quality of research, or because of problems with visas or work permits.
- Demand for European research and development programmes constantly exceeds supply. At the same time, they are perceived as over-complicated and administratively heavy, which reduces their interest for certain important groups, such as small and medium-sized enterprises.

**Possible solutions at EU level**

- Implement a framework that encourages more investment from public funds and even more so through private investment.
- EU rules on State aid should foster investment; specific rules will be updated - research (2005) and innovation (2006).
- Fully implement the EU Environment Technologies Action Plan (ETAP).
- Build a bridge between research and industry, for example through "Innovation Poles" in our regions and the creation of a "European Institute for Technology" to attract the best minds and best brains to Europe.
- Enhance attractiveness for R&D activities through fast track visa and work permit arrangements for third country researchers.
- Use the Framework Programme to double the EU research policy budget to increase the rate in Collaborative Research and industry participation.

Possible solutions at Member State level

- Member State governments must increase their research funding, and put in place measures to encourage private investment at national level, in order to reach the target of 3% of GDP.
- All those involved in an industry should contribute to an identification of the strategic research needs of that industry, to maximise existing resources.
- Make science a more attractive career option for young people by revising curricula to upgrade science in schools.
- Remove barriers that prevent researchers from moving to work in the EU, such as overly restrictive visa or work permit requirements.
- Promote the opening of National research programmes to other Member State enterprises and increasing cooperation to foster open research and innovation to increase the impact of research on competitiveness and the globalisation of research.

Key messages to society

- In order to compete internationally, the EU has to deliver high-quality innovative products and services. Research and development is needed to deliver them.
- Eco-innovation is an economic opportunity for the EU – with a real potential for higher growth. Europe is strong in this area and can use this to strengthen its global competitiveness. Therefore, the Commission will promote R&D in eco-innovation.
- Member States and the Commission need to work towards an increase in R&D spending of 3% of GDP. If Europe continues to invest less in R&D and to invest less efficiently, it cannot hope to attain its objective as the most dynamic and competitive world economy.
- Investment in R&D pays off in terms of economic and productivity growth. The new Framework Programme for Research and Development will be geared towards addressing the problems facing EU investment in research and development. It must be properly funded if it is to succeed in this ambition.
Part II EU 2006: half-way towards Lisbon

The Lisbon and Barcelona European Councils signalled to the European Union the important role of R&D and innovation. One of the goals set by the European Union was to raise overall research investment in the EU from 1.9% of GDP to approaching 3% by 2010.


Knowledge and innovation for growth became one of three main areas for action in the new Lisbon partnership for growth and jobs. Research and innovation should be put at the heart of EU policies, EU funding and business.

The aim of this is to revitalise the European economy by jointly implementing actions in three areas:

- actions to make Europe a more attractive place to invest and to work;
  - Extend and deepen the internal market
  - Improve European and national regulation
  - Ensuring open and competitive markets inside and outside Europe
  - Expand and improve European Infrastructure

- actions to leverage knowledge and innovation for growth
  - Increase and improve investment in Research and Development
  - Facilitate innovation, the uptake of ICT and the sustainable use of resources
  - Contribute to a strong European industrial base

- actions directly targeted at creating more and better jobs.
  - Attract more people into employment and modernise social protection systems
  - Improve the adaptability of workers and enterprises and the flexibility of labour markets
  - Investing more in human capital through better education and skills
In the following we will consider the situation in some of these domains in 2005-2006 with respect towards achieving the Lisbon goals.

**Progress towards the 3% objective:**

An examination of the evolution of R&D intensity in individual Member States in the period 2000-2003 allows for making a distinction between four groups of countries that impact in divergent ways the progress towards the 3% objective at the EU-level.

– The first group consists of the countries that define the general trend towards stagnation in R&D intensity. France, the UK and to a lesser extent Germany hold back the progress made at EU-level by other countries. As they are the biggest investors they determine the overall trend.

– The second group consists of leaders in R&D (Sweden, Denmark, Austria and Belgium) that are pulling ahead of the EU average, but their weight is far less. Especially Sweden has been able to progress very substantially over the recent years, however in 2003 business expenditures slowed down. Finland, that is known as a traditional R&D champion has seen its R&D intensity stagnating since 2000.

– A third group with Cyprus, Estonia, Hungary, Lithuania, Spain, Italy and Slovenia are rapidly catching up with the rest of the EU. Their impact on the overall R&D-intensity is small.

– A fourth group consisting of Latvia, Poland, Slovakia, Greece, Portugal and Ireland is falling behind the EU average. The Netherlands can also be classified in this fourth group, although their R&D intensity is still very close to the EU average.

**Progress towards the 2/3 business funding objective**

In general the share of business funding has suffered from the economic downturn. In the majority of the EU countries it was stagnating or deteriorating leading to a small decrease of the overall share of business funding. The analysis of the situation and progress of each Member State with regard to the 2/3 objective allows a distinction between several groups of EU countries:

– The R&D intensive countries Sweden, Finland, Denmark, Germany and Belgium, are maintaining or even slightly improving the share of R&D funded by the private sector. Slovenia is the only one pulling further ahead of the EU average strongly.

– On the other hand France and other countries with some weight such as Spain, the Netherlands and the Czech Republic, that were close to the average level confirm the trend to stagnation or even fall back of the business share. Ireland, a country falling further behind EU average in terms of overall R&D intensity, has also suffered from a weakening involvement from the private sector in the financing of R&D.

– Another group composed of Greece, Portugal, Estonia, and to a lesser extent Austria, are catching-up strongly with the rest of the EU. The good performance of Greece and Portugal as regards the share of the private sector, however, should not hide the weakening position of these countries in terms of overall R&D intensity.

– A last group with Latvia, Hungary, Lithuania, Slovakia, and to a lesser extent Poland and the UK are falling further behind the EU average. Especially for Poland, Slovakia and Latvia, the low and decreasing contribution from the private sector to R&D may explain a large part of the weak performance in terms of R&D intensity.
EU 2005 - in relation to GDP, EU27 R&D expenditure stable at 1.84%
In real terms, EU27 R&D expenditure grew by 1.5% per year between 2001 and 2005

In 2005 the EU27 spent just over 200 billion euro on Research & Development (R&D). R&D intensity (i.e. expenditure as a percentage of GDP) in the EU27 stood at 1.84%, the same as in 2004. R&D intensity remained significantly lower in the EU27 than in other major economies. In 2004, R&D expenditure was 2.68% of GDP in the United States, 3.18% in Japan, while it has reached 1.34% in China in 2005. R&D expenditure in the EU27 rose by 1.5% in real terms on average per year between 2001 and 2005, compared to 1.7% in the United States and 2.0% in Japan between 2001 and 2004.

In 2004 the business sector financed 55% of total EU27 R&D expenditure, while the corresponding share was 64% in the United States, 75% in Japan and 66% in China.

In 2005, the highest R&D intensities among the Member States were registered in Sweden (3.86% of GDP) and Finland (3.48%), followed by Germany (2.51%), Denmark (2.44%), Austria (2.36%) and France (2.13%). The lowest intensities were found in Romania (0.39% in 2004), Cyprus (0.40%), Bulgaria (0.50%) and Slovakia (0.51%).

Annual average growth rates of R&D expenditure in real terms over the period 2001 to 2005 ranged from +18% in Latvia, +17% in Estonia, +15% in Cyprus and +11% in Lithuania to -2% in Belgium and -1% in Slovakia.

The business sector finances the highest share of EU27 expenditure on R&D (55%), followed by the government sector (35%) and funding from abroad (8%). Among Member States, Luxembourg (80%) recorded the largest share of R&D expenditure financed by the business sector in 2004, followed by Finland (69%), Germany (67%), Sweden (65%), Belgium and Denmark (both 60%). Three Member States registered shares for the business sector of 20% or less: Malta and Cyprus (both 19%) and Lithuania (20%).
Research and Development expenditure

<table>
<thead>
<tr>
<th>Country</th>
<th>R&amp;D intensity, R&amp;D expenditure as % of GDP</th>
<th>R&amp;D expenditure</th>
<th>R&amp;D expenditure financed by business sector, as % of total</th>
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- Data not available
- Estimated or provisional data
- EU27, EU25 and EU15: Eurostat estimate


Hungary: Excludes defence
Slovenia: 2005 data: partial coverage of certain sectors.
USA: Excludes most or all capital expenditure.

China, USA and Japan: OECD
1. Preliminary data for 2005. The figures for R&D intensity for previous years have been revised downwards compared to those published in News Release 156/2005 of 6 December 2005, due to upward revisions in the level of GDP for the EU and the majority of Member States, in particular following the allocation of FISIM (Financial Intermediation Services Indirectly Measured) to user sectors.
2. The EU goals in Research and Development, as set by the Lisbon summit strategy, are to achieve by 2010 a R&D intensity of at least 3% for the EU as a whole, and to have two thirds of R&D expenditure financed by the business sector.
3. R&D expenditure is expressed in million current euro while the annual average growth rates in real terms of R&D expenditure are calculated from expenditure expressed in million constant 1995 Purchasing Power Standard (PPS). PPS is an artificial currency that reflects differences in national price levels that are not taken into account by exchange rates. This unit allows meaningful volume comparisons of economic indicators over countries. Aggregates expressed in PPS are derived by dividing aggregates in current prices and national currency with the respective Purchasing Power Parity (PPP).


**Expenditure on R&D**

Expenditure on R&D is the most widely reported indicator of S&T effort at the national level. In the understated words of the OECD:

*Expenditure on R&D can be considered as an investment in knowledge that can translate into new technologies and more efficient ways of using existing resources. Insofar as it is successful in these respects, it is therefore plausible that higher R&D expenditure would result in higher growth rates.*

The R&D expenditure can be analysed from different points of view:
1. gross domestic expenditure on R&D (GERD), expressed as a percent of GDP
2. higher education expenditure on R&D (HERD), as a percent of GDP
3. Government Budget Appropriations or Outlays on R&D - GBAORD
4. business expenditure on R&D (BERD) is believed to be more closely linked to commercial innovation outcomes than R&D spending overall.

**R&D expenditure trends**

In 2004, R&D expenditure as a share of GDP in the EU-25 decreased slightly to 1.90%. The gap with regard to R&D expenditure in Japan (3.15% in 2003) is widening as R&D expenditure as a share of GDP in Japan is growing. However, the gap with the United States (2.59%) is closing as R&D expenditure as a share of GDP in the United States is falling. Looking at the estimates by institutional sector, most of R&D expenditure is carried out in the business enterprise sector (BES). The BES accounted in 2003 for 64% of R&D expenditure in EU-25, which is below the percentages in the United States (69%) and Japan (75%).

In 2004, the leading EU-25 Member States in terms of R&D intensity were Sweden and Finland, with 3.74% and 3.51% of GDP devoted to R&D expenditure, respectively. Other EU-25 countries with R&D intensity rates above the EU average of 1.90% are Denmark (2.61%), Germany (2.49%), Austria (2.26%), France (2.16%) and Belgium (1.93%).
R&D intensity in the new Member States is on average below the EU-25 figure. Although the Czech Republic and Slovenia achieved rates of above 1.20%, all the other new Member States were below the 1% mark in 2004. In 2004, the EU-25 spent EUR 195 billion on R&D, recording an annual growth rate of 3.4% compared to 2003. Most R&D in the EU-25 is carried out in Germany (EUR 55.1 billion), France (EUR 35.6 billion) and the United Kingdom (EUR 30.6 billion). These three countries accounted for almost 2/3 of total R&D expenditure in EU-25. The highest annual average growth rates (AAGR) achieved from 1999 to 2004 were in new Member States: Lithuania (21.5%), Hungary (18.5%), Estonia (17.7%) and Cyprus (16.2%). The Russian Federation (24.7%) and China (20.9%) also achieved very high AAGR.

Table 2.4

| R&D expenditure as a percentage of GDP, by sector of performance, EU-25 and selected countries - 2002 to 2004 |
|---------------------------------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|-- |--
Government Budget Appropriations or Outlays on R&D - GBAORD

GBAORD data measure government support to R&D activities or, in other words, how much priority Governments place on the public funding of R&D.

In 2004, the budget appropriations for R&D in the United States amounted to approximately 90 billion 1995 constant PPS. In the European Union, the equivalent figure was just in excess of 60 billion 1995 constant PPS, whereas it did not quite reach the 20 billion mark in Japan.

As a percentage of GDP, GBAORD in EU-25, Japan and the United States amounted to 0.76%, 0.71% and 1.08%, respectively. During the period 1994 to 1999, GBAORD in the United States and in EU-15 expressed in relative terms (as a percentage of GDP) declined, compared with an increase in the same period in Japan. Between 1999 and 2004, trends were quite different. GBAORD in EU-15 expressed as a percentage of GDP was stable, whereas it increased slightly in Japan and even more so in the United States.

Within EU-25 in 2004, Finland (1.03%) and France (1.01%) had the highest proportions of government budgeting spent on R&D activities as a proportion of their respective GDPS. At the other end of the scale, Greece, Cyprus, Lithuania, Luxembourg, Latvia, Romania and Malta showed GBAORD ratios no higher than 0.3% of GDP.
At the EU-15 level, budgets increased between 1999 and 2004 for all socio-economic objectives except for "Production and rational utilization of energy" and "Agricultural production and technology", "Industrial production and technology" (6.6%) and "Protection and improvement of human health" (4.7%) had the highest rates of increase.

**GBAORD by socio-economic objectives**

Figure 1.2 presents GBAORD broken down by socioeconomic objectives. In 2004, the main EU-15 socio-economic objective was "Research financed from General University Funds (GUF)". Indeed, almost one third (31.6%) of the total GBAORD was allocated to this objective. In Japan, the main socio-economic objective was also "Research financed from GUF" with an even higher proportion (33.5%). In the United States, it was "Defence" which accounted for more than half of total GBAORD (55.8 %). By comparison, "Defence" within EU-15 ranked as the third main objective and accounted for only 14.7% of total GBAORD.

Japan's second main socio-economic objective of the government R&D budget was "Production, distribution and rational utilization of energy" (17.1%). Unlike in Japan, energy in EU-15 and in the United States was one of the less important objectives, with 2.5% and 1.2% of total GBAORD respectively.

After "Defence", the United States earmarked the largest part of their budget to "Protection and improvement of human health" (23.1%). By comparison, EU-15 only allocated 6.8% of its total GBAORD and Japan 3.9%. At EU-15 level, "Research financed from GUF" was followed by the objective "Non-oriented research" with 15.1%.
After "Defence" (14.7%) came the objective "Industrial production and technology" with 11.4% of total GBAORD respectively.

Summing up, then, government budgets financed less diversified research in the United States than in EU-15 and in Japan. In fact, almost 80% of the total GBAORD in United States went to only two objectives.

Taking a look at objectives that receive little funding from the governments of the three major economies, we find mainly objectives related to the earth: "Exploration and exploitation of the earth", "Infrastructure and general planning of land use", "Control and care of the environment", "Agricultural production and technology". The same is also true of the objective "Social structure and relationships".

![Distribution of GBAORD by socio-economic objective in percentage, EU-15, Japan and the United States - 2004](image)

Figure 1.5 shows, by country, GBAORD expressed as a percentage of GDP. The main advantage of this indicator is to remove the weight of countries and thus facilitate a comparison of GBAORD across countries. In 2004, total GBAORD of EU-25 accounted for 0.76% of GDP. The EU-15 average was slightly higher, at 0.77%.

However, the European average masks large differences between countries. As a matter of fact, Iceland led with 1.50% of GDP devoted to GBAORD in 2004. Two other countries had a GBAORD higher than 1% of GDP: Finland (1.03%) and France (1.01%). France was also the second-ranked European country for allocating the highest public budgets to R&D in absolute terms (EUR). In Sweden, Spain and Norway GBAORD as a percentage of GDP was also higher than the European average (0.76%). GBAORD of ten Member States ranged between the European average (0.76%) and 0.5% of their GDP. It was especially true for three out of the four main European countries in terms of budgets granted to GBAORD expressed in absolute terms: Germany (0.75%), the United Kingdom (0.71%) and Italy (0.65%). At the end of the scale, there were Greece, Cyprus, Lithuania, Luxembourg, Latvia, Romania and Malta, where GBAORD was at or below 0.3% of GDP. Moreover, GBAORD did not even attain 0.2% in Latvia, Romania and Malta. In Malta, GBAORD stood at a negligible 0.01% of GDP.

Figure 1.7 shows the share of EU-25 total GBAORD granted by the four main budgeting countries. In 2004, total GBAORD of EU-25 amounted to almost EUR 78 billion at current prices. Germany allocated the highest budgets to GBAORD, with EUR 16.7 billion. It was closely followed by France with 16 billion, and to a lesser extent by the United Kingdom and Italy with EUR 12.2 and EUR 9.2 billion respectively. These four Member States were responsible for approximately 70% of the EU-25 total GBAORD.
(EUR 77.9 billion). The remaining 21 Member States together granted EUR 23.7 billion or approximately 30% of the EU-25 total GBAORD. Of these, seven allocated more than one billion euro to GBAORD: Spain, the Netherlands, Finland, Belgium, Sweden, Austria and Denmark. It was also the case for Norway. At the other end of the scale, five Member States allocated less than EUR 100 million to GBAORD. These were Luxembourg, Lithuania, Cyprus, Malta and Latvia.

**Figure 1.7**

Total GBAORD in euro per inhabitant, EU-25 and selected countries - 2004

R&D personnel

In 2004, 1.46% of total employment in EU-25 was in R&D, the head count being 2.82 million people. When measured in full-time equivalent, EU-25 R&D personnel amounted to more than 2 million, which represents an increase of 1.3% compared to the previous year. At national level, Iceland led with 3.48% of total employment in R&D in 2003, ahead of Finland (3.11%), Sweden (2.49%), Denmark (2.29%) and Norway (2.26%).
In 2004, 53.4% of R&D personnel in EU-25 were employed in the business enterprise sector - BES, 31.1% in the higher education sector - HES and 14.3% in the government sector - GOV. In 2003, Germany and France employed almost half of the EU-25 R&D personnel measured in full-time equivalent, as their R&D personnel amounted to 473 000 and 346 000 persons respectively. Germany and France were ahead in all institutional sectors, often followed in third and fourth position by Spain and Italy. In 2004, over 1.2 million researchers, measured in FTE, were employed in EU-25, an increase of 57 800 since 2002.

The BES is the sector with the highest share of total employment engaged in R&D activities within the EU-25 (Table 3.7). In 2003, the proportion in the BES was 0.66%. In the HES, this share amounted to 0.58% in 2003, gaining 0.01 percentage points compared with the previous year. In the GOV, for its part, only 0.19% of total employment was R&D personnel.

Looking at the data at national level, a different pattern emerges. The share of persons employed in R&D has a different weight according to the sector of performance from one country to another. For example, in Luxembourg or Denmark the BES comes far ahead
of the other sectors (with shares of 1.88% and 1.37% respectively). At the opposite end of the scale, Lithuania reached only 0.05% in the BES.

In the HES, the figures for Sweden (1.15%), Finland (1.00%), Estonia and Greece (both 0.82%), Norway (0.97%) and Iceland (0.84%) were well above the EU-25 average in 2003. The smallest shares of R&D personnel in terms of total employment working in the HES were registered for Luxembourg (0.03%), followed by Cyprus (0.18%).

Finally, the government sector scored the smallest proportion of R&D personnel in terms of total employment. The exception of Cyprus can be noted since, with a share of 0.22%, the GOV had the highest proportion of R&D personnel in terms of total employment compared with the BES and HES (0.17% and 0.18% respectively).

In 2003, Germany and France employed almost half of the EU’s R&D personnel measured in full-time equivalent, as their R&D personnel amounted to 472,533 and 346,078 persons respectively (Table 3.9). Italy and Spain came next, with 161,828 and 151,487 persons respectively in 2003. Whereas Germany accounted for 23% of total R&D personnel in the EU-25, it employed 28% of the EU-25’s R&D personnel in the BES and only 16% in the HES.
Table 3.9

R&D personnel in FTE and percentage of females, by sector of performance, EU-25 and selected countries - 2003 and 2004

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(i) HU, SK: defence excluded (all or mostly).

The majority of EU-25 Member States (except for Latvia and Hungary) saw their number of researchers increase between 2002 and 2004. Most European researchers work in Germany (269 000), France (193 000) and Spain (101 000).

Female researchers were under-represented in the EU-25 compared to male, especially in the business enterprise sector. In 2003, they accounted for 28.3% of total researchers and for only 19.6% of researchers in the BES. The percentage of female researchers was in general higher in the new Member States and candidate countries. In 2003, in EU-25, 573 000 R&D researchers measured in FTE were employed in the BES. The largest share of these business R&D researchers were working in the manufacturing sector (413 000).

"Natural sciences" accounted for the highest proportion of researchers in the higher education and the government sectors. In 2003, close to one quarter of R&D personnel in full-time equivalent were concentrated in the ten leading regions.
Human Resources in Science and Technology - HRST

Data on Human Resources in Science and Technology (HRST) contribute significantly to the measuring of the new economy. They review the supply of, and demand for, highly qualified persons in science and technology.

The overall number of students taking tertiary education courses is growing in Europe, at an annual average rate between 1998 and 2003 of 5% for male students, and of up to 6% for female students. In 2003, over 14 million people in the EU were following tertiary education courses, of whom more than 350 000 were PhD students.

Doctorate students are in general following second stage of tertiary education programmes (ISCED level 6), which lead to the award of an advanced research degree, e.g. a doctorate in economics, in sociology or in physics. The programmes are therefore devoted to advanced study and original research and are not based on course-work only. They usually require 3-5 years of research and course work, generally after a Master's degree. Indicators of the number of doctorate students therefore provide an idea of the degree to which countries will have researchers at the highest level of education.

Even excluding Germany, Greece, France, Luxembourg and Slovenia - for which no data were available - there were over 350 000 doctorate students in the EU-25 in 2003. As shown in Table 4.2, "science, mathematics and computing" are relatively more popular subjects than "engineering, manufacturing and construction", even when looking at the participation of doctorate students. In the EU, Hungary and Ireland had the highest proportion of their doctoral students taking science courses, at 76.4% and 41.4% respectively; next came Belgium and Cyprus (32.5% and 31.6% respectively).
<table>
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<tr>
<th>Country</th>
<th>Students in any field</th>
<th>% Female</th>
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<th>% of all students</th>
<th>In engineering, manufacturing and construction</th>
<th>% of all students</th>
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<td>287,013</td>
<td>19.6%</td>
<td>204,076</td>
<td>10.3%</td>
<td>68,649</td>
<td>20.4%</td>
</tr>
<tr>
<td>DK</td>
<td>201,745</td>
<td>29.6%</td>
<td>176,586</td>
<td>9.9%</td>
<td>21,771</td>
<td>10.8%</td>
</tr>
<tr>
<td>EE</td>
<td>2,312,197</td>
<td>32.8%</td>
<td>6,039,320</td>
<td>10.1%</td>
<td>17,357</td>
<td>11.0%</td>
</tr>
<tr>
<td>EL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES</td>
<td>1,640,597</td>
<td>22.5%</td>
<td>247,091</td>
<td>13.5%</td>
<td>322,832</td>
<td>17.5%</td>
</tr>
<tr>
<td>FR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE</td>
<td>161,557</td>
<td>27.2%</td>
<td>35,047</td>
<td>14.1%</td>
<td>20,310</td>
<td>11.2%</td>
</tr>
<tr>
<td>IT</td>
<td>1,913,852</td>
<td>22.6%</td>
<td>146,897</td>
<td>7.7%</td>
<td>313,170</td>
<td>16.3%</td>
</tr>
<tr>
<td>CY</td>
<td>18,272</td>
<td>16.9%</td>
<td>2,376</td>
<td>13.0%</td>
<td>237</td>
<td>5.5%</td>
</tr>
<tr>
<td>LV</td>
<td>176,944</td>
<td>34.3%</td>
<td>8,071</td>
<td>7.0%</td>
<td>11,764</td>
<td>6.9%</td>
</tr>
<tr>
<td>LT</td>
<td>167,596</td>
<td>33.1%</td>
<td>9,060</td>
<td>5.8%</td>
<td>33,599</td>
<td>19.8%</td>
</tr>
<tr>
<td>LU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td>380,483</td>
<td>16.9%</td>
<td>26,266</td>
<td>8.6%</td>
<td>55,470</td>
<td>14.2%</td>
</tr>
<tr>
<td>MT</td>
<td>8,946</td>
<td>14.1%</td>
<td>467</td>
<td>5.2%</td>
<td>274</td>
<td>7.6%</td>
</tr>
<tr>
<td>NL</td>
<td>636,767</td>
<td>24.8%</td>
<td>51,000</td>
<td>4.0%</td>
<td>62,034</td>
<td>10.1%</td>
</tr>
<tr>
<td>AT</td>
<td>232,802</td>
<td>22.0%</td>
<td>26,727</td>
<td>11.6%</td>
<td>21,169</td>
<td>13.4%</td>
</tr>
<tr>
<td>PL</td>
<td>1,963,360</td>
<td>30.5%</td>
<td>123,145</td>
<td>6.5%</td>
<td>266,720</td>
<td>13.0%</td>
</tr>
<tr>
<td>PT</td>
<td>389,181</td>
<td>26.3%</td>
<td>31,331</td>
<td>7.8%</td>
<td>55,059</td>
<td>21.1%</td>
</tr>
<tr>
<td>SI</td>
<td>101,459</td>
<td>30.9%</td>
<td>4,077</td>
<td>4.6%</td>
<td>17,459</td>
<td>17.2%</td>
</tr>
<tr>
<td>SK</td>
<td>188,389</td>
<td>16.6%</td>
<td>13,713</td>
<td>8.7%</td>
<td>28,794</td>
<td>17.9%</td>
</tr>
<tr>
<td>FI</td>
<td>291,004</td>
<td>44.6%</td>
<td>33,937</td>
<td>11.6%</td>
<td>77,986</td>
<td>26.0%</td>
</tr>
<tr>
<td>SE</td>
<td>414,157</td>
<td>37.7%</td>
<td>41,526</td>
<td>10.1%</td>
<td>71,736</td>
<td>17.3%</td>
</tr>
<tr>
<td>UK</td>
<td>2,267,993</td>
<td>21.7%</td>
<td>307,760</td>
<td>13.5%</td>
<td>177,194</td>
<td>7.7%</td>
</tr>
<tr>
<td>IS</td>
<td>13,347</td>
<td>22.3%</td>
<td>2,418</td>
<td>10.7%</td>
<td>630</td>
<td>6.5%</td>
</tr>
<tr>
<td>NO</td>
<td>2,438</td>
<td>25.7%</td>
<td>24,223</td>
<td>11.4%</td>
<td>13,365</td>
<td>6.3%</td>
</tr>
<tr>
<td>ESA</td>
<td>14,429,183</td>
<td>22.6%</td>
<td>1,349,550</td>
<td>19.6%</td>
<td>2,016,324</td>
<td>14.3%</td>
</tr>
<tr>
<td>CH</td>
<td>146,905</td>
<td>20.7%</td>
<td>21,457</td>
<td>11.5%</td>
<td>25,354</td>
<td>13.7%</td>
</tr>
<tr>
<td>HU</td>
<td>230,313</td>
<td>25.8%</td>
<td>11,477</td>
<td>5.1%</td>
<td>50,489</td>
<td>22.1%</td>
</tr>
<tr>
<td>RO</td>
<td>642,911</td>
<td>16.2%</td>
<td>34,105</td>
<td>5.2%</td>
<td>126,909</td>
<td>21.6%</td>
</tr>
<tr>
<td>TR</td>
<td>1,266,329</td>
<td></td>
<td>40,4</td>
<td>10.7%</td>
<td>285,969</td>
<td>20.6%</td>
</tr>
</tbody>
</table>

Note: Estimations excluding EL, FR and LU. EU-15, EU-25 and ESA.
The stock of human resources in S&T (HRST) is growing over time. In order, Germany, the United Kingdom and France had the highest number of HRST in 2004 (more than 10 million in each country), which accounted for nearly half of the EU's 76 million HRST between 25 and 64 years old. However, in terms of total employment in the same age group, the 29.5 million persons working in S&T and having a tertiary education (HRSTC) accounted for 15% of total employment. This proportion goes up to 25% when people working in S&T without tertiary level education are included (HRSTO).
In the majority of EU countries, scientists and engineers were predominantly male. The highest share of scientists and engineers (S&E) in 2004 is found in Belgium, where 7.5% of the labour force declared that they had an occupation qualifying them as SE.
Services have far more S&T workers than manufacturing. Close to half of the people working in the "other knowledge-intensive services", which include 'Education' and 'Health' and 'Social work', had completed tertiary S&T education in 2004.

In general, unemployment rates in 2004 for HRST were much lower than for non HRST. In the EU, the HRST unemployment rates reached only 3%, while the rate of unemployment for non HRST climbed to 10%.

Looking at mobility, countries with a large population had the greatest number of employed HRST aged 25-64 years who changed job during 2004. The United Kingdom registered the highest number of HRST job-to-job mobility, with 925 000 persons, followed by Germany (730 000 persons), France (571 000 persons) and Spain (447 000 persons). The 25-34 year olds are more likely than higher age groups of HRST to move from one job to another.
Innovation

There are two main European instruments for measuring and analysing innovation: the Community Innovation Survey (CIS) and the European Innovation Scoreboard (EIS). As new CIS 4 data will become available only in autumn 2006, the CIS 4 is only explained briefly. More details are given on the results of the 2005 EIS, which is partly based on CIS data.

The EIS is the policy instrument developed by the European Commission, under the Lisbon Strategy, to evaluate and compare the innovation performance of the EU Member States. It uses a limited number of indicators and results, most of them produced within the European Statistical System. EIS 2005 covers the EU-25 Member States, the EFTA Member States (excluding Liechtenstein), the candidate countries (excluding Croatia), Japan and the United States.

The core part of the EIS is the calculation of the Summary Innovation Index (SII), which makes it possible to divide the EU-25 Member States into four groups depending on their innovation performance (Figure 5.1):

- **Leading countries**: Switzerland, Finland, Sweden, Denmark and Germany
- **Average performance**: France, Luxembourg, Ireland, United Kingdom, Netherlands, Belgium, Austria, Norway, Italy and Iceland.
- **Catching up**: Slovenia, Hungary, Portugal, Czech Republic, Lithuania, Latvia, Greece, Cyprus and Malta.
- **Losing ground**: Estonia, Spain, Bulgaria, Poland, Slovakia, Romania and Turkey.

![Figure 5.1: Summary Innovation Index (SII) in 2005 and annual average growth rate 2003-2005, EU-25 and selected countries](image)

*Source: European Innovation Scoreboard 2005.*

Notes: The circles in Figure 5.1 identify the four main country groupings: top = leading countries, middle = average performers, bottom right = catching up, and bottom left = losing ground.
Five key dimensions of innovation performance

Innovation is a non-linear process. The 26 EIS innovation indicators have been classified into 5 categories to better capture the various aspects of the innovation process. These five categories cover different dimensions of innovation performance with a limited set of indicators:

- **Innovation drivers** measure the structural conditions required for innovation potential
- **Knowledge creation** measures the investments in R&D activities
- **Innovation & entrepreneurship** measures the efforts towards innovation at the firm level
- **Application** measures the performance expressed in terms of labour and business activities and their value added in innovative sector
- **Intellectual property** measures the achieved results in terms of successful know-how.

Figure 6 shows the ranking of countries for each of these groups from the worst to best performer.

### INPUT – Innovation drivers

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 S&amp;E graduates per 1000 population aged 20-29</td>
<td>Eurostat</td>
</tr>
<tr>
<td>1.2 Population with tertiary education per 100 population aged 25-64</td>
<td>Eurostat, OECD</td>
</tr>
<tr>
<td>1.3 Broadband penetration rate (number of broadband lines per 100 population)</td>
<td>Eurostat</td>
</tr>
<tr>
<td>1.4 Participation in life-long learning per 100 population aged 25-64</td>
<td>Eurostat</td>
</tr>
<tr>
<td>1.5 Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)</td>
<td>Eurostat</td>
</tr>
</tbody>
</table>

### INPUT – Knowledge creation

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Public R&amp;D expenditures (% of GDP)</td>
<td>Eurostat, OECD</td>
</tr>
<tr>
<td>2.2 Business R&amp;D expenditures (% of GDP)</td>
<td>Eurostat, OECD</td>
</tr>
<tr>
<td>2.3 Share of medium-high-tech and high-tech R&amp;D (% of manufacturing R&amp;D expenditures)</td>
<td>Eurostat, OECD</td>
</tr>
<tr>
<td>2.4 Share of enterprises receiving public funding for innovation</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>2.5 Share of university R&amp;D expenditures financed by business sector</td>
<td>Eurostat, OECD</td>
</tr>
</tbody>
</table>

### INPUT – Innovation & entrepreneurship

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 SMEs innovating in-house (% of all SMEs)</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>3.2 Innovative SMEs co-operating with others (% of all SMEs)</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>3.3 Innovative expenditures (% of total turnover)</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>3.4 Early-stage venture capital (% of GDP)</td>
<td>Eurostat</td>
</tr>
<tr>
<td>3.5 ICT expenditures (% of GDP)</td>
<td>Eurostat</td>
</tr>
<tr>
<td>3.6 SMEs using non-technological change (% of all SMEs)</td>
<td>Eurostat (CIS)</td>
</tr>
</tbody>
</table>

### OUTPUT – Application

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Employment in high-tech services (% of total workforce)</td>
<td>Eurostat</td>
</tr>
<tr>
<td>4.2 Exports of high technology products as a share of total exports</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>4.3 Sales of new-to-market products (% of total turnover)</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>4.4 Sales of new-to-firm not new-to-market products (% of total turnover)</td>
<td>Eurostat (CIS)</td>
</tr>
<tr>
<td>4.5 Employment in medium-high and high-tech manufacturing (% of total workforce)</td>
<td>Eurostat</td>
</tr>
</tbody>
</table>

### OUTPUT – Intellectual property

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 EPO patents per million population</td>
<td>Eurostat</td>
</tr>
<tr>
<td>5.2 USPTO patents per million population</td>
<td>Eurostat</td>
</tr>
<tr>
<td>5.3 Tifidac patent families per million population</td>
<td>Eurostat, OECD</td>
</tr>
<tr>
<td>5.4 New community trademarks per million population</td>
<td>OHIM</td>
</tr>
<tr>
<td>5.5 New community designs per million population</td>
<td>OHIM</td>
</tr>
</tbody>
</table>

Source: European Innovation Scoreboard 2005.
Figure 6. Innovation performance per group of indicators
Countries generally perform at a comparable level in each of these groups. However, there are some noteworthy exceptions. Germany, Italy and Luxembourg are performing less well in Innovation drivers, Switzerland in Knowledge creation and Iceland in Applications than in the other groups. Estonia, Latvia and Portugal are performing much better in Innovation & entrepreneurship and the Czech Republic and Ireland in Applications than in the other groups.

There is some evidence that countries with an even performance on each of the key dimensions perform better overall than countries with an uneven distribution. Germany’s weak performance on Innovation drivers might thus hamper the effect of increased efforts in other key dimensions on the overall innovative performance of the country. A similar statement can be made for Knowledge creation in Denmark, the UK and Switzerland, and Innovation drivers in Austria and Portugal. The opposite might also hold true: a country can also over perform in one of the key dimensions without fully benefiting of an improved overall innovative performance. This might be the case for Innovation & entrepreneurship in Estonia and Portugal, and Applications in Ireland.
EU research in a bibliometric mirror

Bibliometric methods have become well established over the past ten years as useful tools for assessing the scientific impact of basic research. They are based on the use of publication and citation data. Measures of scientific publishing in the form of numerical data are called bibliometric science indicators. The following are a few examples of bibliometric science indicators.

Number of publications
• Describes outcomes of research.
• Publication numbers are studied by country, major field of science, discipline, sector and organisation.

Share of publications
• Number of a country’s publications as a proportion of all publications in the OECD countries, for example.

Number of publications relative to population or GDP
• Gives a rough indication of the output of research relative to the size or wealth of the nation.

Number of citations
• Number of citations received by certain publications during a certain period.

Share of citations
• Number of citations received by a country’s publications as a proportion of citations received by all OECD publications, for example.

Impact factor
• Gives a rough indication of the visibility, scientific impact and quality of research.
• Number of citations / number of publications.
• Average number of citations received by the publications of a certain country, organisation etc. during a certain period.

Relative citation impact
• Gives a rough indication of the visibility, scientific impact and quality of research.
• Impact factor for a certain country / impact factor for OECD, while the relative citation impact for the OECD is one.
• How many per cent more or less citations a country’s publications, for instance, have received in comparison with the average for the OECD countries during a certain period.
• How many per cent more or less citations a country’s publications in the natural sciences, for instance, have received in comparison with the OECD average for the natural sciences during a certain period.

One important use for these measures in science administration and at universities is for purposes of assessing research outcomes. The rapid growth of assessment and evaluation has also led to an increased use of various indicators describing the volume, level and impact of research.

Bibliometric science indicators have somewhat limited applicability, and it is rarely that their interpretation is straightforward and unproblematic. They do, however, provide a
useful backdrop for discussion as well as for the formulation of new questions. If used uncritically, bibliometric indicators may lead to flawed conclusions.

Publication and citation practices vary among disciplines, and therefore direct comparisons are not possible. There are often marked differences between different fields of research in terms of how quickly they respond to new literature, the life-span of publications and publishing and citation practices. In medicine and molecular biology, for instance, research results may become outdated within a matter of months, whereas in the social sciences many studies may still be cited decades after their publication. These differences will also be reflected in the impact factors recorded in different disciplines. For example, the following table contains bibliometric indicators for Finnish publishing in 1981–2005.

<table>
<thead>
<tr>
<th>Publications</th>
<th>1985</th>
<th>1995</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of publications</td>
<td>3,301</td>
<td>5,769</td>
<td>8,304</td>
</tr>
<tr>
<td>% share of EU 25a countries’ publications</td>
<td>2,0</td>
<td>2,3</td>
<td>2,4</td>
</tr>
<tr>
<td>% share of OECD countries’ publications</td>
<td>0,8</td>
<td>1,0</td>
<td>1,1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>% share of EU 25a countries’ citations</td>
<td>2,0</td>
<td>2,4</td>
<td>2,9</td>
</tr>
<tr>
<td>% share of OECD countries’ citations</td>
<td>0,7</td>
<td>0,9</td>
<td>1,3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Citation indices</th>
<th>1981-1985</th>
<th>1991-1995</th>
<th>2001-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact factor</td>
<td>2,75</td>
<td>3,59</td>
<td>5,6</td>
</tr>
<tr>
<td>Relative citation impact</td>
<td>0,88</td>
<td>0,96</td>
<td>1,13</td>
</tr>
</tbody>
</table>

Impact factor = number of citations / number of publications.
Relative citation impact = impact factor for Finland / impact factor for the OECD.
(For example, in 2001–2005 the impact factor for Finland was 5.60 and for the OECD 4.96, i.e. the index value is 5.60/4.96 = 1.13.)

An important indicator of the research quality is the top 1% of world publications that received the most citations in a certain time slot. By the beginning of the 2000s almost one per cent of Finland’s publications was among the top one percent of world publications.
Next table presents publication numbers in OECD countries per GDP (1,000 million current PPP\$b in 2004) in 2005. Countries listed in order of relative publication numbers.

<table>
<thead>
<tr>
<th>Country</th>
<th>Publications per GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>65</td>
</tr>
<tr>
<td>Sweden</td>
<td>61</td>
</tr>
<tr>
<td>New Zealand</td>
<td>55</td>
</tr>
<tr>
<td>Finland</td>
<td>53</td>
</tr>
<tr>
<td>Denmark</td>
<td>52</td>
</tr>
<tr>
<td>Netherlands</td>
<td>44</td>
</tr>
<tr>
<td>Canada</td>
<td>43</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>43</td>
</tr>
<tr>
<td>Australia</td>
<td>41</td>
</tr>
<tr>
<td>Belgium</td>
<td>40</td>
</tr>
<tr>
<td>Norway</td>
<td>35</td>
</tr>
<tr>
<td>Austria</td>
<td>33</td>
</tr>
<tr>
<td>Germany</td>
<td>32</td>
</tr>
<tr>
<td>Greece</td>
<td>31</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>31</td>
</tr>
<tr>
<td>Hungary</td>
<td>30</td>
</tr>
<tr>
<td>France</td>
<td>30</td>
</tr>
<tr>
<td>Slovakia</td>
<td>29</td>
</tr>
<tr>
<td>Poland</td>
<td>28</td>
</tr>
<tr>
<td>Ireland</td>
<td>28</td>
</tr>
<tr>
<td>Spain</td>
<td>27</td>
</tr>
<tr>
<td>Portugal</td>
<td>27</td>
</tr>
<tr>
<td>Turkey</td>
<td>26</td>
</tr>
<tr>
<td>United States</td>
<td>26</td>
</tr>
<tr>
<td>Italy</td>
<td>24</td>
</tr>
<tr>
<td>South Korea</td>
<td>23</td>
</tr>
<tr>
<td>Japan</td>
<td>20</td>
</tr>
<tr>
<td>Mexico</td>
<td>6</td>
</tr>
</tbody>
</table>

Sources: Main Science and Technology Indicators 2006/1; Thomson Scientific, NSI 1981–2005.
Next figure presents OECD countries’ relative citation impacts in 1991–1995 and 2001–2005. Countries listed in order of the citation impacts for the most recent period. Relative citation impact = impact factor for a country (number of citations / number of publications) / impact factor for OECD.
The following figure brings out the publishing profiles of OECD countries by major field of science in 2001–2005.
The next table contains relative citation impacts for OECD countries by major field of science in 2001–2005. Countries are listed in order of their relative citation impact.

<table>
<thead>
<tr>
<th>2001–2005</th>
<th>Natural Sciences</th>
<th>Engineering and Technology</th>
<th>Medical Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States</td>
<td>Switzerland</td>
<td>Switzerland</td>
</tr>
<tr>
<td>2</td>
<td>Switzerland</td>
<td>Denmark</td>
<td>United States</td>
</tr>
<tr>
<td>3</td>
<td>Iceland</td>
<td>Denmark</td>
<td>Iceland</td>
</tr>
<tr>
<td>4</td>
<td>United Kingdom</td>
<td>United States</td>
<td>Denmark</td>
</tr>
<tr>
<td>5</td>
<td>Netherlands</td>
<td>Austria</td>
<td>Belgium</td>
</tr>
<tr>
<td>6</td>
<td>Denmark</td>
<td>Germany</td>
<td>Belgium</td>
</tr>
<tr>
<td>7</td>
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Relative citation impact = Impact factor e.g. for the major field of natural sciences in a country (number of citations / number of publications) / impact factor for the same major field in OECD countries. The relative citation impact for the OECD in all major fields of science is one and is indicated in each table with a horizontal line.
**Patents**

**Total patents**

Patents statistics are widely used to generate indicators that help to measure a country's technological output. In 2002, 59,736 patent applications to the EPO came from EU Member States, 46,816 from the United States and 24,494 from Japan. 87,116 patents granted by the USPTO came from inventors residing in the United States, 32,178 from Japanese residents and 24,733 from European residents. These figures show that there is a home country advantage.

Data on patent families are generally less biased, as the "home advantage" disappears to a certain extent. In 1999, 36% of triadic patents came from American investors and 29% each from European and Japanese investors. Looking at absolute EPO patent applications Germany is far ahead, while in terms of population size Finland and Sweden were the best performing EU countries.
High-tech patents
In 2002, EU-25 inventors applied for 11 052 high-tech patents to the EPO, as against American investors applying for 13 958 and Japanese for 6 255. In 1999, the USPTO granted 3 820 high-tech patents to European inventors, 8 013 to Japanese inventors and 23 224 to Americans.
In terms of absolute EPO applications Germany is again well ahead, but in terms of population size Finland and Sweden are the best performing countries in high-tech patenting.
Communication technology, Lasers, Micro-organism and genetic engineering, Semiconductors, Computer and automated business equipment and Communication technology are the groups where most patenting takes place.

**Employment in high-tech industries and knowledge-intensive services**

In 2004, almost 130 million people were employed in services in EU-25, whereas more than 36 million were employed in manufacturing. Of the 130 million jobs in services in EU-25, half of these were in knowledge-intensive services and the other half in less knowledge-intensive services.

Of the 36 million people employed in manufacturing, 11 million were in medium-high-tech manufacturing (5.7% of total employment) and more than 2.2 million in high-tech manufacturing (1.1% of total employment). Of the total workforce in manufacturing and services of 166 million, almost 20 million persons were employed in high-tech manufacturing and services within the EU in 2004.

In EU-25 less than 30% of all persons employed in manufacturing were female. This ratio was often higher in the new Member States than in the old ones. The highest ratio of female employment was in high-tech manufacturing (35.6%).

In EU-25, 60.1% of persons employed in all services were female. This proportion is about twice as high as the employment share of female in total manufacturing. However, the proportion of female employees was lower in knowledge-intensive services and lower still in high-tech KIS, with ratios of 53.4% and 33.8% respectively.

**R&D in high technology**

For the EU-25 Member States for which data are available, more than 90% of total business R&D expenditure was spent in high and medium-high-tech manufacturing in Germany, Hungary and in the United Kingdom. In general, the proportion of researchers among R&D personnel was higher in high-tech manufacturing than in total manufacturing. Hungary had the highest proportion with 85.8% of researchers in high-tech manufacturing.

R&D investment is highly concentrated in the EU. Three countries (Germany, France and the United Kingdom) account for around three quarters of both total R&D investment and sales and about 60% of the total number of EU Scoreboard companies. The economic sectors with the highest rates of growth in R&D investment worldwide are services, pharmaceuticals and biotechnology. Each region of the world has a different specialisation. The EU, the United States and the rest of the world group (especially Switzerland) specialise in pharmaceuticals and biotechnology.
Background data

## 9.1 Population

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Part III EU best practice in R&D governance

Austrian R&D and Innovation Policy

Main research policy setting mechanisms

The Austrian research and innovation system consists of three main components:
• the research oriented part including publicly funded institutions like the universities, the “Austrian Research Centres”, the “Competence Centres” and research dominated enterprises;
• the strategic and/or operative part with the Council for Research and Technology Development, the ministries responsible for innovation policy and the agencies executing specific programmes;
• the “public”, society in general, which came into focus more and more since 2000 as the importance of a broad understanding of innovation and its meaning for the society raised slowly, but continually.

In an effort to create a body with the power to design long-term strategies for Austrian innovation policy, the Council for Research and Technological Development was created in 2000. The government tried to react on a perceived lack of strategic intelligence within the system. As an explicit measure to improve coherence within the system the establishment of the Council sets the starting point for the reorganisation process which was launched in the same year and is still ongoing these days. There is a steering committee including members of the BMVIT, the BMWA and the BMBWK. The Council for Research and Technology Development, however, notes a gap in the coordination of innovation policy.
There are several core institutions which set the main outlines of the policy: the three ministries involved in innovation policy (BMBWK, BMVIT, BMWA) and the Council for Research and Technology Development. Their decisions are mostly based on indicators and benchmarks provided by international and national assessments (e.g. figures from the Innovation Scoreboard, OECD as well as figures from domestic experts like WIFO, Statistic Austria etc.).

The main actors in Austrian Innovation policy (Council + 3 ministries) select the stakeholders they want to involve in their discussions, but there are no binding rules how to set up working-groups for new programmes or measures. Most measures are designed by the ministries. In last year, there has been an increased willingness within the Council to open discussions on innovation and research topics to a broader range of stakeholders. Especially new recommendations which the Council publishes on a regular basis are now generally prepared with the involvement of experts from the area the recommendation will focus on. The BMWA founded a “Platform Innovation” to outline Austria’s progress in the Lisbon process and to make proposals on the means and ways to succeed in the strategy.
Main research policy setting mechanisms

Government policy making and coordination

Political responsibility for the development of the innovation system is at the federal level divided between the following three ministries:
2. The Ministry for Transport, Infrastructure and Technology (BMVIT, http://www.bmvit.gv.at/) is responsible for the major non university research organisations and most of the technology programs.
3. The Ministry for Economics and Labour (BMWA, http://www.bmwa.gv.at/BMWA/default.htm) supports a range of organisations of the Austrian innovation support infrastructure for SMEs and has set up several programs with the key topics technology transfer, innovation management and mobilisation of equity capital for high-tech start-up.

Beside these main players in science and technology policy, even though the Ministry of Finance (BMF, https://www.bmf.gv.at/) does not directly get involved in financing innovation policy, it plays an important role within the policy system because it governs the allocation of financial resources and sets at least implicitly standards in design and monitoring of new programs.

Research funding system

Brief description

30% of gross domestic expenditure for R&D come from the public, federal sector, 6% from the provinces, 43 % from industry and 20% from abroad. The organisations involved in funding are, on the governmental level, first of all the BMBWK, who is in charge of university funding, but also of other research funding, the BMVIT, in charge of the most of research programs, as well as the BMWA. These two are also in charge of the FFG. Moreover, the BMVIT represents the republic as co-owner in Austrian Research Organisations (ARC index.cfm, ...), whereas the Austrian Academy of Science (index.cfm), scientific associations and museums etc depend on the BMBWK, and the Christian Doppler Society on the BMWA.

University funding has considerably changed with the University Act of 2002 (index.cfm), introducing performance contracts on which further funding will be based. Companies mainly address the funding agency (FFG index.cfm) for support, however, the technical ministries also run specific research programs.

National public research funding

Overview

Gross domestic expenditure for R&D (GERD) in Austria amount to 5773,86 million Euro in 2005, or 2,35% of GDP. Besides "classical" funding mechanisms of public budget - based on the federal budget law, financial means are attributed to the different ministries
to fulfill their tasks, part of them are forwarded to financing agencies like the FFG, co-financed by two ministries - a specificity has been introduced in Austria with so called "sondermittel" (extraordinary means), which are not directly attributed to ministries in charge, but pass a recommendation process by the RTD Council (index.cfm). The first „offensive programme for R&D“ (2001-2003) provided 508,7 million Euro extra-budget, in the first part of the following offensive-programme II (2004-2006), 600 million Euro have been reseved in total, and 180 million for 2004. This is completed by the national foundation for research, technology and development, providing 125 million per year.

**Basic research funding**

There is no comprehensive overview about „basic research funding“ in Austria, however, in considering university funding and funding by to Austrian Science Fund FWF (index.cfm), most of it is covered.

Firstly, concerning university funding, Austria has started some fundamental reforms in the university sector (A comprehensive overview on the 2001 university reforms is given at http://www.bmbwk.gv.at/universitaeten/pm/publ/Higher_Education_in_Aust6820.xml) affecting also university funding. The University Act of 2002 (http://www.bmbwk.gv.at/medienpool/8019/8019_ug02_engl.pdf, has implied significant changes for universities (see Universitätsbericht 2005, p. 34ff, http://www.bmbwk.gv.at/universitaeten/pm/publ/univbericht_05.xml):

• The size of the university and the number of students play a decisive role in the budget of the individual universities. However, since January 2004, universities are now given a global amount (Globalbetrag) and allocation is left to the universities themselves.

• Moreover, university revenue now goes directly to the university budgets and is not a part of general federal revenues. This also includes general tuition fees (currently 363 € per term for students from Austria and other EU and EEA countries).

• Universities are encouraged to raise more funds from contract research, from EU funding or the Austrian Science Fund (FWF index.cfm), a fund to promote basic research. Contractual funding of universities today amount to approx. 187 Mio. € per year, which is about 7% of total federal university funding.

• Following the recommendation of the Austrian council for science and technology development, 170 Mio. € have been allocated from the special funding “Offensivprogramme I and II” to universities between 2001 and 2006. These funds are mainly assigned to improvements of the infrastructure.

• In 2005 and 2006, 0.4% and 0.8% of the global amount to universities are used to promote organisational change and specialisation at universities. This amounts to 20.5 Mio. € for the two years. The funds have been allocated on a competitive basis.
Since 2004, Austrian universities are required to publish financial statements.

Starting in 2007, financial means each university will be tied to 3-year contracts (Leistungsvereinbarung) between the Federal Ministry for Education, Science and Culture and the universities. The Leistungsvereinbarung contains the services to be provided by the university, including teaching, research, mobility of researchers and students, co-operation, strategy, specialisation, etc.

From 2007 on, university funding will comprise of a basic budget, which is laid down in the Leistungsvereinbarungen for the 3-year period, and a flexible component which is related to performance and quality indicators. This flexible component amounts to 20% of the global amount. University funding has become more competitive, as well as more targeted towards specific technologies or functions within the innovation system (for example science-industry-collaborations). Moreover, public funding is now targeted to commit the organisations to certain goals and strategic orientations.

Structure of funding
There is a trend towards stronger project- and programme-based funding, public funding have been increased with the aim to leverage also the private R&D investments.

Secondly, the Austrian Science Fund (index.cfm) is funding fundamental research in all disciplines. It is mainly alimented by the federal budget and the research fund of the Austrian national Bank, which merged in the R&D National Fund (FTE-Nationaistiftung) in 2003. Total budget of the FWF amounts to € 111,88 million in 2005, 64% coming from the federal budget. 85% of applications for FWF funding are submitted by coordinators which are affiliated with an Austrian University. This hints at the eminent relevance of the FWF for the Unviersity system in Austria. (See G. Streicher et al: Evaluation FWF – Impact Analysis. Joanneum research, March 2004). Other applicants come from the Austrian Academy of Science (4%), R&D institutions under company law (1%), public institutions (3%), and other or no current affiliation. The overall approval rate in the period covered by the impact analysis, (1998-2003) was 51%.

Thematic priorities and other targeted funds

FIT-IT (index.cfm), funded by the BMVIT and managed by the FFG, stands for "Research, Innovation and Technology for Information Technologies", promoting visionary and interdisciplinary projects, which lead to significant technological innovations and contemporaneously open up new application areas. The aim is to recognize future markets at an early stage and to prepare the market for such researcher. Target groups are companies and research facilities, which contribute to the latest technical developments. The programme has been enlarged to three programme lines:
- Semantic Systems and Services
- Systems on Chip and Systems in a Package
- Embedded Systems
- **NANO-Initiative** ([index.cfm](#)): The Austrian NANO Initiative is a multi-annual funding programme for Nanoscale Sciences and Nanotechnologies (NANO for short) in Austria. It coordinates NANO measures on the national and regional levels and is supported by several Ministries, Federal provinces and Funding institutions, under the overall control of the BMVIT Federal Ministry for Transport, Innovation and Technology. The programme is managed by FFG Österreichische Forschungsförderungsgesellschaft (Austrian Research Promotion Agency) on behalf of the BMVIT. The orientation and the structure of the Austrian NANO Initiative have been developed jointly with scientists, entrepreneurs and intermediaries.

In 2004, five outstanding clusters consisting of 39 projects were selected after an international evaluation procedure. 11 Universities, 12 companies and 2 Centres of Competence are leading the clusters.

- **Life-Science:**
  - Gen-Au ([index.cfm](#)) is a research programme of the BMBWK, and will have a running time of 9 years so that it can target the sustainable securing of Austria's scientific and economic competitiveness in genome research. About EURO 10.5 million per year will be provided for funding the GEN-AU programme.
  - LISA is a platform and coaching of start-up firms, programme of BMWA, managed by AWS.

- **Austrian Programme on Technologies for Sustainable Development** ([index.cfm](#)): This five-year research and technology program has been developed by the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT). It initiates and supports trendsetting research and development projects and the implementation of exemplary pilot projects. This programme is funded by the BMVIT and managed by the FFG. The Ministry invites tenders in three subprogrammes:
  - "Building of Tomorrow"
  - "Energy Systems of Tomorrow"
  - "Factory of Tomorrow"

- **The research programme >node<** ([index.cfm](#)) of the Austrian Federal Ministry for Education, Science and Culture (bm:bwk) addresses the future of democracy in Europe. The ongoing process of European integration and in particular the planned enlargement of the European Union present new challenges for the evolution of democracy in Europe. With >node<, scientists are invited to rethink democracy, to analyse political developments and processes and the mechanisms that guide and control them, and to come up with options and alternatives for the further development of democratic politics. Currently the third round of a two-stage selection process is open.

- **The programme IV2S — intelligent transport systems and services** ([index.cfm](#)) is funding strategic subcets and technology fields for a limited time period.
Institutional funding

According to a 2005 study, 4% of institutional funding (2003 data), or €41,4 million, go to non-university research organisations (mainly to the Austrian Research Centres group, ARC). 82% goes to universities, 5% to the Academy of Science, 6% to international organisations and 2% elsewhere. Additionally to federal funding, some public research centres receive regional funds, like Joanneum Research in Styria or Salzburg Research in Salzburg. Moreover, the FTE-Nationalstiftung has started to co-fund ARC (Austrian Research Centres), the Academy of Science and Christian Doppler Gesellschaft (CDG) in 2005.

Institutional funding on the federal level is mainly administered by the Ministry of transport, innovation and technology (BMVIT), in charge of ARC, but also by the Ministry of the Economy (financing CDG) and the Ministry of education, science and the arts (BMBWK, financing the Academy of Science).

Co-funding and indirect funding of private R&D

The three key-policy instruments for promoting public-private partnerships are the Christian Doppler Laboratories, the Competence Centres programmes and the A plus B programme.

- The Competence centre programmes K-plus (index.cfm funded by BMVIT), K-kind and K-net (index.cfm funded by BMWA) finance more or less institutionalised research collaborations with obligation for participation of academia and industry, for a 7 year period with intermediate evaluation, based on common research programmes and projects and on a selection process covering both scientific and managerial criteria.
- Christian Doppler laboratories are installed in universities, get a seven year funding and concern pre-competitive and cooperative research funding.
- AplusB (index.cfm) funds innovative, technology-oriented spin-offs from the academic sector. AplusB provides professional support for scientists in the difficult process of turning a good idea into a viable business. This involves both: not only counselling and assistance during the actual start-up phase and but also establishing the idea of entrepreneurship more firmly in academic theory and practice. Six AplusB-Centres were established in which start-ups are qualified, counselled and coached. Two more are being established in 2005 as a result of a second call. FFG / Structural Programmes has been commissioned by the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT) to implement and operate the AplusB impulse programme.

Strategic Orientation of RTD and Innovation Policy

The discourse on research, technology and development that has been strengthened as a result of both the Lisbon process and increased national efforts has also resulted in a stronger strategic focus in this policy area. Problem areas and structural deficits have been identified and analysed. The tools to overcome them have been sharpened.
In 2002 the Austrian Council published the National Research and Innovation Plan, which became a key point of reference for RTD and innovation policy. It summarised the status of the discussion on research, technology and innovation in Austria at a very early stage of the Lisbon process. The ten fields of action defined in the Plan reflect the dominant themes of RTI policy in Austria:

- Greater integration of science and industry is emphasised as an essential goal for strengthening the innovation system. The instruments to strengthen co-operation between the two sectors - such as the Competence Centres programme that was set up in the late 1990s - will be made more effective.
- Thematic key areas that steer funding toward the development of specific technologies or applications are an important element of the EU Research Framework Programmes. Austria, with its strong tradition of bottom-up funding, has deficits in this area. Policymakers have responded with initiatives to support strategic emerging thematic areas such as the life sciences, nano-sciences, information and communications technologies, space and aviation and traffic technologies.
- Austria's industrial structure has deficits in the high-tech segment, which in the long-term stunt competitiveness and lead to the loss of growth opportunities. Providing support to high-tech start-ups on the one hand, and anchoring corporate headquarters in Austria on the other hand are both regarded as suitable instruments for accelerating structural change.
- The size pattern of the Austrian economy requires that particular attention be given to the needs and problems of small and medium-sized enterprises. Specific forms of research funding aim to strengthen their innovative capability and in particular to encourage them to pursue more radical innovations.
- Women are grossly underrepresented in science and research. This is not only a waste of valuable human resources, in more general terms, it also represents an obstacle to the development of research, technology and innovation. Programmes to improve the integration of women will therefore be expanded in future.
- The European goal of developing a European Research Area requires Austria to have clear strategies for the internationalisation of its RTI policy. Small countries like Austria benefit from integration in international knowledge networks to a particular degree.
- To the extent that research, technology and innovation is becoming a focus of increasing political attention and reaping the gains from increased allocations of tax revenue, RTI policy is also called upon to seek and organise public dialogue. This dialogue with the public will become an indispensable element of RTI policy.

**Strategies for the Future**

In the middle of the first decade of the new millennium an assessment of Austria's position in terms of research, technology and innovation provides encouraging news for Austria. After an impressive catching-up process in recent years Austria now has the prospect of closing the gap on the European front-runners.
The position that Austria has earned for itself in the European RTI concert opens up excellent opportunities for the future. However, it also brings with it an obligation to maintain the present level of effort and dedication to reform. The target has been set in the Barcelona goal of achieving a research quota of three percent of GDP by 2010. Austria is one of the few countries in the EU that stands a realistic chance of meeting this target.

However, the path is steep and following it will require constant increases in R&D expenditure of between seven and nine percent per annum. This calls for a mustering of all forces. The quality and efficiency of the innovation system must be improved.

In many fields of action this means optimising and strengthening existing policy approaches, in a number of areas however, new strategic directions will have to be taken. In its position paper "Strategy 2010 - Perspectives for Research, Technology and Development in Austria", the Austrian Council has developed some rudimentary strategies for achieving this goal, thus opening a new phase of the public debate on research, technology and innovation policy.

The following areas are emerging as the main strategic focus:

- Integration and co-operation between science and industry remains a top priority for RTI policy. The instruments of co-operative research must be strengthened and sharpened.
- Special priority is given to implementing a new strategy for the continuation of the Competence Centres programme, which by bundling resources aims to build up competence centres with critical mass, high scientific standards and an international orientation.
- The efficiency and effectiveness of the funding system must be improved still further. This requires the efficient co-ordination of regional and national R&D activities, and management of the funding instruments with the support of monitoring and evaluation instruments.
- Safeguarding an adequate supply of human resources requires greater efforts to increase the percentage of women in research, world-class university education and measures to foster mobility.
- Not least of all, the challenge is to give new impetus to quality throughout the entire innovation system while at the same time promoting excellence at the top. The objective of this "strategy of excellence" is to make Austrian research a global leader in an increasing number of research themes, research projects and research teams. The implementation of this concept of a university of excellence in the form of the Austrian Institute of Advanced Science and Technology (AIST) should serve as a model.

Important policy documents

1. **Strategy 2010** (Strategie 2010 - Perpektiven für Forschung, Technologie und Innovation in Österreich - Weiterentwicklung des Nationalen Forschungs- und
The new strategic orientation can be summarised in three basic principles:
* Promote quality on a broad level and excellence at the top.
* Strengthen networking and co-operation between science and industry.
* Improve the efficiency and effectiveness of the promotion system.

The emphasis will fall on the following themes:
* EXCELLENCE: Promoting Quality and Outstanding Achievement I
* INTERNATIONALISATION: Thinking in a Global Framework
* INTENSITY: Increasing the Use of Resources
* CO-ORDINATION: Bundling the Forces of RTI Policy
* EFFICIENCY: Goal-oriented Use of Funds
* EQUAL OPPORTUNITIES: Integrate the Gender Perspective
* MULTIPLICATION OF KNOWLEDGE: Strengthen Human Resources
* LOCATIONAL QUALITY: Enhance Attractiveness


Austria has to put its emphasis on the improvement of these innovation indicators, primarily on these, which lie under the European average. Therefore, the Austrian National Research and Innovation Plan was developed. Its goal was the improvement of the Austrian research and innovation landscape.

Six fields were defined: IKT, Environment & Energy, Life Sciences, Nano- and Microrotechnologies, Mobility and Transport, Socialsciences & Humanities. These priority fields are 1) Bio science, 2) Genomics and bio technology, 3) Technologies of the information society, 4) Nano technologies, 5) Multi functional materials, 6) New methods of production, 7) Aeronautics, 8) Food quality and safety, 9) Sustainable development, 10) Global change and 11) Ecosystems.
Research & Innovation in Belgium

R&D&I institutional structure of Belgium

As a result of the institutional reforms implemented over the past three decades, today Belgium is a Federal Authority. Several responsibilities, so far in the hands of the central state, were thus progressively transferred to the new federated entities, the Communities (French Community, Flemish Community and German-speaking Community) and the Regions (Walloon Region, Brussels-Capital Region and Flemish Region). The Communities are in charge of culture and education as well as person-related issues. The Regions are responsible for economic policy, energy policy (except the nuclear fuel cycle), civil engineering works, transport and the environment. The Federal Authority deals with several other domains such as foreign affairs, national defence, justice, finance, social security, part of the public health and internal affairs policies.

Brief description

The governance of the Belgian Research system reflects the federal structure of the country.

The **Federal Science Policy office** coordinates science policy at the federal level as well
as on an international level. The Federal Government also coordinates some research of
national interest such as space research.

The Regions and Communities coordinate their own specific policies through the
regional Governments and agencies.

The Flemish R&D system is governed by the Ministry of the Flemish Community with
the key agency being the IWT, and the main funding channel for research at universities
FWO-Vlaanderen. These in turn govern the various principal instruments and measures
within the Flemish region.

The Walloon Region and the French Community are two separate entities with the effect
of a split of research policy whereby the French Community, which governs, through its
Ministry of the French-Community, the fundamental research aspects and the education
system including all French-speaking universities, whilst the Walloon Government
governs applied and industrial research with economic development purposes. The
Walloon Government also supports technology guidance and funding for interfaces
between research organisations, industry and universities. The key agency within the
Walloon administration is the DGTRE.

The Brussels-Capital region's R&D policy is governed by the Ministry of the Brussels-
Capital region and the implementing agency is IRSIB-IWOIB.

The Federal, Walloon (CPS), French Community, Brussels-Capital and Flemish (VRWB)
Science and Policy Councils act as advisory bodies within their own sub-system in the
country. The Inter-ministerial Commission on Science Policy (CIMPS-IMCWB) is the
instrument of consultation between the different governments dealing with research
policy. It is the place where the co-operation agreements are worked out (including on
matters of international importance) and where various procedures for collaboration and
exchange of information between the different power levels are implemented.

**Main research policy setting mechanisms**

**Government policy making and coordination**

At federal level, scientific policy is governed by the Federal Minister responsible for
Science Policy. The policy is executed by the Belgian Science Policy Office, a
department of the federal Ministry.

The Walloon Region’s R&D policy is placed under the responsibility of the Minister with
Research and New Technologies in its portfolio. The Directorate General for
Technology, Research and Energy (DGTR) is responsible for the implementation of
policy and administration of all Walloon R&D programmes targeted to research centres
and companies.

In the French Community, the responsibility for R&D lies with the Minister of Education
and Scientific Research. Implementation of this policy is placed under the Directorate General for non-obligatory Education and Scientific Research. The Community has a dedicated public body in the National Fund for Scientific Research (within the French speaking part of Belgium, FNRS), which is in charge of university funding.

In the Flemish Community/Flemish Region, the Vice-Minister-President of the Flemish Government and Flemish Minister for Economy Enterprise, Science, Innovation and Foreign Trade governs R&D policy. Design and implementation is carried out by the Department of Economics, Science and Innovation (EWI), former Science and Innovation Administration (AWI). The Region has a dedicated public agency in the Institute for the Promotion of Innovation by Science and Technology in Flanders (IWT). Funding at universities is channelled through the Fund for Scientific Research FWO-Vlaanderen.

Finally, the Region of Brussels-Capital has its R&D governed by its Minister of Economy, Employment and Science Policy. The policy is administered by IRSIB-IWOIB.

The following formal coordination mechanisms exist for S&T policy at federal level:

- The Inter Ministerial Conference on Science Policy, the body in charge of consultation and development of cooperation agreements between the federal, regional, and Community authorities;
- The Committees organised by this conference, one for international matters and one for national matters.

**Distribution of competence in the field of science policy**

"Prime" responsibility in the field of scientific research is assigned to the Communities and Regions, in accordance with their respective areas of activity. The Federal Authority, however, exceptionally still withholds certain "exclusive" responsibilities. Some of these are subject to co-operation agreements signed with the federated authorities concerned.

The Communities are responsible for the general support of research carried out in higher education institutions. The Regions provide the general support of industrial and technological research and innovation. The Federal Authority, besides supporting research required for the fulfilment of its own assignments, also finances the federal scientific institutions, space research conducted in an international context, data transfer networks between scientific institutions as well as several other activities requiring uniform implementation at national or international level.

**Structures of dialogue and co-operation mechanisms**

The federated entities thus benefit from considerable autonomy. At the same time, however, structures of dialogue and co-operation mechanisms between the various federal and federated authorities has been set up, both at ministerial level (the Inter-ministerial Conference for Science Policy, IMCSP) and at administrative level (the

**Advisory bodies**

Each executive entity (Federal Authority or federated entities) has an advisory board (the Council of Science Policy) whose task it is to provide the government with advice and recommendations, be it at the government's request or on its own initiative. These advisory bodies are composed of experts from the scientific, economic and social sectors.

**Implementation and funding of public research**

Traditionally, there are various systems of financial support for research in Belgium. Part of this budget is directly allocated to the researchers by the competent administrations (state and federated entities). The remainder is granted indirectly, by means of funds or autonomous funding institutions (federated entities) which decide for which purposes the funds should be used.

The universities (which come under the responsibility of the Communities) perform most of the fundamental research. Besides, each authority funds and runs several own research and public-utility institutions. A group of sectoral collective research centres meeting the specific needs of the companies in terms of scientific and technological research, is jointly funded by the companies of the concerned industrial sector and public authorities (Federal Authority and Regions).

**Research in industry**

In Belgium, 2/3 of the R&D activities are funded by the industrial sector, such programmes being mainly (95%) channelled towards in-house research. If one adds public funding, the R&D research carried out in firms levels up to 70% of the gross domestic expenses for R&D. Public funding of industrial research and the promotion of technologies is primarily a responsibility of the Regions. Various approaches have been adopted by the Regions, according to their own priorities and taking account of the specific characteristics of the regional industrial scenario. Public support comes in the form of grants for basic industrial research and refundable loans for the R&D of prototypes, new products and manufacturing processes. Particular attention has been given to SMEs and innovation in the context of these financial support schemes.

R&D activities in companies focus on chemistry and pharmacy (about 40% of the expenses), electronics and electrotechnology (almost 20% of the expenses), mechanical construction, the manufacture of precision tools and transport equipment.
Research funding in Belgium

Brief description

R&D funding in Belgium flows through the various Governmental and non-Governmental bodies at the Federal, Regional and Community levels to reach public and private R&D performers. All state entities independently determine their R&D spending and thus, the Federal, Walloon, French Community, Brussels-Capital and Flemish governments all define their own funding system according to their needs and rules.

The Federal Government funds research programmes of national interest, the largest one being space research. In addition R&D tax deduction schemes and exemptions on advanced payment on wages for researchers are also developed and administered at federal level.

The Regions fund their own specific policies through own agencies. The Flemish R&D system is governed by the Ministry of the Flemish Community with the key funding agency being the IWT, the main funding source for university research is FWO-Vlaanderen.

The Walloon Region and the French Community are two separate entities with the effect of a split between, on the one hand scientific and fundamental research policy governed by the French Community, through its Ministry of the French-Community, with a main fund being FNRS, and on the other hand, the applied and industrial research governed by the Walloon Government with DGTR as key funding agency.

The Brussels-Capital Region's R&D policy is governed by the Ministry of the Brussels-Capital region, and the main funding body is IRSIB – IWOIB.

National public research funding

Overview

As mentioned, Belgium has a decentralised decision-making and governance system for R&D funding. Within it, the Federal level accounts for a restricted part or the R&D funding (less than one-third). The Federal level provides funding for research of national interest such as security as well as for international research programmes such as space research. Fiscal incentives are also present at federal level.

Funding for basic research is the responsibility of the Communities. This includes both institutional funding, competitive funding across universities, and support to individual researchers.

Funding for applied and technological research with the view of raising value-added in the economy, is under responsibility of the Regions. This includes both direct funding to companies and funding of research centres and technology diffusion activities.

The relative shares of the federal and federated entities in overall budgetary credits for
R&D In Belgium are as follows: 45.75% comes from the Flemish Community (including Community and Regional competencies); 29.63% from the federal state; 13.37% from the French Community; 10.23% from the Walloon Region, and 1.02% from the Region of Brussels - Capital (Source: 2003 figures from the Federal Office for Science Policy).

Total budgetary allocations from the public sector for R&D in Belgium amount to 1714 Millions€ in 2005 (initial figures from the Federal Office for Science Policy). These funds are allocated to the following sectors:

* 26% as institutional funding to third-level education institutions and 12% for the large Research Funds which are (partly) allocated on a competitive basis
* 13% to scientific institutions
* 18% in the form of research action programmes, which are open to public research and/or private research performers, also including individual grants for researchers
* 11% for industrial research (there is also private research funding in the previous line)
* 13% for international research programmes.

In terms of objectives pursued by the research funded by public credits, the following split is calculated (initial figures for 2005 by the federal office for science policy):

* 42% for technological objectives
* 25% for non-oriented research at universities
* 19% for the general funds at universities
* 9% for socio-economic objectives.

Enterprises are the main funding source of R&D activities in Belgium (60%). The public sector funds 23.5% of total R&D activities, and foreign sources account for 13% of the total funding sources (2003 figures from the Federal Office for Science Policy).

**Basic research funding**

The mechanisms for funding fundamental research, under the responsibility of the Communities in Belgium, respect the principle of researcher’s initiative and consequently do not incorporate any priorities in terms of sectors or disciplines. The same holds for the “inter-university attraction poles” programme of the federal authority, and other federal programmes, which provide funding for research projects at universities, often in collaboration across the linguistic communities.

The French Community funds R&D in universities mainly through its basic allocation to universities, part of which is devoted to research. The Directorate General for non-obligatory education and scientific research implements and administers the policy for the Community. Additional funding for researchers and research teams, based on competition is channelled through FNRS (95 Millions€ in 2005) and its associated funds, Special Research Fund and the ARC (Concerted Research Actions - 11 millions€ in 2005) programme.

In Flanders, the university research funding falls under the merged Flemish Government. For education and research in universities, the most important funding mechanisms are:
the operational subsidies for the universities (592Mio€ in 2005), the Special Research Fund (BOF, 233 Mio € in 2005) and the FWO-Flanders. FWO-Flanders (115Mio€ in 2005) is governed by the same Ministry and implements policy with regard to basic research at the universities. It is an funding channel which sets selection criteria and evaluation and decision-making procedures and distributes the funds amongst universities and research institutes.

The main aim of this funding for basic university research in both Communities is to finance fundamental research of high quality and to guarantee an excellent level of education for researchers. The policy is not thematically organised. Instead the Communities leave the thematic choices to the researchers and focus on the quality of scientific research to support. There are three further principles to which the Communities subscribe, namely: promoting inter-university cooperation, promoting international mobility of researchers and including research in the European Research Area.

Thematic priorities and other targeted funds

A number of funds and public funding appropriations from Belgian authorities are dedicated to thematic priorities.

At the Federal level there are thematic programmes in areas which fall within the competences of the federal level: space research (the most important in budgetary terms), and other federal research programmes in areas such as information society, national cohesion, normalisation.

Wallonia has mobilising programmes which are a short-term research programmes that are open either to universities and research centres, or to companies, and sometimes to combinations of private and public actors. These programmes have, over the last ten years, notably covered ICT applications, Biotechnology, and Nanotechnology. The areas for these mobilisation programmes are chosen amongst the “40 key technologies” in which Wallonia has scientific and industrial expertise.

Flanders targets its R&D funding through the establishment (in the beginning of the nineties) of major independent research centres, heavily supported by the regional government. IMEC is the worldwide centre of excellence in micro-electronics research. It is a unique and independent European research centre in the field of nano-electronics, nanotechnology, design methods and technologies for ICT systems. It has now become a world player with more than 1,400 researchers. Two other major centres are specialised in biology (VIB) and environment and energy (VITO).

Collective research centres, dating from the 50s and financed partly by industry, are present in all Belgian regions. With the federalisation of the country, the public funding part of such centres has been placed under the responsibility of the Regions, which means that these public funds are indeed earmarked for a certain number of sectors. These
sectors are defined according to the old industrial specialisation structure (metalworking, textile, glass, ceramics, road construction, materials etc.) but aim at developing and diffusing new technology applications into all industrial sectors. The Regions have also set up specialised “excellence centres” in a number of sectors or technologies as well as other research centres.

Institutional funding

Institutional funding in Belgium is mainly formed of funding to universities (basic allocations) institutional grants to research centres, and the functioning budgets of implementing agencies such as IWT, DGTR or IRSIB-IWOIB and the various science policy councils. There is no aggregated calculation of the specific shares of public R&D funding from all State entities devoted to this type of institutional funding.

Co-funding and indirect funding of private R&D

Tax incentives schemes for R&D investments and additional personnel in companies, as well as partial exemptions for the advanced payment of wages for R&D personnel in private and public sector are available in Belgium. Collaborative research with shared public and private funding of projects is common practice, but there is no aggregate source presenting the amounts of money involved across all Belgian authorities’ promotion schemes.

Important policy documents

1. National Reform Program. Cabinet of the Prime Minister, 2005. Besides a summary of the developments of the previous years (2000-2005), the policy paper mentions the priorities for the coming years. These priorities are the need for: 1) an innovating economy; 2) the encouragement of entrepreneurship and industrial competition; 3) improvement in the supply and demand system; 4) investment in modern and sustainable capacities; 5) Stimulation for a sustainable use of resources and to foster the synergy between growth and environmental protection.

2. Research, Technology and Innovation in Belgium: the Missing Links. The High Level Group 3% Belgium, 2005. The report pointed to a number of needs and challenges that Belgium face in order to meet the 3% Objectives. These include a need for a major public funding injection in Belgium’s public research infrastructure, improved financial conditions for private R&D investments, an improved correlation between research executed in the public and in the private sectors and the establishment of a Belgian Research Area along the lines of the European Research Area.
Research & Innovation in Denmark

Structure of research system
Brief description

The main player in this system is the Ministry of Science, Technology and Innovation which coordinates all research and innovation policies and most of the funding.

On the agency level the two most important institutions are the Danish Council for Independent Research (Det Frie Forskningsråd), which takes care of researcher initiated "curiosity driven" research, and the Danish Councils for Strategic Research (Det Strategiske Forskningsråd), which is responsible for targeted research based on policy initiatives.

In addition to these two, there is also a separate foundation for basic science The Danish National Research Foundation (Danmarks Grundforskningsfond) and the Danish National Advanced Technology Foundation (Højteknologifonden). These two are not agencies as such, and are not included in the figure.

On research performing level the main actors are the universities, government research institutes (i.e. the ministry owned sectoral research institutes and the independent Approved Technological Service Institutes - GTS institutes), in addition to R&D in companies.

Erhvervsfremmestyrelsen (also known as Erhvervs- og Byggestyrelsen) is the National Agency for Enterprise and Construction (previously known as The National Agency for Enterprise and Housing) and supports regional development fora that include also public research and higher education institutions as can be seen in the 2006 Regional Policy Growth Report (Regionalpolitisk vækstredegørelse 2006, in Danish).

Vækstfonden is a government backed venture capital investment company. Vækstfonden provides funding to fast-growing Danish companies and act as a fund-of-funds investor in the private equity sector in the Nordic region.

The institutions of higher education and research can be divided into two different sectors:

- The university sector
- The college sector

The university sector includes 11 universities, 5 of which are multi-faculty universities. The other 6 specialise in fields such as engineering, education, veterinary science, agriculture, pharmacy or business studies. In addition, there are a number of specialist university-level institutions in architecture, art, music, etc. All university study programmes are research-based, and degrees are awarded at undergraduate and postgraduate level including doctoral degrees. (Source: The Ministry of Education)
Main research policy setting mechanisms

Government policy making and coordination

The main ministry responsible for research policy is the Ministry of Science, Technology and Innovation. The second most important Ministry in terms of R&D financing is the Ministry of Food, Agriculture and Fisheries. The Ministry of Economic and Business Affairs has also some influence on innovation policies.

The Ministry of Science, Technology and Innovation allocates at the moment app. 75 percent of the governmental appropriations to research and innovation. Siune and Aagard point out that co-ordination between sectoral ministries is done on an informal basis under the initiative of the Ministry of Science, Technology and Innovation.

To further improve coordination and to assist in implementing the legislation of the various current reforms, a Council for Technology and Innovation has been established. The council advises the Minister and takes decisions in a number of specific appropriation affairs (amounting to approximately DKK 525 (EUR 70) million in 2004). Members of the Council are appointed by the Minister and cover expertise in science, technology and business.
Below the Ministry level there is a system of **research advisory and funding councils**.

The main advisory council, the Danish Council for Research Policy (**Danmarks Forskningspolitiske Raad**), was established pursuant to a new Act on research advice on 1 January 2004. As provided in the Act the Council replaces the former Danish Council for Research Policy (**Danmarks Forskningsraad**). The Council advises the Minister for Science, Technology and Innovation on research policy, including advice on

- Framework conditions for research
- Research funding
- Large national and international research initiatives
- Development of the national research strategy
- Denmark's role in international research cooperation
- Researcher education and recruitment

The Parliament and other ministers may also ask for the Council’s advice. Advice may be given upon request or on the Council’s own initiative. The tasks of the council include giving general advice on Danish and international research policy for the benefit of society.

The research advisory and funding system is coordinated by the Coordination Committee (**Koordinationsudvalget for Forskning**), which has the responsibility of promoting co-ordination and co-operation between the research councils and between the research councils and the rest of the research and innovation system. The Committee is a consensus organ that has no authoritative role vis-à-vis the research advisory system. The Research Coordination Committee consists of the chairmen of the Council for Independent Research, the Council for Strategic Research, and the Danish National Research Foundation. Furthermore, two members are nominated by the Danish Rectors' Conference, one member is nominated by the Assembly of Director Generals of the Danish Government Research Institutes (**SEDIRK**), and one member by the Council for Technology and Innovation.

In Parliament (Folketinget) research policy is covered by the **Committee for Science and Technology** (**Utvalget for Videnskab og Teknologi**).

The objective of the **Danish Agency for Science, Technology and Innovation (DASTI)** is to promote research and innovation of high international standard for the benefit of the development of Danish society – financially, culturally and socially.

DASTI is an important key player in developments aimed at the overriding political goal of making Denmark a leading entrepreneurial and knowledge society with world-class educational programmes.

The Agency’s activities deal with, among other things, public research funding; researcher mobility; dialogue on priorities in research and technology initiatives; regionalisation of research and innovation; commercialisation of research; interaction
between knowledge institutions and the business community; innovation policy; EU research policy, research dissemination; improved ICT in Danish business and industry. In addition, there are activities pertaining to statistics about and documentation of Danish research and innovation.

The Danish Agency for Research, Technology and Innovation performs secretariat functions for a number of independent councils: the Board of the Danish Councils for Independent Research and the associated scientific research councils; the Board of the Danish Council for Strategic Research and the associated programme commissions and committees; the Danish Research Coordination Committee and the associated Danish Research Training Committee; the Danish Committees on Scientific Dishonesty; the Danish Council for Technology and Innovation and the Danish Research Policy Council. The Agency is also the operational gateway to the Ministry for both the Danish National Research Foundation and the Danish High Technology Foundation.

Furthermore, DASTI is responsible for Denmark’s participation in a number of international operational research organisations.

**Danish National Research Foundation**

The Government established the Foundation in 1991 with a capital of DKK 2bn. The Act decrees that the Foundation must pursue a conservative investment policy to obtain the highest income consistent with capital protection.

The income of the Foundation, and thus its possibilities for funding, are closely tied to the real interest rate. The Foundation forecasts the income for the years ahead under various assumptions as to interest and inflation. These calculations are adjusted regularly.

Since 1993 the Foundation has supported a total of 51 research centres and several minor research programs with a total expenditure of more than 2,3 billion DKK.

**The Objective of the Danish National Research Foundation**

The Danish National Research Foundation is an independent foundation that works to support Danish basic research regardless of subject area. The activities of the Foundation are regulated by law, and the purpose of the Foundation is to support the development of unique Danish research.

It is the position of the board that the best Danish basic research environments should have a possibility for extra support when and if expertise, creativity and the right constellation of people is present in combination. It is the policy of the Foundation to support research centres for longer periods of time.

These centres can be regarded as **Centres of Excellence** by international standards. The centres constitute large ventures by Danish standards. The selection of which centres to support takes place in open competition and based on international peer review of the
quality of the received applications. The Centre of Excellence grants make it possible to attract substantial foreign expertise to the Danish research communities.

As a supplement to the Centres of Excellence, the board of the Foundation has in the spring of 2005 decided to establish the Niels Bohr Visiting Professorship programme. The programme is designed to further the internationalisation of the Danish research environments.

**Centres of Excellence:** At present the Foundation is financing 36 centres of excellence with a total annual budget of about 250 million DKK.

**Visiting Professors:** The "Niels Bohr Visiting Professorship" was initiated in 2005 as a supplement to the Foundation's centres of excellence in order to further the internationalisation of Danish research. In December 2005 the Board chose 6 collaborative research projects, where foreign guest professors will contribute to the further strengthening of existing strong Danish research environments in the period 2006-2011. The investment in the internationalisation of Danish research environments will amount to 90.000.000 DKK.

**Research Training** the Foundation makes substantial funding available for the training of a new generation of researchers. More than 200 Ph.D.-students have over the years been funded by the Danish National Research Foundation and in 1997/98 two Ph.D. schools were set up:
- International Ph.D. School in Computer Science (BRICS), University of Aarhus
- The International Doctoral School for Bio-medical Science at Centre for Sensory-Motor Interaction, University of Aalborg

**Danish Register-Based Research:** Since 1995, the Foundation has implemented several initiatives in order to strengthen the infrastructure of Danish register-based research.

**Grants:** The Foundation primarily distributes grants to independent groups of scientists to form centres of excellence. A centre is headed by a director of research and can be granted up to 10 years of funding.

As a supplement to the centres of excellence, the Board of the Foundation has decided to establish the Niels Bohr Visiting Professorship in the spring of 2005.

The Danish National Research Foundation calls for proposals every 2-3 years via this home page, announcements the press and relevant journals and on the Danish research institutions. The Foundation does not support individual projects.

**Research funding in Denmark**

**Brief description**

The R&D expenditures of Danish industry are to a high degree funded by industry itself (86 percent), but also to a certain degree by foreign industry. Public sources, both national and EU funding, plays a rather minor role to industry. The R&D expenditures of
the public sector to a very limited degree fund industrial R&D. Of the public R&D expenditures universities and colleges receives most of the funding.

The total flow of funding used for R&D activities (funder or receiver in Denmark) includes more than the R&D activities of industry and the public sector institutions. Partly industry uses funding to purchase R&D services, both nationally and internationally, and partly national public funding is used for R&D activities undertaken abroad. Both these flows of funds are included in Danish research statistics. In 2003 the total "R&D budget" in Denmark was DKK 40.5 billion (€ 5.4 billion). Of this industry financed about DKK 25 billion (€ 3.4 billion), the public sector about 10 billion (€ 1.3 billion), public non-profit institutions about DKK 1 billion (€ 0.1 billion) and international funding nearly DKK 4 billion (€ 0.5 billion). Of this total about 10 percent was used for R&D undertaken abroad.

**National public research funding**

**Overview**

Denmark has a clear demarcation between bottom up research on the one hand and strategic research on the other. The advantage of this system is that the need for researcher and curiosity driven research as well as targeted research of social and economic importance becomes equally visible in the political landscape.


The [Council for Strategic Research](Det strategiske forskningsraad) administers strategic research programmes in areas of political priority. It funds research projects and gives advice to applicants. The Council is also contributing to increased university-industry collaboration.

These research councils manage approximately 10 percent of the public R&D expenditure. In 2005 the governmental R&D budget was about 10 billion DKK, of these 10 billion DKK received the research councils 1.241,8 Mio DKK, the universities received 5.079 Mio DKK, the sector research institutes got 1.048,9 Mio DKK and other research instutions got 440,5 Mio DKK. For more details look into the report [Indikatorer for Dansk forskning og innovation 2005, Table 8.5](#).

There is also an independent [Danish National Research Foundation](Danmarks Grundforskningsfond), which funds research of high international standard. Since 1991 the fund has allotted some DKK 3 billion (EUR 0.4 billion) to Danish research institutions. In 2005 it was supporting 33 research centres.
Basic research funding

The funding to academia and other organisations that conduct fundamental research not earmarked for specific thematic priorities is either transferred to the universities directly or channelled through the Council for Independent Research. The universities alone receive 51 percent of the total annual public appropriations for research in Denmark (2005).

The Council for Independent Research is an umbrella organisation for five research councils and supports research projects (competitive funding) based on the research initiatives of the researchers themselves. The five research councils include:
- The Research Council for Culture and Communication
- The Research Council for Nature and Universe
- The Research Council for Society and Trade
- The Research Council for Health and Illness
- The Research Council for Technology and Production

Thematic priorities and other targeted funds

The other part of the system funding Danish research is the Council for Strategic Research which finances research based on politically defined programmes. To allocate programme appropriations ad hoc committees are established.
Thematic priorities are in 2006:

- sustainable energy production and use of energy,
- correlations between food, nutrition and health,
- interdisciplinary application of nanotechnology, biotechnology and ICT.

The Danish Council for Strategic Research is allotting DKK 420 mill (EUR 56 mill) in 2006 to the Innovation Accelerating Research Platforms (see further details to the Platforms in the section Research Policy, subsection Current research policy goals) in following areas:

- DKK mill 98 to food, health, lifestyle and medicine resistance
- DKK mill 26 to health initiatives targeting foreign substances, including doping
- DKK mill 26 to biological production from renewable resources
- DKK mill 2.5 to animal experiments and ethics
- DKK mill 10.5 to renewable energy
- DKK mill 97.8 to renewable energy and the environment
- DKK mill 26 to water as a resource and an element of the natural environment
- DKK mill 97.8 to cross-sectoral use of nano-, bio- and informatin technologies
- DKK mill 26 to "hotspots" including new modes of production (includes creativity and innovation and the "experience economy")
• DKK mill 10 to citizens' IT safety (Compare: Announcement of the Council on the Web)

Together the two research councils receive about 12 percent of the total public appropriations for research in 2005 (compare: Dansk Center for Forskningsanalyse: Indikatorer for dansk forskning og innovation 2005).

Institutional funding

The R&D expenditure of the Government Intramural Expenditure (GOVERD) was 2.5 billion DKK (or 333 million Euro) in 2003. This amounts to 7 per cent of the Danish Gross Domestic Expenditure on R&D of this year. About 60 per cent of the GOVERD is funded though non-competitive funds - mainly basic allowances from the government. Additionally 20 per cent is funded by mission-oriented government funds. Only 2 per cent of the GOVERD is funded by the business sector.

The R&D expenditure of the non-for profit research organisations in Denmark amounted to 245 million DKK (32.7 million Euro) in 2003. The breakdown of the R&D expenditure of this type of R&D organisations by funding sources is almost identical with the one of GOVERD.

If we look at allocations to R&D over the Danish government budget, we see the following distribution of funds among institutional types (Mill DKK 2005, 2000 in brackets):

Universities and other institutions for higher education: Mill DKK 5079 / EUR 677 (2000:- 3619)
Other research institutions: Mill DKK 1489 / Mill EUR 199 (2000: - 1649)
Research Councils etc.: Mill DKK 1242 / Mill EUR 166 (2000:- 699)
Other (including Høiteknologifondet): Mill DKK 1737 / Mill EUR 232 (2000 - 2239)
International/abroad:
Mill DKK 466 / Mill EUR 62 (2000:- 677)
**Total: Mill DKK 10014 / Mill EUR 1335 (2000: 8883)**

Co-funding and indirect funding of private R&D

In 2003 12 percent of industrial R&D was financed by national industry, 2.4 percent by public sources and 12 percent by sources abroad. The funding from the public sector is particularly low in Denmark. For comparison the relevant figures for Norway is 10.4, Sweden 5.9 and Great Britain 10.9 percent).

35 percent of Danish companies bought R&D services in 2003. 3.1 percent of R&D performed by public R&D institutions was funded by Danish companies, compared to 6.6 percent for EU15. 52 percent of Danish companies actively involved in innovation and R&D was engaged in R&D cooperation with other companies in 2003. 32 percent was cooperating with public research institutions.
Important policy documents

1. **Action plan of the Danish Council for Strategic Research - Research that counts.** The Strategic Research Council (Forskningsstyrelsen, Ministry of Science, Technology and Innovation), 2004.

According to the action plan the Danish Council for Strategic Research will prioritise:
- Research related to the Innovation Accelerating Research Platforms (defined by the Government) e.g. in areas where a) Denmark has internationally recognized research environments, b) Denmark has internationally competitive business clusters and c) there is an obvious need for research-based solutions and where new technology may provide innovative breakthroughs.
- The build-up of Centres of Strategic Research focusing on collaboration between public research institutions and society in general;
- Initiatives to arrange conferences and meetings throughout Denmark to establish the necessary dialogue in collaboration with relevant players;
- Quality assurance of the research programmes under the auspices of the other Danish ministries while working to coordinate them with its research initiatives and their principles;
- To map the Danish research institutions' use of and need for infrastructure, and submit proposals for a strategy of collaboration on the prioritisation of research infrastructure, both nationally and internationally;
- To work for a prompt and significant expansion of funding in the areas of food and health, energy and environment and nanotechnology, biotechnology and IT, and in the cross fields between the disciplines in these three action areas, as well as allocating funding to Centres for Strategic Research with no particular thematic focus.

2. **Denmark's National Reform Programme.** Danish Government, 2005

The Danish government's strategy for structural reforms aims at improving the long-term potential for growth and employment within the framework of good social conditions and sound environmental and sustainable fiscal development.

Following issues are addressed:

1. Economic policies aiming at ensuring high and stable employment, sustainable public finances and good framework conditions for growth
2. Denmark as a knowledge society with following challenges:
   - To ensure increased private investment in research and development and better interaction with public research.
   - To double the number of PhDs.
   - To improve the primary and lower-secondary school system including strengthening evaluation and quality development processes.
   - To increase the number of students who complete a secondary education programme and, at a later stage, tertiary education programme.
   - To ensure continued improvements in the framework conditions for innovation and entrepreneurs.
   - To appropriate DKK 10 billion (1.34 billion EURO) for an increased effort in research, innovation, entrepreneurship and education until 2010.
3. Efficient competition and the internal market
4. Sustainability, the environment and energy
5. Employment policy
6. Continuous improvements of the public sector
Research and Development in Estonia

Characterisation of research systems and policies

Basic information

The main players of Estonian research system include public universities (a few private universities do operate in Estonia, but their focus is mostly on education, not research), technology companies (mostly focused on technology development, not research, though), and government policy and funding structures. In terms of research, public universities are really at the core of the system and account for the majority of research conducted in Estonia. Research policy in Estonia is generally seen as covering the university research, and innovation policy as covering private sector research. This is largely due to the fact, that nearly all basic research is conducted in universities and private sector focuses almost exclusively on product development and innovation.

Although there has been some progress over the past five years in increasing R&D funding, it has not been quite as significant as it was projected to be according to Knowledge-Based Estonia. Research and Development Strategy 2002-2006. The strategy projects total R&D investments on the level of 1.5% of GDP by the year 2006 with the government contributing a significant share of this as the private sector slowly increases its investment levels. The actual investment into R&D in 2006 is about two-thirds of what was expected (in 2004, total investments into R&D amounted to 0.91% of GDP) and is growing but slowly.

Estonian R&D policy is still largely lacking well-balanced co-ordination and there is a strong divide between the research policy side (Ministry of Education and Research) and the innovation policy side (Ministry of Economic Affairs and Communications). The result of this divide is somewhat reflected in the research and innovation system with either ministries focusing on their own activities and not really making major effort to link the academic research and business innovation. Nevertheless, some initial steps to promote inter-sectoral collaboration are yielding good results. The Ministries collaborate in their efforts to enhance the quality of Estonia's research infrastructure.

Estonia's research system has gone through major restructuring in the past 15 years, yet the process is far from being completed. The structural changes are continuing with new collaborative research systems being set up (Centres of Scientific Excellence, Competence Centres), and with further consolidation of the university system. All these processes are undertaken with the goal of increasing the quality of research and the competitiveness of the institutions. The main factor motivating such behavior is the extremely competitive nature of government research funding distribution.
Main research policy setting mechanisms

Government policy making and coordination

The two main ministries responsible for R&D and innovation policy are the Ministry of Education and Research, and the Ministry of Economic Affairs and Communications. These two Ministries are responsible for the general horizontal policies and infrastructure development for research and innovation, as well as for funding research in their area of expertise. Organisation of Research and Development Act assigned the responsibility for funding area-specific research to all ministries, but in reality only the Ministry of Agriculture is filling this task along with the two main Ministries.

The Ministry of Education and Research is responsible for research policy, which currently focuses mostly on the support of basic research in public research institutions (mainly universities) and on enhancing the quality and capacity of Estonian research infrastructure. The Ministry's work is supported by its expert policy advisory body - Science Policy Committee. In addition, the Ministry also receives advice from Science Competence Council on the distribution of the regular funding instruments. In EU related matters the Ministry collaborates with Archimedes Foundation, which functions as Estonian contact point for all EU programmes and projects (e.g. Framework Programmes, COST etc). Estonian Science Foundation is responsible for distributing grant financing and is therefore also the expert advisor on the relevant issues.

The Ministry of Economic Affairs and Communications is responsible for technology and innovation policy and works closely with business sector to better facilitate the emergence of technology-intensive economy. The Ministry is assisted by its expert policy advisory body - Innovation Policy Committee. In addition, the Ministry also relies...
heavily on the expert advice from its main implementing body - Enterprise Estonia. Enterprise Estonia staff works with all the target groups of national innovation policy programmes on a daily basis, and is therefore a valuable source of feedback for the Ministry.

The two Ministries collaborate closely with the Research and Development Council that advises the Government about all major research and development policy issues. The Ministries prepare proposals for approval by the Council and the Cabinet in collaboration with the Council's Secretariat. The Council is an instrumental expert body that brings together all the important organisations and stakeholders involved in and affected by research and innovation policy. The Council is chaired by the Prime Minister, which links it directly to the Cabinet. It also includes the three other most relevant ministers for research and innovation policy - the Minister of Education and Research, the Minister of Economic Affairs and Communications and the Minister of Finance. The logic is that if these 4 ministers manage to agree on a policy proposal along with most important academic and industry experts, then the proposal has a good chance of being approved by the Cabinet. The Council also includes the President of the Academy of Sciences, rectors of the two main universities, President of Estonian Chamber of Commerce and Industry and other experts. It thus has a very good mandate from all the three sectors.

**Research funding system**

![Estonian National R&D Funding System diagram](image-url)
Brief description

Majority of Estonia's research funding is determined and distributed by the Ministry of Economic Affairs and Communications and the Ministry of Education and Research. They determine the types of policies funded and assign numbers to specific funding channels.

The Ministry of Economic Affairs and Communications uses national programmes as its preferred channel of funding. The Ministry prepares the programme documents and funding numbers, and then Enterprise Estonia implements these programmes upon the instructions received from the Ministry, and distributes the funding to end users.

The Ministry of Education and Research has a slightly more complex funding system - it uses both national programmes and special funding streams. The only implementing agency the Ministry has is Estonian Science Foundation. The foundation distributes grant funding to individual researchers. The rest of funding is distributed by the Ministry itself following the advice of Science Competence Council. These funding streams are: targeted funding for research groups; base-line funding for research institutions; Centres of Scientific Excellence Programme that supports the activities of the Centres of Excellence; and two subject-specific national programmes that support research and data collection.

In addition to these two Ministries, all other Ministries are assigned the obligation to support research in their field of competence. Only one Ministry - the Ministry of Agriculture - has done this so far running now the second round of a programme that supports research and data collection in plant genetic resources.

National public research funding
Overview

The gross R&D expenditure in Estonia reached about 0.91% of GDP in 2004, approximately two-thirds of which is contributed by the government sector. Most of the government R&D expenditure flows pass through the Ministry of Economic Affairs and Communications, and the Ministry of Education and Research. Most of the funding is distributed through various national programmes, but the Ministry of Education and Research also distributes funding through targeted funding of research themes, grant funding for individual researchers and base-line funding for R&D institutions. The size of research policy budget is also notably larger than the budget of innovation policy. Total expenditure on R&D in 2004 was 82.7 million Euros (1.294 billion Estonian kroons), and the government expenditure on R&D was roughly 50.5 million Euros (790 million Estonian kroons).

National programmes are generally prepared for 2-4 years at a time, and usually include funding projects over the length of this period. In reality, however, these numbers can change significantly, because final budget numbers are always determined during annual budget negotiations with the Ministry of Finance. The Ministry of Finance is therefore
viewed as one of the most influential Ministries for research policy along with the Ministry of Education and Research and the Ministry of Economic Affairs and Communications. This is the very reason the Minister of Finance is included in the Research and Development Council, since this helps to keep the Minister better informed about why increased spending in research is so critical.

**Basic research funding**

There are three major funding channels for basic research and they are all distributed on a competitive basis, in principle.

1. Grant funding is distributed by [Estonian Science Foundation](#) to individual researchers on a competitive basis. These research grants are allocated once a year through a public competition where all researchers (must have at least PhD) can submit their research proposals. These proposals can suggest research projects lasting up to four years, but funding is still decided on an annual basis. In 2005, about €5.8 million (91.2 million Estonian kroons) was distributed in grant funding.

2. Targeted funding is distributed by the [Ministry of Education and Research](#) following the advice of Science Competence Council. Targeted funding goes to research groups of positively evaluated research institutions for research in specific thematic areas. Applications for targeted funding usually include projects extending through multiple years, but funding for every consecutive year is directly dependent on the positive assessment of the previous year's work by the expert panels of Science Competence Council. Targeted funding is the most sizeable research funding channel in Estonia with the budget of €14.7 million (230 million Estonian kroons) in 2005 and €16.8 million (263 million Estonian kroons) in 2006.

3. The most recently (re-)established funding channel is base-line funding distributed by the Ministry of Education and Research directly to research institutions. The funding is meant for the implementation of strategic development goals of research institutions, which basically means they are free to use the money according to their specific needs. One of the major expenses this funding is most likely to cover is the matching requirements of various ERA research projects Estonian research institutions participate in. The total budget for base-line funding was €4.1 million (64.4 million Estonian kroons) in 2005 and €5.1 million (80.11 million Estonian kroons) in 2006.

**Thematic priorities and other targeted funds**

According to [Knowledge-Based Estonia. Research and Development Strategy 2002-2006](#) there are three key areas of research prioritized in research and development policy:

- User-friendly information technologies (IT) and development of the information society - to promote the development of the information society where access to
information, and opportunities for its use in everyday life, is ensured for everyone, and the development of IT applications in enterprises encouraged;

- Biomedicine - to encourage the unification of clinical medicine and molecular biology research, whereby the resulting application should be used to improve public health and to develop enterprise in the biotechnology field;
- Materials' technologies - to encourage the use of new materials and equipment, and the development of related applied research and enterprise based on materials technologies.

No special programmes have been established, though, for the promotion of these priority areas and they are rather a suggestion for preferential choice. In reality, funding is distributed rather according to the quality and merit of the research project than its thematic area.

A few minor subject-specific programmes have been established, but the size of their budget is negligible and they are meant more for the support of the infrastructure of scientific knowledge. Three of these programmes are funded by the Ministry of Education and Research:

- "Language technology support for the Estonian Language 2006-2010" supports the development of language technology research, which is an interdisciplinary field combining information technology and linguistics. The 2006 budget of the programme was slightly below €0.5 million (7.3 million Estonian kroons).
- "Collections of Humanities and Natural Sciences 2004-2008" supports research on the rich historic collections of humanities and natural sciences Estonian research institutions and museums possess. The 2006 budget for the programme was about €0.8 million (12.9 million Estonian kroons).
- "The Estonian Language and National Memory 2004-2008" supports research focusing on the evolution of the Estonian language and national culture. The 2006 budget of the programme was slightly below €0.5 million (7.6 million Estonian kroons).

The fourth subject-specific programme is funded by the Ministry of Agriculture and it is called "Collection and Conservation of Plant Genetic Resources for Food and Agriculture for the Years 2002-2006" that supports scientific research and data collection in plant genetic resources.

**Institutional funding**

The non-academic research is mostly performed in private sector and mostly for product development purposes. Private sector research is supported by a couple of innovation policy programmes developed by the Ministry of Economic Affairs and Communications and implemented by Enterprise Estonia. These innovation policy programmes include:
• **R&D Financing Programme** that supports feasibility studies, and product development and applied research projects conducted by companies. The funding distributed in 2005 amounted to €8.1 million (126.8 million Estonian kroons).

• **Competence Centre Programme** supports the establishment of small R&D institutions operated together by a number of companies and universities. The goal of these Centers is to engage in applied research needed for the product development of their founders. Within the period of 2005-2006 funding contracts were signed with 5 Competence Centres with total programme funding amounting to about €6.4 million (99.8 million Estonian kroons).

The non-profit sector R&D expenditure levels are almost negligible, partially because no strong research centres have evolved in the non-profit sector.

**Co-funding and indirect funding of private R&D**

Innovation policy programmes that support private sector research generally require a specific level of contribution from the applicant side. This essentially means that nearly all the projects funded through these programs are co-funded projects.

**Competence Centre Programme**, for instance, covers only between 35% and 75% of the total costs of the projects launched in any Centre (the funding level varies according to the size of the companies involved in the Centre). This means that the companies have to contribute a significant share of funding to these Centres.

**R&D Financing Programme** has a similar type of arrangement. It funds between 35% and 75% of the project costs depending on the size of the company and the nature of research, and between 60% and 100% of the project costs if it is applied research conducted in a research institution.

**Centres of Excellence in Research**

In 2002, the Centres of Excellence Programme was launched in Estonia. The first ten centres, covering a wide range of research disciplines (gene and environmental technologies, analytical spectrometry, non-linear studies, behavioural and health sciences, physics, chemistry and material sciences, molecular and clinical medicine, basic and applied ecology, dependable computing, cultural history and folklore) were selected on the basis of open competition and foreign assessment. The next competition for centres of excellence will take place in 2006.

A centre of excellence consists of internationally recognised research groups working in close or complementary areas and performing research at a high level. A centre of excellence has a clearly defined common research goal and a positive impact on doctoral studies in its field of research. Research groups within a centre aim for synergy between different research disciplines.
Quality assurance

Estonia has had an independent system of quality assurance in place since the mid-1990s. Quality assessment is a continuous process consisting of four parts: institutional self-analysis; site visits conducted by a body of foreign experts; oversight by the autonomous Higher Education Quality Assessment Council (higher education) or Science Competence Council (R&D), which make decisions regarding study and research programmes of institutions; and institutional self-improvement activities.

Active assessment of higher education study programmes began in 1997, research evaluation in the spring of 2000. Higher Education Accreditation Centre, a member of the European Network of Agencies of Quality Assurance (ENQA), is responsible for organisation of both higher education and research evaluation and making accreditation and evaluation decisions public.

To carry out the evaluations the evaluation committees are formed on the recommendations of which the respective councils make proposals to the Minister of Education and Research regarding institutions and their operation. These committees are made up of representatives of research and development institutions as well as of researchers from foreign countries, and the local experts who participate in the evaluation visits as observers. The participation of foreign researchers is intended to guarantee the greater objectivity of the evaluation.

All costs of the evaluation are covered by the Ministry of Education and Research from the resources allocated from the state budget.

QA in R&D Institutions

In connection with the accreditation process of study programmes, research evaluation started in the spring of 2000. The purpose of research evaluation is:

- to judge the activities of research and development institutions and the research topics implemented by the them to ensure the state funding for internationally recognised research;
- to identify deficiencies in the activities of research and development institutions;
- to give recommendations on the development concerning research and development areas important to the state.

- The evaluation is organised by research areas or specialties and is conducted by an evaluation committee consisting of four members, including at least three external experts. Evaluated research and development institutions submit a self-assessment report by the term established by the Minister of Education and Research.

Institution must enable the evaluation committee to visit the institution, to interview scientists and submit additional documents when required. Evaluation Committee will
then submit in writing the summary decision containing judgement based on the following criteria of evaluation:

- innovativeness of the results of research;
- quality of research;
- strategy and perspective of research;
- competence of research groups and their capability for development; success in applying for funds and grants;
- national and international co-operation;
- implementation opportunities for the research results and their importance for the Estonian society;
- correspondence of R & D on institutional level.

Evaluation committee submits the evaluation judgements on a four-point scale: excellent (väga hea), good (hea), satisfactory (rahuldav), and unsatisfactory (mitterahuldav). Unsatisfactory judgement is a basis for non-evaluation of the research and development institution. Estonian Scientific Competence Council will then make a proposal of evaluation (evaluated/not evaluated) on the basis of the results of the evaluation, draft proposals and recommendations made by the evaluation committee.

**R&D strategies**

At present, the main guideline and document for Estonian R&D policy is the Estonian Research and Development Strategy 2002-2006, *Knowledge-based Estonia*, which was approved by the Estonian parliament in December 2001. The strategy formulates the aspiration of Estonia to become a knowledge-based society where research and development are valued highly as one of the preconditions for the functioning and development of the entire society.

The year 2006 saw the finalisation of the new research, development and innovation strategy document for 2007–2013, *Knowledge-based Estonia II*. After adoption by the Riigikogu (Parliament), it will lay the legal foundation for R&D strategy in the coming years. The draft strategy sees Estonia as an innovative, highly competitive, successful country within the European research and economic area. The document emphasizes the necessity for a longterm perspective in R&D investments, in order to better weigh the impacts and requirements arising from external factors (global trends in scientific, technological and economic development; the internationalisation of research, etc.) as well as internal factors (the implementation analysis of the previous strategy document, the need to apply scientific knowledge to meet socio-economic challenges, etc.). The strategy highlights the key role of human resources and the transfer of knowledge in raising the quality of R&D and building the innovative capacity of industry. It also devises the instruments for achieving the identified aims.

*Estonian Ministry of Education and Research. Estonian Research and Development Strategy 2002 - 2006*
Important policy documents and legislative acts


Republic of Estonia Education Act. Consolidated text May 2004

Organisation of Research and Development Act. Consolidated text Dec 2003

Universities Act. Consolidated text May 2004

Institutions of Professional Higher Education Act Consolidated text May 2004

University of Tartu Act Consolidated text May 2004


Private Education Institution Act Consolidated text May 2004

Vocational Educational Institutions Act Consolidated text May 2004

Study Allowances and Study Loans Act Consolidated text May 2004

Recognition of Foreign Professional Qualifications Act
Consolidated text May 2004
R&D and Innovation in Finland

Basic characterisation of the research system

Stability at the level of the policy governance system and a widely spread consensus among the key innovation actors is probably one of the principal factors contributing to the observed past success in the Finnish innovation policy. A particular characteristic for the governance system appears to be trust and mutual understanding concerning the factors facilitating economic growth and competitiveness.

The organisational structure of the Finnish innovation and research system consists of four operational levels. The highest-level governance takes place at the Parliament and at the National Government. The Government is supported in matters related to research, technology and innovation policy by a high level advisory body, the Science and Technology Policy Council of Finland. The Science and Technology Policy Council of Finland and the Committee for the Future of the Parliament provide the official forum at the highest policy-making level for policy debate.

The second level consists of the ministries. The key ministries with respect to research policy are the Ministry of Education and the Ministry of Trade and Industry. While there is a sectoral division of labour between science and technology policy, over the past years the cooperation has increased significantly between these two ministries in issues related to science and innovation. This is partially due to their similar and joint objectives to promote research funding in government budget, for which their close participation in Science and Technology Policy Council has provided a good platform. As a general trend, there is a move from narrowly defined science and technology policy towards a broad-based innovation policy incorporating issues of research policy, technology policy, and elements from various other policies.

The third level consists of the R&D funding agencies, Academy of Finland and Tekes, the Finnish Funding Agency for Technology and Innovation. Academy of Finland funds basic research through competitive grants. While the majority of Tekes funds is allocated to R&D projects carried out by companies, Tekes is also a large financier of university research.

At the fourth level there are the organisations that conduct research: universities, public research institutes, private research organisations and business enterprises.

Overall, research policy occupies a key position in the Finnish Government programme. In 2005, government budget appropriations on research and development amount to EUR 1.59 billion. Government R&D expenditure as a proportion of overall government spending exclusive of debt servicing stands at 4.5% (Government R&D funding in the state budget 2005). With a total of EUR 5.0 billion spent on research and development, the GDP share of R&D expenditure was 3.5 per cent in 2003. The expenditure is estimated to have increased to EUR 5.4 billion in 2005 (http://www.research.fi/k_tk-menot_en.html).

The institutional structure of the Finnish R&D system is presented in this picture. The bulk of the research and development in Finland is carried out by business enterprises with their own funds, i.e. about 70% of the national R&D effort. The use of the national
innovation system in Finland has been very pragmatic. The system involves all those elements which contribute to the generation, diffusion and application of new knowledge.

**Main research policy setting mechanisms**

**Government policy making and coordination**

*Science and Technology Policy Council*
An important institution for building and maintaining consensus has been the Science and Technology Policy Council, which has operated under the leadership of the Prime Minister. Even though the Council has meagre resources and is basically an advisory body, it still plays an important role in the formulation and promotion of basic guidelines for the Government, and in the coordination of the science and technology policy-related tasks handled by different ministries. In addition, it has ensured adequate continuity for science and technology policy from one government to the next. Taking care of framework conditions has been the essence of the Council’s contribution. It has provided general support for active science and technology policy across the entire economy. Alongside its main tasks, growing importance has been given to collaborative relations with other societal sectors, such as economic, industrial, labour, environmental and regional policies and social and health care. The Council has also commissioned or otherwise initiated a large number of evaluations from the very beginning of 1990’s and
is carefully following the operational and structural development of public research. In this respect, the Council works as a supervisory body to the functioning of the Finnish research and innovation system and ensures the quality of its assessments. The Science and Technology Policy Council of Finland was established in March 1987. New Decree on the Science and Technology Policy Council of Finland 27 October 2005. **Current Term 1.3.2005 - 29.2.2008**

The remit of the Council shall be to assist the Government and its ministries by:

- following international developments in research and technology and the development needs they cause in Finnish research and technology
- addressing major matters relating to science and technology policy and preparing plans and proposals concerning them for the Government;
- addressing the overall development of scientific research and researcher training;
- addressing the development and utilisation of technology and technology impact analysis;
- addressing important matters relating to international science and technology cooperation;
- addressing the development and allocation of public research and innovation funding;
- addressing important legislative questions concerning research, technology and scientific education; and
- taking initiatives and putting forward proposals in matters within its remit to the Government and its ministries.

**Structure of the Council**

The Science and Technology Policy Council is chaired by the Prime Minister. The membership consists of the Minister of Education and Science, the Minister of Trade and Industry, the Minister of Finance, and 0-4 other ministers appointed by the Council of State.

In addition to them the membership includes ten other members well versed in science and technology. These members must include representatives of the Academy of Finland, the National Technology Agency of Finland, universities and industry as well as employers' and employees' organisations. The Council of State appoints the members for the term of the Parliament.

**Subcommittees**

The Council has a science policy subcommittee and a technology policy subcommittee with preparatory tasks. These are chaired by the Minister of Education and Science and by the Minister of Trade and Industry, respectively.

**Secretariat**

The Council's Secretariat consists of one full-time Secretary General and two full-time Chief Planning Officers. They are appointed for four-year term. The clerical tasks are taken care of at the Ministry of Education.
Agencies and organisations in research

Research-related tasks in the Ministry of Education sector are handled by agencies and institutes subordinate to the Ministry, expert bodies appointed by the government or the Ministry, and partner organisations, notably the Academy of Finland, the National Archives Service, the Research Institute for the Languages of Finland, and the Repository Library.

The Academy of Finland is an important source of research funding. The Academy finances a wide range of basic research, which underpins innovative applied research and the utilisation of research findings. Most of the Academy funding is channelled to university research. The Academy, jointly with Tekes, administers EU research programmes and international research organisations in Finland.

The Academy of Finland is an expert organisation on research funding. The Academy seeks to enhance the quality and reputation of Finnish basic research by research funding allocated on a competitive basis, by systematic evaluation and by influencing science policy.

In 2005, Academy support for research at Finnish universities and research institutes amounted to EUR 224 million. This represents more than 13 percent of total government research funding. Each year Academy-funded projects account for a total of some 3,000 researcher-years.

The wide range of high-level basic research funded by the Academy of Finland provides a sound basis for an innovative applied research and the exploitation of new knowledge.

The Academy's operations cover all scientific disciplines, from archaeology to space research and from cell biology and psychology to electronics and environmental research.

Tekes, the National Technology Agency of Finland, is the main organization for applied and industrial R&D in Finland. Tekes supports applied and industrial R&D with about 380 million euros annually. The funds are awarded from state budget.

Tekes’ primary objective is to promote the technological competitiveness in Finnish industry and the service sector by technological means. Activities should diversify production structures, increase production and exports, and create a foundation for employment and social well-being.

Tekes offers excellent channels for cooperation with Finnish companies, universities and research institutes. Tekes’ technology programmes aim at gaining new technology expertise and product development options in the important business areas for the future.

The programmes also offer good frameworks for international R&D cooperation. Currently Tekes has 24 ongoing technology programmes with total value of 1.3 billion euros.
Tekes coordinates and offers financial support for participation in international technology initiatives including EU research programmes, EUREKA, research activities of OECD’s energy organization IEA (International Energy Agency), European Cooperation in Scientific and Technical Research (COST), European Space Agency (ESA) and Nordic Cooperation.

Sitra, the Finnish National Fund for Research and Development, is an independent pioneer, a neutral public fund answered for by the Finnish Parliament. Sitra's operations are mainly financed through income from endowment investment and project finance.

Sitra promotes economic prosperity in Finland through venture capital investment in technology companies and funds as well as by developing new and successful business operations. Through its research, training and innovative projects, Sitra contributes to the conditions of societal decision-making.

Sitra projects provide information on the future challenges faced by society and develop operative models as a basis for new solutions.

The National Archives Service is an expert and service organisation which ensures that archival material of great importance for the individual and society is preserved in a compact form and is easily available for use. The National Archives Service is responsible for securing the preservation of and access to documents of prime relevance to our national heritage.

The Research Institute for the Languages of Finland studies the Finnish, Swedish, Saami, Romany and Sign languages. It advises and guides in language problems and keeps various linguistic research archives, materials and an extensive linguistics library for the use of researchers.

The Repository Library receives and preserves materials transferred from research and public libraries and makes them available to users.

Expert bodies in research

The National Advisory Board on Research Ethics is an expert body appointed by the Ministry of Education to make proposals and issue opinions on legislative and other matters concerning research ethics.

The Committee for Public Information follows achievements in science and scholarship, arts and technology in Finland and abroad and developments in national and international knowledge.
Evolution of the research governance structures
Overview of evolution

During the recent years, a lot of emphasis has been placed on the structural development of the Finnish research system. Many development activities are still at a preliminary stage or under a review, but in other areas of development decisions have already been taken as how to improve the functioning of the research system. The main development priorities are presented in the Government Resolution on the Structural Development of the Public Research System. They are based on four assessments initiated by the Science and Technology Policy Council:

All the Universities in Finland are state owned and financed from the budget of the Ministry of Education. It has been suggested that condensing the university would be beneficial for the quality of the Finnish research system (Neuvo 2005). In 2005 the Science and Technology Policy Council of Finland decided that the number of universities will not be increased in the future and existing universities will be formed into larger operational entities.

Also the structure of the sectoral research institutes is under review. Based on a recent assessment of the sectoral research system (Huttunen 2004), the Science and Technology Policy Council set a working group to define the changes to be implemented in the public research institutes.

Intermediaries have not traditionally been considered as part of the Finnish innovation and research system. In 2005, an assessment on the intermediaries recommended, that they be closer integrated as part of the innovation system (Koskenlinna 2005).

Finally, the funding frames for biosciences research were decided in 2005 based on the work of a working group (Jäppinen 2005). The working group recommended that the operations of the five Finnish biotechnology centres be supported.

Relation between public and private actors

Public private partnerships are well integrated into the Finnish research system. Rather than being organised as separate structures, they are part of the governance of the public research system. Typical examples include industry representation in the Science and Technology Policy Council and in the board of the Academy of Finland. Also Tekes technology programmes are public private partnerships by nature. Approximately half of programme budgets is financed by Tekes, and the other half by industry.

Science - industry links

The linkages between science and industry are currently being shaped by legislative reforms associated with the role of universities. The financial autonomy of universities is being increased through legislation in order to promote national and international networking and expertise at the highest level. The transfer of immaterial property rights
from universities to business companies in exchange for share ownership is expanded and made more flexible through legislation. Work is ongoing to look into the possibility of raising the ceiling for tax exempt donations from business to universities.

A Government Bill (HE 259/2004) concerning, among others, inventions made at universities has been submitted to Parliament in 2004, with a view to intensifying the use of results of research by clarifying the rights and compensation policies associated with them. Furthermore, the Act on the State Budget has been so amended that it is now easier for limited companies set up by universities to make commercial use of research results.

In addition, the public research financing will be increased. Most of the extra investment in research from the public sector will be channelled into competitive funding through Tekes and the Academy of Finland. There is a broad consensus in Finland that competitive funding is the best way to activate businesses and public research institutes to tackle more challenging R&D projects and to encourage them to step up their investment in research (The Lisbon Strategy for Growth and Jobs - the Finnish National Reform Programme 2005-2008).

Role of scientific umbrella organisations

There are few scientific umbrella organisations in Finland. In this respect the relevant organisations include different types of associations and interest groups such as the Finnish Council of University Rectors, the Rectors Conference of Finnish Polytechnics (ARENE) and the Finnish Union of University Professors. These associations do not have a formal role in the governance of the Finnish research system but, rather, represent certain stakeholder groups influenced by research policy. The impact of these organisations on research policy varies. During recent years, they have contributed for instance to the development of the instruments in supports of research careers, the development of university administration, and the legislative reform concerning university inventions.

Research funding in Finland

Brief description

The main flows of government R&D funds are presented in the organogram for the year 2005. The figures are presented in million euros. The first level presents the government R&D appropriations for the Ministry of Education, the Ministry of Trade and Industry and other Ministries. The flows of funding from the Ministries to funding agencies, universities, research institutes and business enterprises are presented. The percentage indicates the share of organisations’ total government appropriation allocated for the given organisation (type). The information regarding the Ministries is based on the ‘Government R&D funding in the state budget 2005’ published by Statistics Finland, and figures for the Academy of Finland and Tekes are based on the 2005 annual reports of the respective organisations.
Funding flows

### National public research funding

**Overview**

In 2005, government budget appropriations or outlays on research and development amount to 1.59 billion euros. Increase from the previous year is 56 million euros, which in real terms corresponds to 1 per cent. Government R&D expenditure as a proportion of overall government spending exclusive of debt servicing stands at 4.5%. The proportion of government R&D expenditure of GDP is approximately 1%.

For the FY 2005, the Ministry of Education (MoE) received by far the greatest amount of government R&D funds among the ministries; altogether 672 million euros. This represents 42.1% of the total government R&D funds (with a real annual increase of 1.0%). In the administrative field of the Ministry of Education are all the universities (20) and the Academy of Finland. Universities received 417 million euros, which corresponds to 62% of direct public research and development funding allocated by the MoE. The Academy received almost 224 million euros from Ministry of Education to be granted for basic research on the basis of competition.

In terms of research funding, the Ministry of Trade and Industry (MTI) is the second most important ministry in Finland. Its share of the total funding in 2005 was 546 million euros, nearly 35% of the total (with a real annual increase of 0.5%). Up until 4-5 years
ago its share was still in pair with that of Ministry of Education, while recent increases in university and basic research funding have decreased MTI’s relative importance. Under the administrative field of MTI areTekes (448 million euros) and several research institutions (with 75 million euros of budget R&D funding).

The second tier ministries in terms of research funding are the Ministry of Social Affairs and Health (116 million euros or 7% of total) and the Ministry of Agriculture and Forestry (99 million or 6% of total). The other ministries, in order of their research volume, are the Ministry of Defence (53 m€), Ministry of Transport and Communications (32 m€), and Ministry of the Environment (26 m€). All other ministries fund research with volume of less than 15 million euros annually. Research Institutes received 177 million euro (47%) of public R&D funding allocated by these Ministries (Government R&D funding in the state budget 2005).

In 2005, Tekes funding decisions totaled up to nearly 430 million euros, a source of funding for more than 2 100 projects. Selective project funding is the basis of Tekes operations. Funding and expert services are channelled to technological R&D projects run by companies, research institutes, and universities. Of total funding decisions made, 250 million euros were allocated for projects at companies (58%), 116 million euros for universities (27%), and 43 million euros (10%) for research institutes (Tekes annual review 2005).

The overall funding volume of the Academy was 219 million euros in 2005. Universities received 167 million euros, or three fourths of the funding, and research institutes 17 million euros (8%).

**Basic research funding**

There is an increasing trend in the research funding of Finnish university sector. In 2003, the research expenditure of universities amounted to EUR 976 million with an annual increase of EUR 51 million. Increases in the core funding from the government budget were EUR 41 million, corresponding to 81 % of the increase. (It should be noted that the figures presented also include the funding from research programmes that is by nature earmarked to specific priorities.)

In total, 45 % of the funding of university research expenditures consisted of core funding, the share of external funding being 55%. The largest external financer of research is the Academy of Finland. It provided one fourth of total external funding. The funding from Tekes decreased and amounted to EUR 75 million (14 % of external funding). Private companies provided research funding for EUR 56 million (10%).

**Thematic priorities and other targeted funds**

The main instruments for providing targeted research funding include the research programmes of the Academy of Finland as well as the Centres of Excellence programme, also funded and coordinated by the Academy. These are described below:
The research programmes of the Academy (see for instance Systems Biology and Bioinformatics, SYSBIO or Social Capital and Networks of Trust, SOCA) composed of a large set of individual projects. Academy’s research programmes have been seen as tools for promoting a new kind of research culture that revolves around diverse and multilayered interaction, networking and cooperation. In particular, they have increased multidisciplinarity in Finnish university research. They provide an important mechanism for developing targeted basic research as well as domestic and international cooperation among academia. Academy has annually around 20 research programmes going on, each running typically for three years (as compared to Tekes average 4.5 years) and from 2003 onwards for four year periods in order to suit better post-graduate training needs. Both domestic and international cooperation have increased in recent years in the funding of research programmes. International cooperation is in fact, a specific target for the research programmes by the 2003 strategy of the Academy. As one consequence, the need for coordination between different funding mechanisms, differentiating interests, decision-making processes and time frames has also increased. This is often seen as the most important hurdle for international research cooperation at programme-level. In the funding of its research programmes, the Academy had cooperation with 26 private and public bodies. The Academy has taken active steps towards international networking and research programmes. Since 1995, the Academy has also funded and coordinated national centres of excellence in research (CoE), again often in collaboration with Tekes and other organisations. For 2000-2005 term there are 26 CoEs and for the partially overlapping term of 2002-2007, there are another 16 CoEs. Four of these CoEs receive support for co-operation with National Natural Science Foundation of China. Furthermore, from 2003 onwards there has been a pilot of Nordic Centres of Excellence Programme focusing in the global change research and funded jointly by Nordic Natural Science Councils, Nordic Councils of Ministers and the Nordic Academy of Advanced Study.

Institutional funding

The total R&D expenditures of Finnish sectoral research institutes amounted to 515 million in 2003. The share of core funding from the government budget was EUR 284 million or 55%. The share of external funding was EUR 232 million (45%), of which 42% was provided by the government, 29% by domestic companies and 8% by other domestic sources. In addition, 21% of external funding came from international sources.

Co-funding and indirect funding of private R&D

During recent years, the public share of R&D funding has decreased due to the rapid growth of the Finnish electronics industry. In 2003, total R&D expenditures in the private sector were EUR 3.5 billion, of which the share of public funding was EUR 181 million or 5.5%. A large majority (85%) of public sector financing was provided by Tekes (Statistics Finland 2004).

The R&D funding instruments of Tekes can be divided in two categories. Tekes provides R&D funds for individual projects both directly as well as through technology
programmes. The share of technology programmes of total R&D funding was 41% in 2005 (Tekes Annual Review 2005).

The national technology programmes organised and funded by Tekes are a mechanism to allocate resources on important development areas. In the end of 2005 there were 25 Tekes technology programmes under way, which means that many of the programmes are minor even by Finnish standards. The programmes are not generated by a centralised strategic planning mechanism. Initiatives for new programmes come from universities, research institutes, firms, industry associations, etc., and they are dealt with informally or semi-informally in various cooperation bodies with representatives from these organisations.

Tekes technology programmes are used as funding instruments to direct national research and development efforts of enterprises, research institutions and universities into selected technologies, priority themes or similar missions. Compared to broad, openly managed research programmes and networks, Tekes technology programmes are in principle target or mission oriented schemes.

The size and focus of Tekes technology programmes varies considerably across the programme portfolio. The duration of programmes is usually between 4-6 years and their budgets range from few million euros to over two hundred million euros. Tekes typically funds approximately 50% of the programme budgets (see TrendChart for more information on Tekes technology programmes).

Research performers
Universities
Finland has an exceptionally large network of universities and polytechnics. In 2003 there were around 170 000 degree students in 20 universities and 160 000 students in 31 polytechnics, having representations in 82 locations around Finland. All Finnish universities are publicly owned, while the polytechnics can be private, semi-private or public institutions. Finnish municipalities are important owners of polytechnics.

Each five years, the Ministry of Education prepares a Education and Research Development Plan, which forms the key document for the development of Finnish universities. This plan is also adopted and endorsed by the National Government, setting out the specific objectives and for the work and operation of universities. It is then left for the universities to rather independently implement the relevant policies. The Ministry of Education then negotiates bi-annually with each university on their results, directions and funding.

Public research organisations

There are in total 20 government research institutes in Finland, with a total research volume of around 470 million euros (2004). Their total number and also the volume are very high in international comparison. Most research institutes are sector specific and provide information, testing, etc. for the fields and purposes of their relevant sector ministries, with one main exception – VTT. The Technical Research Centre of Finland (VTT) is by far the largest research institute with personnel of around 3000 and a
research volume of some 212 million euros. It is also clearly a multisectoral contract research organisation (only some 30% of is direct budget funding). On average, just over half of the public research institutes' financing comes from the state budget.

**Private research performers**

The largest industry-owned research institutes operate in the ICT –sectors (Nokia Research Center) and in the pulp and paper sector (Oy Keskuslaboratorio – Central Laboratorium Ab). The latter one being a shared institute of various industrial operators. It is typical to the Finnish sectoral research however, that besides these few exceptions, there are hardly any other privately or industry-owned research institutions in Finland. The reason to this is quite obvious: The Technical Research Centre of Finland, VTT has been dominantly large and successful in most industrial sectors, providing little need, incentive or possibilities for the creation of private research establishments.

**Important policy documents**

**Government Resolution on the Structural Development of the Public Research System 2005.**

The government resolution defines how the organisations steering, financing and implementing research are developed during the next years. The resolution addresses different levels of the Finnish research system: the system level, decision-making and steering organisations, universities and polytechnics, sectoral research and government research institutes, intermediaries, and monitoring and evaluation of the implementation of the resolution.


A general approach underlying the development measures of the plan is to develop the education and research system with a view to a balance and interaction between its different sectors. The objectives stressed by the development plan include the following:

1. International cooperation at the different level of the research system is enhanced.
2. Public R&D financing for higher education institutions will be developed to promote national and regional innovation as well as to respond to the development needs of businesses and welfare service producers.
3. Public support will be directed for promising research fields with major importance to Finland, particularly for the development and internationalisation of centers of excellence. This objective will be supported both by increasing the funding of both the Academy of Finland as well as the university core funding.
4. Impact analysis, evaluations of the research system as well as foresight methods will be further developed to strengthen the national knowledge base for science policy.
**The Irish R&D and innovation system**

Ireland has many of the characteristics of a newly industrialised country in terms of its research, technological development and innovation structure. For example, it has no prestigious, long established technological universities, which is a characteristic of the education landscape in continental Europe and the US. In the 1960s, Ireland established two new technological universities and a network of regional technical colleges, now called Institutes of Technology (IoTs). The latter are mainly teaching institutes with a growing research capability. Furthermore, Ireland has very few public or private research bodies. The largest is TEAGASC, the agricultural research and development body.

Approximately 90% of fundamental research is performed within the university sector. Neither indigenous industry nor foreign-owned industry (in their Irish operations) performs basic research. Nevertheless, the recent commitment to fundamental research at national level is impressive. Unprecedented resources have been made available for selected research areas of strategic importance, mainly through the Technology Foresight initiative and the Programme for Research in Third Level Institutions (PRTLI).

Under the National Development Plan (NDP) 2000-2006, the Irish Government is allocating a substantial investment in Research Technological Development and Innovation (RTDI). Total overall expenditure in the NDP amounts to €5 billion of which the RTDI element amounts to €2.5 billion, some 50% of the total expenditure in the Plan.
The structure of the research and development system has changed since the publication of the first White Paper on Science, Technology and Innovation in 1996. The present system was agreed by the Government in June 2004.

It consists of four main policy actors:

1. The Cabinet Sub-Committee on Science and Technology: The Sub-Committee includes the Taoiseach (Prime Minister) and Tanaiste (Deputy Prime Minister) and is composed of ministers whose Departments have a significant research agenda.

2. The Inter-Departmental Committee on Science, Technology and Innovation: This Committee is chaired by the Minister for Enterprise, Trade and Employment and consists of senior civil servants from the main research spending Government Departments and the Chief Science Adviser (see 3 below). Its role is to assist in the prioritisation of science, technology and innovation expenditure across Government Departments and to ensure a "joined-up Government" approach to science and technology.

3. The Chief Science Adviser: This position was created in June 2005 and the role of the Chief Science Advisor is to provide independent expert advice on any aspect of science, technology and innovation as requested by the Government. The Chief Science Adviser formerly reports to the Cabinet Sub-Committee on Science and Technology and also participates in—but is not a member of—the newly formed Advisory Council for Science, Technology and Innovation (see 4 below).

4. The Advisory Council for Science, Technology and Innovation: This twelve member council drawn from industry and academia replaces the former Irish Council for Science, Technology and Innovation and its functions are to act as the primary interface between stakeholders and policymakers in the Science, Technology and Innovation (STI) arena, contributing to the development and delivery of a coherent and effective national strategy on STI and to provide advice to Government on medium and longer-term policy for STI and related matters.

Main research policy setting mechanisms

Government policy making and coordination

Following a government decision in June 2004, a new set of science and technology structures were announced. At the apex of the structure is the Cabinet Sub-Committee on Science, Technology and Innovation which is chaired by the Minister for Enterprise, Trade and Employment. Below the Cabinet Sub-Committee are the Office of the Chief Science Adviser and the Inter-Departmental Committee on Science, Technology and Innovation (which includes representatives of the main research spending government departments). The latter has a direct line of responsibility to the Cabinet Sub-Committee whereas the input of the Office of the Chief Science Adviser to the Cabinet Sub-Committee is more of an indirect nature. The Office of the Chief Science Adviser and the Inter-Departmental Committee have a reporting relationship with each other.

Below both organisations in the science and technology structure is the newly created
Advisory Council for Science, Technology and Innovation. It provides inputs to both the Office of the Chief Science Adviser and the Inter-Departmental Committee on Science, Technology and Innovation.

Forfas, the national policy and advisory board for enterprise, trade, science, technology and innovation, provides a supporting role to both the Office of the Chief Science Officer and the Advisory Council for Science, Technology and Innovation.

The two main ministries or government departments with respect to research spending are the Department of Enterprise, Trade and Employment and the Department of Education and Science. The Department of Enterprise, Trade and Employment has responsibility for funding in the business sector and also provides the funds for Ireland's Technology Foresight Investment in biotechnology and ICT which is administered by Science Foundation Ireland. The main research and technological development and innovation policy making unit within the Department is the Office of Science and Technology.

The Department of Education and Science through the Programme for Research in Third Level Institutions (which is administered by the Higher Education Authority) funds research in third level institutions.

The two research councils, the Irish Research Council for Science, Technology and Engineering (IRCSET) and the Irish Research Council for the Humanities and Social Sciences, providing funding for post-graduate research.

A new committee, the Research Funders committee, has been established under the chairmanship of the Chief Science Adviser and its members consist of the main research funding and policy organisations such as Forfas, the Higher Education Authority, Science Foundation Ireland, and the Department of Agriculture and Food. Its focus is to ensure high level co-ordination between the major agencies. Another grouping, the Standing Committee of Research Funding Bodies, has similar but smaller membership and mainly concentrates on operational matters.

A number of high level advisory bodies such as the National Competitiveness Council and the Expert Group on Future Skills Needs provide advice and guidance on issues relating to their areas of remit to research policy-makers.

The new Strategy for Science, Technology and Innovation 2006-2013 gave notice of the Government's intention to set up two new organisations, Technology Ireland and the Higher Education Research Group, to assist in the co-ordination of the implementation of the strategy.
Research funding system

Brief description

The Irish public research funding system comprises a number of funding bodies, each of which report to individual Government departments. The Office of Science and Technology (OST) which is located within the Department of Enterprise, Trade and Employment has responsibility for the overall national science budget.

The two main research funding organisations are:

- Science Foundation Ireland (SFI) was established in 2000 to administer Ireland's technology foresight fund (€646 million) to support academic researchers and research teams in the fields underpinning two broad areas, biotechnology and Information Communications Technology. It operates under the auspices of the Department of Enterprise, Trade and Employment.

- The Higher Education Authority (HEA) is the funder of the HEA Block Grant which provides the necessary floor for research funding in the third level sector and the Programme for Research in Third Level Institutions (PRTLI) which provides support for institutional strategies, inter-institutional collaboration, large-scale research programmes and infrastructure. A total of €605 has been provided to the higher education sector under the PRTLI during the period 1999-2006; a substantial amount of this funding was provided from private philanthropic sources including Atlantic Philanthropies. The HEA reports to the Department of Education and Science.

Other funding organisations include the Irish Research Council for Science, Engineering and Technology whose Embark Initiative which provides funding for post-graduate research students and sectorally-focused research funding and performing agencies such as the Marine Institute, the Health Research Board, the Environmental Protection Agency and Teagasc (the agricultural research body).
National public research funding
Overview

The most recent available data shows that the total State funding of science and technology (S&T) activities from government departments, agencies and offices increased by 9.7% between 2003 and 2004, from €1.88 billion to €2.06 billion. Total State funding of S&T includes expenditure by the exchequer, expenditure by the EU and finally receipts from the earned income of activities. State funding is estimated to have risen by a further 6.5% in 2005 to total €2.20 billion.

The largest contributor to the overall State S&T budget in 2004 was the exchequer, which accounts for over 86% of the total spend. Exchequer funding for science and technology activities increased by €130.5 million (7.9%) compared to 2003, to total €1.78 billion in the outturn for 2004. Exchequer expenditure on R&D was estimated at €616 million in 2005.

The Irish Government currently invests in a wide range of R&D-based programmes including:

- Programmes to support research and development performed in the higher education sector e.g. funding given via Science Foundation Ireland, the Higher Education Authority’s Programme for Research in Third Level Institutions, the Irish Research Council for Science, Engineering and Technology and the Irish Research Council for the Humanities and Social Research;
• R&D programmes performed in the government sector by government departments and agencies e.g. Teagasc (the research, training and advisory board for the agri-food sector) and the Health Research Board;
• Projects to assist businesses develop and increase R&D capabilities e.g. via programmes operated by IDA Ireland (the agency responsible for promoting inward investment) and Enterprise Ireland (the agency charged with the development of indigenous manufacturing and internationally traded service sectors);
• Supporting R&D infrastructure across all sectors of performance.

The exchequer’s percentage share of total public funding has risen from 60% in 1995 to 97% in 2005 and, by contrast, the EU contribution has declined from 40% in 1995 to just 3% in 2005.

Under the National Development Plan 2000-2006, the Irish Government is allocating €2.5 billion for investment in Research Technological Development and Innovation (RTDI).

Basic research funding

The publication by the S&T Indicators Unit within Forfas, the national policy advisory board for enterprise, trade, science, technology and innovation, of the report, "Survey of Research and Development in the Higher Education Sector 2004", shows that research in the Irish higher education sector amounted to €492 million in 2004, an increase of 53% of the HERD recorded in 2002. The increase in HERD was achieved in both real and nominal terms.

The strong increases in HERD are due mainly to additional R&D funding through "direct" government spending initiatives such as Science Foundation Ireland (which oversees Ireland's technology foresight investment in biotechnology and ICT) and the Higher Education Authority's Programme for Research in Third Level Institutes (PRTLI) and "indirect" government funding (recurrent funding via the Higher Education Authority's block grant).

Total government funding (including direct and indirect sources) accounted for 83% of all research income in the higher education sector in 2004, increasing its funding share from the 79% recorded in 2002. Other sources of research income for the higher education sector include funding from the European Union, foreign sources, Irish enterprises and other national funding (including internal funds).

The seven universities remain the dominant performers of R&D across the higher education sector and continue to account for the majority of HERD (94%). However, there was also a strong increase in the amount of expenditure dedicated to R&D activities across the fourteen institutes of technology between 2002 and 2004. Research expenditure in the institutes of technology sector amounted to €30.4 million in 2004 while the universities accounted for €461 million.
Thematic priorities and other targeted funds

An intensive technology foresight programme carried out in 1998-1999 involving representatives of the public sector, academia and industry concluded that biotechnology and Information Communications Technology (ICT) had the potential to be important engines for future growth and Ireland should develop a world class research capability in these disciplines as an essential foundation to capitalise on that growth. The Irish Council for Science, Technology and Innovation (ICSTI) which co-ordinated the technology foresight programme specifically asked government to establish a fund which would enable Ireland to become a centre for world class research excellence in niche areas of ICT, biotechnology and their underlying sciences. ICSTI argued that without such a research capability to support the technology-based industries, which now accounted for more than two thirds of manufacturing output in Ireland, it would be impossible to sustain the momentum built up by the inward investment policy. Ireland would gradually lose its comparative attractiveness for manufacturing industry and the basis of its export led growth in the 1990s.

The Irish Government then decided to commit €646 million to a Technology Foresight Fund for academic researchers and research teams in biotechnology and ICT. It established Science Foundation Ireland (SFI) to administer this investment fund. Through its investments in biotechnology and ICT research, SFI is seeking to support knowledge creation and human capital development, which are the corner stones of a knowledge economy.

Institutional funding

Total expenditure on research and development in the public non-academic sector was estimated by Forfás, the national policy advisory board, to amount to €135.1 million in 2005 as compared with €127.4 million in 2003 (current prices). Teagasc, the agri-food research, training and advisory agency, continue to be the largest performer of R&D in the State sector, accounting for just under half of the total R&D performance in the sector. Other major performers include the Marine Institute and the Economic and Social Research Institute.

Co-funding and indirect funding of private R&D

"Building Ireland's Knowledge Economy," the Irish 3% Action Plan, indicates that approximately 4.5% of private sector research in Ireland in 2001 was Government funded -- compared to the average contribution in other EU Member States of 8%.

The Enterprise Strategy Group which was established in 2003 to prepare a report (Ahead of the Curve: Ireland's Place in the Global Economy) that would serve as a blueprint for an enterprise strategy for growth and employment in Ireland recommended that Government increase the level of public funding for applied research and in-firm R&D should be progressively increased to match that invested by the Department of Enterprise, Trade and Employment in basic research. This includes support for in-firm capability.
development, commercialisation, cluster-led academic research and innovation partnerships.

**Research performers**

**Universities**

Ireland has 7 universities, 14 Institutes of Technology and a small number of private colleges in its third level education sector. Approximately 90% of basic research in Ireland is undertaken in the third level sector.

**Public research organisations**

Compared to large EU Member States, Ireland has very few public research organisations. The activities of these organisations are mostly focused on natural resources (food, agriculture, forestry and marine), health, energy and the environment.

**Research and technology organisations**

Unlike major EU Member States, Ireland does not have any research and technology organisations of note.

**Private research performers**

Foreign-owned companies in Ireland were responsible for just over 72% of total BERD performed in Ireland in 2003 (estimated at €1,075 million), a rise from the 65% BERD share recorded in 2001. The role of foreign-owned companies was particularly pronounced in some of the high spend sectors such as pharmaceuticals, instruments and electrical and electronic equipment.

The total number of R&D active firms (both Irish-owned and foreign-owned) amounted to 1,125, an 11% drop in the level of R&D performing firms recorded in the 2001 BERD survey. The number of foreign-owned R&D performing firms fell by 11.9% during the period 2001-2003 while the number of Irish-owned R&D performing firms fell by 10.7% during the same period.

**Important policy documents**


The Strategy outlines in some detail how the Government proposes to achieve the 3% R&D target. The document has very close parallels with the national 3% action plan, "Building Ireland's Knowledge Economy."

The core elements of the strategy are to develop a world class research infrastructure and to double Ireland's throughput of researchers. The document recognises that science, technology and innovation is largely underdeveloped in Ireland and that a significant
effort will be needed to achieve the national goal of placing Ireland as a leading knowledge-based economy. The strategy covers a number of important policy areas that concern the 3% objective:

- Developing a world class research infrastructure in Ireland;
- Protecting and commercialising ideas and know-how;
- Research and development for enterprise, innovation and growth;
- Science education and society;
- Research in the public sector;
- Science, technology and innovation linkages in the island of Ireland and internationally;
- Implementation of strategy.

The strategy represents the first comprehensive approach undertaken by policy-makers that represents a whole-of-government approach (previously, individual government departments had developed their own science strategies). Accordingly, the document notes that the Inter Departmental Committee on Science, Technology and Innovation will play a major role in the implementation of the strategy.
**R&D system in Lithuania**

**Brief description**

The picture shows some of the major players in the Lithuanian R&D and innovation system. They are divided into three groups: policy decision makers, policy support and implementation agencies, and the target organisations.

The R&D system can not be fully separated from the National Innovation system. The continuing efforts in setting up a national innovation system and innovation-based economic development during the last five years were translated in the development of an innovation policy framework and setting up an institutional innovation support network. The major criticism that the Lithuanian NIS continuously faces is the lack of linkages and interactions among various actors groups – especially between R&D and higher education sector, as well as business and innovation intermediaries. Therefore the high co-ordination improvement efforts were made in redesigning an institutional setting. As science and technology policy making is a prerogative of Lithuanian Science council and the Ministry of Education of Science (function delegated to the department of Science and Studies), the latter has established an institutional structure of R&D funding (consisting of institutional funding and competitive funding, administrated by Lithuanian science foundation) and R&D support. The latter being helped by the International Science and Technology programmes development agency. Both institutions are supporting activities of higher education and public R&D institutions, but they are not limited to do so. Companies are also supported in terms of R&D funding and advise, especially concerning the participation in international R&D programmes. The Ministry of Education and Science is also in charge for the supply of human resources for the economic system, and also for the upgrade of the competencies and qualifications of the highly skilled; the general development of the qualifications of the working population lies under the ministry of Social Affairs and Labour. The Ministry of Economy is focused on R&D in business facilitation and support. The measures designed are directly aimed at in-house R&D development, and helping to create and develop technology platforms.
Main research policy setting mechanisms
Government policy making and coordination

The general Lithuanian policy directions are set by Lithuanian Seimas (Parliament). The Lithuanian parliament has approved a national strategy towards knowledge economy and set as a highest priority the development of knowledge and high value added activities in the country. The major assets to be developed are original and productive R&D base, innovative business sector and highly skilled human resources for R&D and innovation in science and business sectors.

The function of development and implementation of innovation policy is performed by the Lithuanian government, and especially the Ministry of Economy, while the knowledge generation and R&D activities are regulated by the Ministry of Education and Science. Innovation and R&D policy framework has undergone significant changes since 2001. In spring 2005 the two high level policy advisory Commissions - the Science and Technology Commission and Science and Education Commission - were reorganised into the single Science, Technology and Innovation Commission, which should join the efforts of scientific and business community and serve the national aim of faster economy upgrading towards knowledge intensive economy. The Commission is the highest level policy co-ordination body, representing Science, Education and Business communities, as
well as the government, and is chaired by the Prime Minister of Lithuania. The Commission works on a regular basis and has a permanently functioning secretariat. Another important high level policy advisory body on R&D policy is the Science Council. It serves as a scientific adviser and consultant to the Seimas (Parliament) and the Government in solving strategic issues of research and higher education. It analyses the situation in the research and higher education system, makes proposals and drafts decrees for the Department of Science and Higher Education, makes proposals about the right of institutions to confer doctoral degrees, supervises the award of research degrees and academic titles, and provides notification of doctoral degrees issued for Lithuanian citizens abroad. The Science Council remains one of the major Lithuanian Science and technology policy drivers, with the declarations and allocations of funds for research and initiation of establishment of important political bodies. Today, it is in charge for the development of Lithuanian R&D priorities.

The Higher Education Council advises the Ministry of Higher Education and Science on issues of strategic development in higher education. The main tasks and functions of the council are to analyse and evaluate the development strategy for higher education in Lithuania, advice the Ministry of Higher Education and Science, develop proposals for the ministry, and draw conclusions on issues relating to the development and enhancement of higher education.

The Lithuanian Academy of Sciences is an autonomous, state-subsidized scientific establishment bringing together distinguished Lithuanian scientists as well as foreign scholars whose activities are related to Lithuania. The academy serves as an independent advisory body to the government on scientific, educational, cultural, economic, technical, and social advancement. It also acts as a scientific expert on key issues of economy, culture, society and other fields, participates in drafting the strategies for their development, identifies the priorities for research and high technologies and assists to their implementation.
Research funding system

The Lithuanian R&D funding system's main characterisation lays with a huge share in public funding and only moderate business R&D investments. Public R&D is allocated via three major streams – institutional funding (0.26% GDP), targeted, customer oriented R&D and public R&D procurement (0.19% GDP), and competitive R&D (0.03% GDP).

The institutional funding goes directly to R&D and higher education institutions and is mainly aimed at maintaining existing structures and payments for the scientific staff. Competitive based R&D funding is allocated via Lithuanian Science and Study foundation. Here institutional projects, independent science group projects, and joint – business and R&D sector projects are funded. In addition, the R&D projects, commissioned by enterprises, are funded on the competitive basis.

State institutions also act as an important customer of R&D services. Projects of applied science, R&D studies are launched and financed by the Lithuanian Ministry of Economy, among others. In the programming period 2004 – 2006 the Ministry of Economy launched an independent scheme to promote R&D in business, which is not oriented towards ministerial needs, but is pure support for business R&D projects on the competitive base. The measure is similar to the Lithuanian Science foundation support for R&D, but has a higher financial weight, and also does not oblige business enterprises to co-operate with R&D institutions. Here public R&D institutions and private R&D
performers compete on the basis of **public procurement** rules.

Business sector R&D funding comprises 0.14% GDP. Most of the business R&D is directed towards business needs, but mainly is performed by public R&D institutions (university R&D funded by business is 2.37% above EU average). Charity funds dedicated by business also can be transferred to public R&D institutions or NGO’s.

**National public research funding**

**Overview**

Knowledge creation indicators such as public R&D expenditure, business R&D expenditure, and share of medium-high tech R&D remain far below the EU-25 level. Although the level of public expenditure on R&D is slightly higher than that of neighboring Estonia or Latvia, it remains well below the EU-25 average. The level of business R&D expenditure is amongst the lowest in the enlarged EU (although problems with accounting of R&D expenditure explain part of the gap). The overall R&D/GDP ratio, one of the lowest within the EU-25, equals 0.68%.

More worryingly, there is no real evidence of a positive and sustained upward trend, especially in **business R&D investments** (0.14% of GDP in 2005). 63% of total R&D expenditure in the private sector came from the ICT sector. This is the highest figure among countries of the Baltic region. R&D expenditure makes almost 1% of total turnover in the ICT sector in Lithuania (5% in Finland and 0.3% in Estonia) (Source: RISO, Department of State Information Systems, 2003). Having in mind that Lithuania is one of the poorest EU countries, such a low level of investment does not give any expectation for the improvement of knowledge inputs to the economy. According to official statistics of Lithuania, 381.870 thousand Litas (LT) (1€ = 3.45 LT) were allocated for R&D t in 2003 (30€ per capita). 35.5% were allocated to basic research, 38% to applied research, and 26.5% to experimental development.

The quality of higher education is under scrutiny because of irrelevant funding and pure involvement of S&T studies into R&D activities. Taken together, the state budget funds allocated for R&D and higher education are 1.1% of GDP (46€ per capita) in 2004. Accumulated funds from all sources for R&D and higher education constituted 2.2% of GDP (60€ per capita).

**Public funding** in Lithuania constitutes a bulk of total R&D funding (64%). By comparison, the share for the OECD is 29%, for the old EU Member States it is 34%, and for the new EU Member States 56% on average. Besides low levels of R&D funding, numerous other funding issues persist. The quality of spending has not adjusted to the requirements of a market economy. A major part of government financing consists of institutional funding for R&D institutions—lump-sum budget transfers provided to institutions on a per capita (employee or student) basis—designed to maintain existing staff, facilities, and equipment. Only a small fraction of government financing has been allocated to support what the Government itself has defined as its priority objectives for research. Moreover, R&D funding on the basis of competitive grant selection procedures has been modest by any standards. Program or project funding is close to zero in
Lithuania; this compares with a share of program/project funding of R&D spending in EU member countries of 22% on average, and, for example, 4% in Finland, 40% in Denmark, 33% in Sweden, and 31% in Germany.

The Memorandum between the Political Parties and the academia asks for the State budget allocations for academic studies to grow 0.1% every year and to reach 1% of GDP in 2007. Budget allocations for research and experimental development should also grow by 0.1% GDP every year and reach 1% of GDP in 2010 (the actual figure is 0.68% in 2003). Favourable conditions which need to be created for business investments should account for 2% until 2010. Today, Lithuania falls far behind this objective and ranks 22 among the EU 25 in business R&D expenditure;

The European Union and national efforts for training of human resources should grow significantly and since 2007 more than 50% of national Structural funds resources will be devoted for that. In the current programming period (2004 - 2006) SF investments for infrastructures scheduled for education, science & studies infrastructure in Lithuania consist only of 7.4% - much lower than for example Estonia's share of 30.8%.

**Basic research funding**

The share of basic research in total R&D expenditure is 40.9% in Lithuania (in 2002), when the share recorded for EU-15 is in the range 22-28%.

**Thematic priorities and other targeted funds**

Only a small fraction of government financing has been allocated to support what the Government itself has defined as its priority objectives for research. Moreover, R&D funding on the basis of competitive grant selection procedures has been modest by any standards. Program or project funding is close to zero in Lithuania.

**Institutional funding**

Besides low levels of R&D funding, numerous other funding issues persist. The quality of spending has not adjusted to the requirements of a market economy. A major part of government financing consists of institutional funding for R&D institutions—lump-sum budget transfers provided to institutions on a per capita (employee or student) basis—designed to maintain existing staff, facilities, and equipment.

**Co-funding and indirect funding of private R&D**

There are no key instruments in the area. Co-funding and public-private partnerships are at the initial level only. The co - funding mechanisms are designed as a part of the implementation of the High technology development programme. They are also provided via Support to priority Research and Experimental development trends in Lithuania, and administrated by the Lithuanian Science and Study foundation. Public competitive
funding received by joint public – private R&D consortia from the Lithuanian Science foundation are limited to a few projects in priority areas (for further information www.vmsf.lt). In 2006, 4.8 billion Litas were allocated for the high technology development programme (19 joint public – private R&D projects funded).

The reorganisation of the R&D system and a strengthening of competitive funding are key challenges of the R&D system. However, reform are still ongoing but so far, there is no greater impact and the historical concentration of public resources in public institutions persists. The evaluation of public Science and Study institutions is based on the traditional science results, such as publications, experimental development, patents (which are almost non-existing) etc., and also on the ability to attract international funds and private resources for scientific research. However, these evaluation criteria do not assist in the redirection of public funds to competitive funding schemes, as the bulk of funding still goes to the public institutions.

The Ministry of Economy has introduced a few grant schemes, which address business R&D issues – direct support for business R&D in enterprise sector and support for the participation in technology platforms. These schemes are supposed to increase business R&D and provide additional funding for business R&D.

**Research performers**

**Universities**

Lithuania accounts in total 21 universities. Among them are 15 public universities and 6 private ones. Two of the private ones are priest seminars. In terms of number of students, the largest universities are **Vilnius University** (22,500 students), **Kaunas University of Technology** (17,500), and **Mykolas Romeris University** (16,000).

**Public research organisations**

There are 17 state research institutes, which are acting as independent institutions, but also provide PhD programmes:

**Research and technology organisations**

There are 8 operational Science and Technology Parks in Lithuania. Most of these institutions operate in connection with universities and public research institutions. They also function as technology business incubator, and technology and innovation centres. Some of them host branches of the Lithuanian Innovation centre. The rise of technology parks was due to the adoption of the S&T park concept in 2002, and the Innovation in business programme together with the Strategic SME development guidelines.

**Private research performers**

There are 2 private research institutions in Lithuania (www.mokslas.lt). The research is also performed by R&D service companies (Institute of strategic public administration, and Institute of alternative energy to the Appplied academy of science,
http://www.mokslas.lt/index.cgi?menu_item=private_science_offices), and few companies in high technology priority areas - ICT, lasers, biotechnologies, mechatronics and ICT

**Important policy documents**

**Lithuanian Science and Technology White Paper Implementation Programme,**
Lithuania Government decision Nr. 1646, December 22, 2003

**The Lithuania Long-Term Strategy for Research and Development,** Lithuania Government decision Nr. 1646, December 22, 2003

**Priority Trends for Scientific Research and Experimental Development in Lithuania,** Lithuania Government decision Nr. 1182, July 19, 2002

The main priorities for 2002-2006 are:

- **Scientific research to ensure quality of life of people:**
  - genomics and biotechnologies for health and agriculture,
  - high quality, safe and ecologically clean food technologies,
  - changes in ecosystems and climate,

- **Scientific research to promote a knowledge-based society:**
  - information society technologies,
  - citizens and management in the knowledge society,
  - keeping the national identity in the globalization environment,

- **Scientific research aimed at nanotechnology design:**
  - nanosciences,
  - nanotechnologies,
  - development of multifunctional nanostructure-based materials,

- **Scientific research and experimental development aimed at solving nuclear security and radioactive garbage management problems**
  - nuclear security,
  - radioactive garbage management technologies,

- **R&D to increase international competitiveness of Lithuanian industries:** development of biotechnologies, mechatronics, lasers, information and other high technologies.
R&D system in the Netherlands

The performance of the relatively small economy of the Netherlands is strong in terms of GDP per capita. It is, and has long been, amongst the highest in the EU. However, the GDP growth has been relatively low in the last years. Also the international competitiveness of the Netherlands has decreased, as is indicated by, for example, international ranking of the Institute for Management Development in which the Netherlands dropped from 4th in 2002 to 13th in 2005 (15th in 2004)

Appraisal of the Dutch innovation governance system

The Dutch innovation governance system is a complex system with multiple agencies and advisory bodies. With regard to strategic policymaking, innovation policy is underpinned by (internal and external) studies and analyses, advice from advisory bodies and policy consultants, evaluations, benchmarks, prioritisations and stakeholder involvement. Important coordinative roles in innovation policymaking are played by the Committee on Science, Technology and Information Policy (CWTI) at the level of the ministries and the Council for Science, Technology and Information Policy (RWTI) at the level of the Cabinet. The Innovation Platform also has a coordinative role. The coordination between the Ministry of Economic Affairs and the ministry of Education, Culture and Science has improved over the last years, especially at the level of target setting and prioritisation.

There is a system of policy review in place. The so-called VBTB-project (“From Policy budgets To Policy accountability”) which was started several years ago a new style of making budgets was introduced which aimed to establish a clear link between policy objectives, activities and the allocation of resources. This new style also left its mark on policy processes, highlighting the importance of setting clear, measurable targets and the use of performance indicators and systematic monitoring and evaluation. Since 2002, policy design and evaluation are subject to the ministerial decree on performance measurement and evaluation (RPE). Based on the RPE, the ministry of Economic Affairs has developed a guideline for a systematic evaluation of policy instruments.

In order to engage in trans-national learning and benchmarking, the Ministry of Economic Affairs participates in various panels and expert groups of the European Commission and the OECD. It also does regular “competitiveness assessments” in which the Netherlands are compared to other countries. The Ministry also performs specific studies on policy topics and new policy instruments in international comparison.

Summarising the strengths and weaknesses of the Dutch innovation governance system, the major strengths include: broad stakeholder involvement in early phases of the policy cycle; a shift towards creating networks of existing organisations instead of launching new organisations or structures; an ongoing streamlining of instruments which increases transparency in national innovation policy; a willingness to undertake policy experiments; and various cases of good practice in interdepartmental co-ordination. Weaknesses include: long lead times for decisions; high transaction costs of stakeholder involvement; a small number of key stakeholders with large influence in various committees; a tendency towards a “committee culture” in which publication of strategic
documents receives more attention than actual implementation; room for experimentation has been limited by the streamlining; interdepartmental collaboration which is still in its infancy; and complexity of innovation governance system.

The national innovation system
The national innovation system of the Netherlands is a complex system with many actors, funding mechanisms and relations. For the purpose of discussing the main institutions of the Dutch NIS, this section divides them into five main categories:
1) governmental actors that play a key role in setting broad policy directions
2) governmental agencies
3) bridging institutions, such as high-level councils which act as intermediaries between governments and the rest of the innovation system
4) universities and related institutions that provide key knowledge and skills
5) private sector actors.

Diagram 1  Organisational chart of the innovation governance system
Brief description

The two main ministries in the national research governance system are the ministry of Education, Culture and Science and the ministry of Economic Affairs. There are various advisory bodies, including:
- the Innovation Platform, set up in 2003 to propose strategic plans to reinforce the Dutch knowledge economy and to stimulate collaboration between the public research infrastructure and industry.
- the Advisory Council for Science and Technology Policy (AWT), gives solicited and unsolicited advice to government and parliament on science, technology and innovation policy, and on information policy in the fields of science and technology.
- the Sector Councils have an advisory role for the various ministers on specific policy areas in their research sectors. The sector councils have a tri-partite composition with representatives from researcher community, users and government.
- the Strategic Advisory Councils, which occasionally advise the government on matters of science and technology policy.
- the Royal Netherlands Academy of Arts and Sciences (KNAW), which provides advice to the government on matters of science and technology, especially in the field of basic research.
- the Netherlands Academy of Technology and Innovation (formerly known as Netherlands Forum for Technology and Science, NFTW) which gives solicited or unsolicited advice to governmental bodies, societal organisations or political parties.
- the Netherlands Bureau for Economic Policy Analysis (CPB), which is an important advisory body for the government on social-economic matters.

Policy implementation is done mainly by two key agencies: SenterNovem and the national research council NWO.
- SenterNovem is an agency of the ministry of Economic Affairs which implements innovation schemes. SenterNovem also works for other ministries.
- NWO, the Netherlands Organisation for Scientific Research, functions as a funding agency of the ministry of Education, Culture and Science. The NWO encompasses all scientific fields. Its most important tasks are to provide grants for (excellent) research and research equipment and to co-ordinate research programmes. In addition, the NWO administers 9 research institutes.
- the Technology Foundation (STW), which supports and finances scientific-technological research projects and promotes utilisation of results of research by third parties.
- In the fields of specific key technologies (ICT, genomics, catalysis) temporary task forces have been set up to co-ordinate and execute programmes. They have a semipermanent status and are accommodated by NWO.

The public science and research community in the Netherlands includes 14 universities (including 3 universities of technology and 1 agricultural university). In addition, there are 18 so-called KNAW Institutes, which act under the umbrella of the Royal Netherlands Academy of Arts and Sciences (KNAW). There are also nine so-called NWO Institutes that operate under the Netherlands Organisation for Scientific Research.
NWO. Furthermore, there are five Large Technological Institutes, conducting applied research and related activities, such as advising industry and government in specific fields.

_TNO, the Netherlands Organisation for Applied Scientific Research_, is by far the largest (semi-)public research organisation in the Netherlands. TNO is an umbrella organisation with several research centres in the five key areas.

Other actors in the knowledge infrastructure are the agricultural research institutes of the DLO Foundation, several state-owned research and expertise centres and several other institutes in the fields of health and the social sciences. Finally, there are four Leading Technological Institutes (LTIs) which were established in 1997 by the government as virtual organisations in which companies, universities and research institutes participate in public-private partnerships for research and innovation with the aim of strengthening the interaction between industry, research institutes and universities and stimulating the innovativeness of the Dutch economy.

**Governmental actors**
The **Ministry of Economic Affairs** (EZ) is one of the two main governmental actors responsible for (industry oriented) R&D and innovation policy. The other one is the **Ministry of Education, Culture and Science** (OCW) which also plays an important role in defining innovation policy, in particular with regards to scientific research and education. the EZ and the OCW are the most important ministries with regard to innovation policy.

**Governmental agencies**
_SenterNovem _and the national research council **NWO** (the Dutch Organisation for Scientific Research) are the main innovation agencies in the Netherlands. The **Technology Foundation (STW)** supports scientific-technological research projects and promotes the utilisation of results from research.

In the fields of four key technologies (ICT, life science, nanotechnology, catalysis) new bodies have been set up to co-ordinate and execute programmes. Currently, there are three so-called **Temporary Task Forces** that execute ministerial policy. They have a semi-permanent status and are accommodated by the NWO:

a) Advanced Catalytic Technologies for Sustainability (ACTS)
b) Dutch Genomics Initiative (NGI)
c) National ICT Research and Innovation Authority (ICTRO)

The **Dutch Industrial Property Office** (*Octrooicentrum Nederland*) is independent agency of the Ministry of Economic Affairs and is responsible for granting patents in the Netherlands and for dissemination of technological knowledge, which is embedded in patent literature. In effect, it is the executive agency for the patent system in the Netherlands.

_Syntens_ (NL_22) is a network of fifteen regional centres with the aim to strengthen innovativeness of SMEs by making technological and non-technological innovation-oriented knowledge accessible and applicable for SMEs. In 2005, the number of Syntens locations will be reduced to enhance the network’s efficiency. Syntens is an instrument of the Ministry of Economic Affairs to increase knowledge application by SMEs.
The four Regional Development Agencies4 initiate, in collaboration with the business enterprise sector, new economic investments in their regions. Funding for the Regional Development Agencies is provided by the Ministry of Economic Affairs and the provinces.

Advisory and intermediary organisations
There are various advisory bodies in the field of research, technological development and innovation.
In 2003 the Innovation Platform was launched by the Cabinet with the objective to propose strategic plans to reinforce the Dutch knowledge economy and to boost innovation by stimulating business enterprises and organisations in the public knowledge infrastructure to work closely together. The Innovation Platform is headed by the Prime Minister and takes its members from government, business enterprises and knowledge institutes. Members participate in a personal capacity.

Other important advisory bodies are the Advisory Council for Science and Technology Policy (AWT), the Sector Councils, the Strategic Advisory Councils, the Royal Dutch Academy of Arts and Sciences (KNAW) and the Dutch Bureau for Economic Policy Analysis (CPB).

Knowledge and research institutes
The public science and research community in the Netherlands includes 14 universities (including three universities of technology and one agricultural university). The universities are organised in the VSNU – the association of universities in the Netherlands. In addition, there are 18 so-called KNAW Institutes, which are primarily engaged in basic and strategic scientific research and disseminating information. They are called KNAW Institutes because the Royal Dutch Academy of Arts and Sciences (KNAW) acts as an umbrella organisation for these institutes.

There are also nine so-called NOW Institutes that operate under the Dutch Organisation for Scientific Research NWO – the research council in the Netherlands. Furthermore, there are five Large Technological Institutes, conducting applied research and related activities, such as advising industry and government in specific fields. These institutes are active in aerospace, water management, hydraulic engineering, maritime research and energy research.

TNO, the Dutch Organisation for Applied Research, is an independent contract research organization established by law in 1930. The TNO currently has some 5000 employees. It is by far the largest (semi-)public research organisation in the Netherlands. TNO is an umbrella organisation with several research centres in the five key areas of its activity: Quality of Life; Defence, Security and Safety; Science and Industry; TNO Built Environment and Geosciences; and Information and Communication Technology.

Private sector organisations
The business sector in the Netherlands is characterised by that fact that a large part of R&D by Dutch businesses is performed by a limited number of large multinationals: seven large firms perform roughly half of the total private R&D in the Netherlands. These so-called Big Seven are Philips (electronics), AkzoNobel (chemicals/pharmaceuticals), Shell (oil & gas), ASML (integrated circuits equipment), DSM
(chemicals), Unilever (food, personal care) and Océ (copiers). Philips, for instance, accounts for roughly 20% of the total R&D expenditure of all enterprises in the Netherlands. Although the private R&D intensity in the Netherlands is strongly dependent on the development of R&D expenditure in these companies, the share of the Big Seven in the total business R&D expenditure has declined while the share of SMEs has increased in recent years.

**Strategic policy making**

In general, innovation policy design in the Netherlands is underpinned by analyses, evaluations, benchmarks, prioritisation and stakeholder involvement. The basis for current innovation policy – as laid down in the 2003 Innovation White Paper *Action for innovation* – is a series of building block and background studies that have been performed within and on behalf of the Ministry of Economic Affairs, systematically analysing the Netherlands NIS and various aspects of innovation strategy. Numerous studies were performed (both by internal teams as well as external experts) to analyse various aspects of innovation such as the rationale for innovation policy, innovation governance, possibilities for streamlining various (categories of) schemes, international aspects of innovation, interaction between universities and firms, framework conditions, innovative entrepreneurship, breakthrough technologies, etc. An example of such studies is *Working on innovation strength* (2002) which integrated various studies and formulated a policy agenda and policy options, and flagged a number of key problems/challenges.

**Research funding system**

**Brief description**

The ministry of Education, Culture and Science (OCW) is responsible for the 'first flow' (lump sum) funding to universities. NWO and STW receive funding from the OCW and the ministry of Economic Affairs (the latter only in case of STW) for the 'second flow' (competition-based) funding of universities and for the research institutes of NWO. The Royal Netherlands Academy of Arts and Sciences (KNAW) also receives funding from OCW for its KNAW institutes. The total intramural R&D expenditures have increased between 2002 and 2003 and has reached a 1.76% of GDP. This R&D intensity is higher than in 2002 (1.72%) but still lower than in 2001 (1.80%). Due to a correction of the Dutch GDP figures, it appears that already in 2001 the R&D intensity of the Netherlands was not only below the EU15, but also below the R&D intensity of the EU25.
This flow chart shows the R&D flows for the Netherlands in 2002 (from: *Kennis en Economie 2004, Centraal Bureau voor de Statistiek*). It should be noted that the largest R&D tax reduction scheme from the government to stimulate private R&D expenditure (WBSo, 425 million euro annually) is not included in this figure.

Light blue is total R&D expenditure per entity (top: research institutes, middle: universities, left: foreign and EU-funding, right: Netherlands government, bottom: companies). Dark blue is expenditure on outsourced R&D activities.

The largest part of the university and research institute funding comes from the Netherlands government (either directly from the ministries, or indirectly through funding agencies and intermediaries like the Netherlands Organisation for Scientific Research (NWO) and the Netherlands Innovation Agency, SenterNovem).
National public research funding

Overview

In 2003, university research received circa 2.5 billion per year. The total expenditure on R&D in the Netherlands was 8.4 billion euro. Universities receive their funding via three flows. The first flow of base funding (directly via the ministry of Education, Culture and Science) is approximately 60%, while the second flow is 10% and the third flow 30%. The Netherlands Organisation for Scientific Research NWO together with the Technology Foundation STW (for the technical sciences) are responsible for allocating the second flow.

Basic research funding

The 14 universities in the Netherlands receive 1.75 billion euro as first flow funding. Natural science fields are the most important destination with 73 percent. Social science received 20 percent and humanities (language) 7 percent. The total expenditures on R&D with own personnel have hardly changed between 2002 and 2003 but there are some small changes at the level of scientific fields. For example, the expenditures on natural sciences have increased from 423 million to 456 million euro, whereas in the fields of technology and health there has been a decrease in expenditures. In terms of the number of scientific personnel, the field of Health has shown the largest increase from 4496 to 4882 researchers (CBS, 2005).

Thematic priorities and other targeted funds

A number of funds and public funding appropriations from Belgian authorities are dedicated to thematic priorities. At the Federal level there are thematic programmes in areas which fall within the competences of the federal level: space research (the most important in budgetary terms), and other federal research programmes in areas such as information society, national cohesion, normalisation.

Wallonia has mobilising programmes which are a short-term research programmes that are open either to universities and research centres, or to companies, and sometimes to combinations of private and public actors. These programmes have, over the last ten years, notably covered ICT applications, Biotechnology, and Nanotechnology. The areas for these mobilisation programmes are chosen amongst the “40 key technologies” in which Wallonia has scientific and industrial expertise.

Flanders targets its R&D funding through the establishment (in the beginning of 90s) of major independent research centres, heavily supported by the regional government. IMEC is the worldwide centre of excellence in micro-electronics research. It is a unique and independent European research centre in the field of nano-electronics, nanotechnology, design methods and technologies for ICT systems. It has now become a world player with more than 1,400 researchers. Two other major centres are specialised in biology (VIB) and environment and energy (VITO).
Collective research centres, dating from the 50s and financed partly by industry, are present in all Belgian regions. With the federalisation of the country, the public funding part of such centres has been placed under the responsibility of the Regions, which means that these public funds are indeed earmarked for a certain number of sectors.

**Institutional funding**

The main (semi-)public research institutes in the Netherlands are the Netherlands Organisation for Applied Scientific Research TNO and the five so-called Large Technological Institutes (GTIs) (Maritime Research Institute Netherlands MARIN; National Aerospace Laboratory NLR; WL | Delft Hydraulics; GeoDelft; and the Energy research Centre of the Netherlands ECN). In 2003, these (semi-)public research institutes received 1,886 million euro from third parties for doing research. An amount that has increased with 13% from 2002 to 2003.

The KNAW institutes of the Royal Netherlands Academy of Arts and Sciences (KNAW) received 72 million euro in 2005 from the ministry of Education Culture and Science. NWO received 283,7 million euro in 2005 (including both institutional and project funding). TNO is mentioned on the budget of the same ministry for 113 million, including both basic- and target-funding. Overall the trend is to more project- and target-funding, and less basic, institutional funding.

More details are in the information on the main R&D funding ministries.

**Co-funding and indirect funding of private R&D**

Overall, the relative importance of indirect funding and co-funding has increased over the years. It is, however, hard to assess the size of the different instruments because of the diversity in co-funding. Most instruments concerning co-funding and indirect funding can be found under the ministry of Economic Affairs (EZ). The main policy instrument for indirect co-funding research is the WBSO (the R&D Promotion Act). The budgetary importance of this tax-deduction facility is 425 million euro per year.

Bsik is an important instrument with a public funding of 802 million euro for 37 research consortia (public-private partnerships) for a period of four to six years. The contributions to Leading Technological Institutes (29.1 million euro in 2006 from EZ) and the Technology Foundation STW (ca. 46 million euro in 2006 from EZ & NWO) are important forms of co- and indirect funding of private R&D, but also the 'Innovation subsidy co-operation projects' are important instruments in this respect (ca. 100 million euro in 2006).

**Research performers**

**Universities**

There are 15 universities in Belgium, 6 of which are in the Flemish speaking Community and 9 within the French speaking Community. Following the Bologna agreement, linkages and synergies between universities in the same language Community are growing.
Public research organisations
In Belgium, a large part of research on the public side is carried out in universities. These are the 10 federal scientific institutions and a few smaller institutes.

Private research performers

The largest private R&D performers in Belgium include: Janssen Pharmaceutica, GlaxoSmithKline Biologicals &/or SmithKline Beecham Biologicals, U.C.B, AFGA-GEVAERT, Societe Internationale de Telecommunications Aeronautiques, Alcatel Bell, Siemens Atea, Alcatel Microelectronics, Solvay and Barco.

Important policy documents

Ambitions for the higher education system in 2010:

- deliver more knowledge workers
- strengthen ties between education and industry
- developing a stronger international position of the Dutch higher education
- influence European educational agenda setting
- maximize education-participation
- supply challenging education programs

Differentiating and excellence in education is possible only when the role of the government is clear.
Policy measures are identified:

- changing the financing system
- setting performance-standards and implement an audit system
- implement a new law on higher education

The delta plan provides an integral approach of several ministries to increase the number of scientists and engineers in the Netherlands. This specific group of knowledge workers is of main importance for the Netherlands to become a knowledge-based economy.
R&D and Innovation Policy in Slovenia

With 2004 elections, Slovenia re-establish the ministry for science and technology. The new Ministry for Higher education, Science and Technology “got back” from the Ministry of Economy most of the staff in the department for technology development and innovation as well as the activities this department was conducting under Ministry of Economy. The Agency for Scientific Research has begun its operation, while the Technology Agency was formally established, but was not fully operational in 2005 yet due to the procedural issues caused by the reorganisation of the government.

The Slovenian Development Strategy was accepted in June 2005 and stresses the importance of innovation and R&D for economic and social development of the country. Subscribing to the Lisbon and Barcelona objectives, including a three percent R&D investment target, the Strategy calls for the systematic re-orientation of public funding from predominantly basic research to a more targeted research, co-funded by the business sector. The business interest would be decisive in selecting research projects. Several areas were identified as priority thematic areas to qualify for both project funding and the network/centre of excellence funding. Similar objectives are proposed in the National Research and Development Programme.

What continues to be a problem (and has not yet been addressed by the policy) is how to broaden the horizon of innovation policy and make different parts of government see the importance of a coordinated horizontal approach to innovation policy.

Basic characterisation of the research system

The level of R&D investment in Slovenia has been around 1.5% GDP (latest figure for 2004: 1.54% according to Statistical Office) for several years now. Slovenia introduced Lisbon and Barcelona targets into its R&D policy and plans to achieve 3% investment in R&D by 2010, yet the current trends, particularly in the level of increase of public sector financing, are not so optimistic. In terms of R&D input indicators (number of researchers, amount of public R&D investment, positive trends in growth of business R&D investment), Slovenia scores relatively well in comparison to EU average. More problematic is the output side, particularly if measured by number of innovative firms or number of patents (European Innovation Scoreboard, 2005).

Key policy documents in the R&D area had been National Research and Development Programmes, prepared for five year periods and the legal documents, regulating the research (currently the Law on Research and Development -2002) give the legal and policy framework for R&D. The characteristics of the public research funding have so far been the stress on scientific excellence per se and thus avoidance of priority setting. Even if there were policy priorities with regards to scientific areas or types of projects on the paper, the actual results did not confirm them. The influence of science community on the budget allocation and R&D financing system was sufficient to guarantee that no major shift in policy had happened. Several different financing schemes have been developed,
with Research programme financing being the largest. Funding is available for applied projects, for the support of participation in the international research projects, various infrastructure co-financing programmes as well as a special scheme on Targeted research projects, where research is commissioned by different government's offices to support their decision-making process. Institutionally, Slovenia moved from Ministry of Science and Technology to the Ministry of Education, Science and Sports to the current Ministry of Higher Education, Science and Technology. In 2004, Slovenian Research Agency had been established, taking over as an executive agency many of the operational tasks of the Ministry in charge of science.

During the transition period, Slovenia managed to preserve its public R&D sector relatively untouched, since increase in public expenditures outweighed the loss of business funds. The latter occurred as a consequence of collapse of some of the large industrial conglomerates, which lost most of their markets and were slow to adjust. Majority of the larger public research institutes survived, only some of the R&D departments in industry were closed. The availability of public sources and the criteria for dissemination led to a shift towards more basic research in the public research institutions. In the opinion of many this caused that the research conducted in public sector is not attracting private sector funds (Bucar & Stare, 2005; Mulej, 2005). The lack of cooperation between public research institutions and University and business sector is one of the key deficiencies of Slovenian R&D and innovation system.

After the initial slow-down in the beginning of the nineties, the business sector R&D investment has experienced considerable growth in last decade and is much more sector specific, reflecting a predominant role of manufacturing and within the manufacturing, of chemicals- specifically pharmaceuticals and machinery and equipment, especially 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.

Several measures to improve poor linking between public R&D and manufacturing/service competencies have been tried in the past and are suggested in the current policy documents as well. In the policy documents accepted by the government during 2005 (Slovenian Development Strategy, National Research and Development Programme, National Reform Programme for Achieving the Lisbon Strategy Goals, Framework of the reforms) the important role of R&D in helping a more dynamic economic and social development has been recognized, and a comprehensive reform of R&D and higher education sector is suggested. This reform aims at linking research in public sector to the needs of the business sector and contribute to more innovation and increased competitiveness of Slovenian economy.
Brief description

The National Assembly is the top legislative body and its Committee on Higher Education, Science and Technological Development is in charge of discussing the legal and policy documents, related to R&D policy. Once cleared by the Committee, main legal documents (Law on Research and Development, National Research and Development Programme) are passed on to the Assembly for approval.

The Ministry of Higher Education, Science and Technology is responsible for preparing the policy documents in R&D area, for implementation of R&D policy (i.e. the implementation of the national research and development programme), the public R&D budget and the international cooperation in the area of R&D. An advisory body to the government in R&D area is the National Science and Technology Council, with members from research community, higher education institutions, business community and government.

For the execution of R&D policy, a special public agency was established: Slovenian Research Agency. It is responsible for execution of the public research financing, for professional and independent selection process of projects and programmes and monitoring of the research implementation. Slovenian Technology Agency, established according to the same law, is in charge of the programmes promoting technology development, but is due to its prolonged problems with the legal status, its annual programme was only approved in July 2006.

The Ministry of Economy is covering the programmes where entrepreneurship and
innovation policy are combined, so certain policy measures are relevant for R&D as well. The Government Office for Growth (http://www.svr.gov.si/index.php?id=874&L=1) is responsible for the implementation of Slovenian Development Strategy as well as the National Reform Programme for Achieving the Lisbon Strategy Goals.

The four universities and public research institutes constitute the main public research capability. Most of the financial resources come from the government, and are channeled through the Slovenian Research Agency. All research organisations and individual researchers have to be registered at the central registrar at the Slovenian Research Agency if they want to apply for public funding.

**Main research policy setting mechanisms**

**Government policy making and coordination**

The Ministry of Higher Education, Science and Technology is responsible for the preparation of the National Research and Development Programme. The National Research and Development Programme has to be discussed in public and accepted by the Council for Science and Technology of the Republic of Slovenia prior to its submission to the Government. Within the discussion at the Government, all ministries are invited to comment, especially the Ministry of Finance and Ministry of Economy. The Ministry of Finance needs to check the resources available and the dynamics of R&D financing. Ministry of Economy needs to check the compatibility of R&D policy with the innovation policy and the policy to support entrepreneurship.

Upon government's approval, National Research and Development Programme goes to the National Assembly: first to its Committee on Higher Education, Science and Technological Development and then to the Assembly itself. National Research and Development Programme is the basis for annual programme of work of the Ministry of Higher Education, Science and Technology and the budget for research. The budget allocation is negotiated first at the level of the government and finally agreed by the National assembly. On the basis of its resources, the Ministry of Higher Education, Science and Technology funds various programmes, including the Slovenian Research Agency's.

Slovenian Research Agency needs to prepare its programme, consisting primarily from the funding of various research programmes and present it to its Board of Directors. When approved, the Ministry of Higher Education, Science and Technology presents it to the Government for approval. The Agency is responsible for the implementation of the programme and correct use of the resources allocated to these programmes.

The measures directly relevant to innovation policy are prepared by the directorate for entrepreneurship at the Ministry of Economy. The Framework for these measures needs to be approved by the government, which again means that all other ministries are invited to comment and suggest changes. Once approved, the programmes are the responsibility
of each respective Ministry. Currently no specific coordination body at the level of design and implementation of various measures exists, so the coordination of the activities between different ministries is carried out at the level of the Government. One of the tasks of Government's Office for Growth, established in January 2006, is coordination of different policies, including R&D and innovation policy, but this task has not been yet implemented.

Research funding system

![Diagram of Research Funding System]

Brief description

The Ministry of Higher Education, Science and Technology presents its programme in the government budget negotiations. The budget is first approved at the level of the Government. Government then submits the Bi-annual budget proposal for the procedure in the National Assembly. Once the R&D budget gets approved, most of the public research funds are then channelled through the Slovenian Research Agency. The Agency is the main implementation body for public R&D and distributes the resources according to the main programmes it runs. Few specific programmes in the Directorate for technology at the Ministry of Higher Education, Science and Technology are still coordinated by the Ministry itself. In 2006, these include the following measures: the support to technology centres, support to innovation organisations and support to development projects. The implementation of these programmes should go to the Slovenian Technology Agency, once the Agency becomes fully operational.
National public research funding
Overview

According to the latest available official statistical data, the government budget appropriations on R&D by type of transfer were structured in 2003 in the following manner:

- **R&D programmes and projects** account for **47%** of total government budget appropriations on R&D.
  - Of this, basic research received **32.6%** of the total or **69.5%** of R&D programmes.
  - The applied research accounted for **13.2%** of total or **28.0%** of resources available for research funding.
  - The least resources were received by the experimental development, which got only **1.2%** of total government budget or **2.5%** of the funds for R&D programmes.
- **Specific grants** for other measures in R&D area accounted for **49%** of total,
- **4%** of the resources are going into so called **general university funds**.

By the fields of science, the structure of GERD was in 2003 the following (Statistical Office of the Rep. of Slovenia, 2005):

- natural sciences 22.5%
- engineering 38.0%
- medical sciences 10.6%
- agriculture sciences 5.7%
- social sciences 12.8%
- humanities 10.4%.

Basic research funding

The largest share of the basic research is funded through so called "**Research programme funding**", a system established in 1999 to secure stability in funding basic research. The system provides for formation of research groups, formed within specific science discipline. Programme groups comprise a head of group, at least five researches holding a doctorate and technical staff from one or more research organisations. Programme members can take part only in one research programme. Researchers must have a doctorate, a record of research and development results for the last five years, and research titles in line with existing regulations. Young researchers may also participate in the programme group. Evaluation process is spelled out by the Slovenian Research Agency who is responsible for monitoring and administering programmes. So far, bibliometric criteria was favoured, especially scientific articles and citation indexes. In 2004, the [Slovenian Research Agency](#) funded the **Research Group Programmes** in the amount of 47.6 million EUR (Source: Annual Report of Slovenian Research Agency, 2005). According to the field of science, the share of engineering (technical sciences) was the highest at 32.1%, followed by natural sciences at 30.7%. Humanities accounted for
12.3, followed by social sciences at 9.5 and biotechnology at 9.3. The lowest was the share of research programmes in medical sciences at 6.0%. In terms of research performers, most of the financial resources went to public research institutes (51.2%), University of Ljubljana received 33.7%, University of Maribor 7.2%, University Primorska 0.9% and 6.9% of funds went to other recipients, not specified in the Agency's financial summary.

Besides Research Group Programmes, another scheme for financing basic research projects is operated by the Slovenian Science Agency, distributing funds in vicinity of 20% of the Research programme financing. This scheme includes basic research projects of shorter (up to three years) period and the leading recipients in terms of science field were in 2004 medical sciences (32.6%), humanities (23.2%) and natural sciences (20.0%).

**Thematic priorities and other targeted funds**

While the funding of the basic research, organized via Research programmes, does not define specific thematic priorities and selection of programme groups depends primarily on the scientific excellence of the Research programme group and its head researcher, a more targeted funding mode is used for commissioning specific research to assist in public policy. These schemes are known as Target Research Projects. The thematic priorities are specified by each of the interested Ministries, with the aim of the scheme being the provision of scientific support to policy makers in the preparation of their programmes and policies or in the evaluation of the existing programmes.

Annual call coordinated by the Slovenian Research Agency is announced, divided in the thematic priorities in the Slovenian Development Strategy, attributed to specific Ministry. In each priority, the responsible Ministry defines the topics of research connected to its policies (some more broadly, some relatively narrow and specific) and invites the research community to propose projects. Projects can run from one to four years, with semi-annual reporting and annual evaluation. In 2004, theTargeted research projects were allocated little under 3 million EUR, with approximately 60% coming from the ex-Ministry of Education, Science and Sports. The largest recipients of the funds were social sciences, since majority of the target fields related to societal issues (human resources and social cohesion, balanced regional development, economic competitiveness, information society, etc.). In June 2006, a new call for Target Research Projects to support the implementation of the Slovenian Development Strategy 2007-2013 was announced. As a rule, the Ministry of Higher Education, Science and Technology co-finances research set forth by other ministries and does not have its own independent agenda of priorities. In 2006, the Ministry of Defence commissioned the Science Agency to coordinate Target research project named Development for Peace, where topics of specific interest for the Ministry were announced.
Institutional funding

According to the provisions in the Law on research and development (Official gazette of the Republic of Slovenia 96/02 and 115/02), the institutional funding are the obligations of the founder (the government) towards public research and infrastructural institutes (The infrastructure institutes are: Institute of Information Science, which operates Information system on Slovenian Science SICRIS and Co-operative Online Bibliographic System and Services- COBISS). Through these funds, the Research Agency covers the fixed operating costs of the research or infrastructural activities of these institutions. Universities receive their institutional funding from another channel, specifically dedicated to higher education institutions' research institutional funding (not to be confused with institutional funding the universities receive for their teaching activities).

The covering of costs under the founder's obligations comprises: administrative costs, fixed operating costs, and the fixed costs of maintaining and repairing property and equipment. The total amount allocated to institutional funding was 15.6 million EUR (Source: www.arrs.si).

Co-funding and indirect funding of private R&D

Since no official figure is published on public-private partnerships in R&D, only approximation of the amount of co-funding can be given, assuming that all of the applied research projects are co-funded. The allocation of the Research Agency for financing of applied projects in 2004 was about 8.6 million EUR and participation of business enterprises should be minimum 25% (but may be higher). Another approximation may be the share of business sector in financing research performed in government sector and in higher education sector- this amounted to 9% of total funds available to public R&D in 2003 (Source: Statistical Office of the Rep. of Slovenia, 2005). Promotion of public-private research partnership is one of the objectives of the National Reform Programme for Achieving the Lisbon Strategy Goals.

Research performers

Universities

Currently, Slovenia has four universities University of Ljubljana; University of Maribor; University of Primorska and Politehnika. The first three are public universities, funded for their academic tasks mostly by the government. Their research activities are financed in the vicinity of 80% by the public sources. In the spring 2006, a new University has been established (Politehnika, Nova Gorica) the first example of private public partnership in this area. Politehnika as a higher education institution works for more than a decade now, but with the expansion of its programmes it initiated a process of transformation into the university.
Public research organisations

There are 47 research institutes in government sector, employing 1939 researchers. Those of them who have the Ministry of Higher Education, Science and Technology as their founder are entitled for institutional funding. The percentage that institutional funding represents varies from institute to institute, but on average institutes report that 10 - 30% of their budget is covered this way. Institutes can apply with their research groups for research programme funding, for applied projects if they have co-financing from business sector or direct contracts with business sector (National Research and Development Programme).

Research and technology organisations

One of the early measures to promote cooperation between business sector and public research that Slovenia introduced was the formation of technology centres. The system of technology centres has been promoted and systematically developed over the last 10 years. Technology centres are independent legal entities established by several companies for the purposes of R&D in a specific field or branch, as well as for the provision of R&D equipment subsequently made available to companies for their development projects. If a company is understaffed in the R&D field, the personnel from the technology centre provides services for them.

Private research performers

According to the Statistical Office Rapid Report of Feb. 2006, there are 277 research organisations registered in business sector, employing 4499 R&D personnel (FTE), with 1620 classified as researchers, 1082 as expert personnel and 1305 as technicians in 2004. More than 56% of research conducted in business sector is applied research, and additional 40% is experimental development.

Important policy documents

National Research Programme

Strategic objectives:

- increased transfer and use of knowledge for economic, social and cultural development;
- building of qualitative and strong base of researchers for scientific research and RTD activities in industry;
- long-term RTD priorities are those that are needed for qualitative higher and post-graduate education as well as those with big applicability potentials and relevance to economic, social and cultural development.

Priority tasks:

- increased investments in RTD (level of EU average should be reached by 2007);
- increased share of applied research and development from public sources (by 2007: 40% - basic research, 30% - applied research and 30% - development);
- strengthening of national innovation policy;
bigger concentration of public finances on priority areas;
stimulation of co-operation between research institutes, universities and business sector;
stimulation of absorbing capacity for knowledge and technology transfer from research sphere into business sector;
support to private research institutes and strengthening of RTD units in business sector;
stimulation of mobility of researchers, international co-operation;
expanding public understanding of science etc.

Slovenia’s Development Strategy for 2005-2013
The preparation of Slovenia’s Development Strategy (SDS) started on 7 July 2003 when the government decided to commence drafting the Strategy and assigned its expert co-ordination to the Institute of Macroeconomic Analysis and Development (IMAD). The Prime Minister appointed a group of experts, which submitted the first outline of the SDS in September 2003. The outline defined the Strategy’s ten main programme areas. In June 2005 the government adopted the draft Strategy which was then submitted for broad public discussion. Parallel discussions took place in other forums and organisations that responded to the government’s general invitation to participate in the debate, as well as at the IMAD’s website and in the media. After the public debate was closed, the IMAD prepared the Report on the Public Debate, which included key recommendations to the government concerning the completion of individual chapters and guidelines in the draft. The public debate generally signalled that the Strategy’s main objectives were broadly accepted. The government was then expected to further elaborate the SDS’ targets and planned measures in the final version of the document, and to make a clear political commitment to the Strategy’s realisation.

Swedish R&D system

Research and development have had high priority in Sweden in recent decades. In 2001 Swedish R&D expenditure totalled 4.3% of GDP, putting the country number one among the 29 countries of the Organization for Economic Cooperation and Development in terms of R&D investments as a percentage of GDP. The business sector accounted for 78% of R&D expenditure, the higher education sector 19%, other public sector institutions and the private non-profit sector the remaining 3%. As for research financed by the State (central government), R&D appropriations for the 2003 budget year were SEK 23.7 billion.

The high standard of Swedish research is internationally recognised. Independent evaluations almost consistently give high marks to Swedish researchers and show that Swedish research pursued as part of European Union common programs is of high scientific quality.

Selection of the main public actors in the Swedish innovation system and the major flows of public R&D investments 2005

Brief description

General policy is formulated by the government and the Ministry of Education, Research and Culture, the Ministry of Industry, Employment and Communication and the Ministry of Defence. The government and the ministries are supported by the Research Policy Council (RPC) (part of the Ministry of Education, Research and Culture), the Innovation...
Policy Council (IPC) (part of the Ministry of Industry, Employment and Communication) and the Institute for Growth Policy Studies (ITPS), but neither body has any formal authority meaning that they are reduced to advisory functions. On the regional level, policy is formulated in Regional Growth Programmes (RTP) engaging regional stakeholder.

R&D in Sweden is mainly performed by the country's 16 universities (to a limited extent supported by 16 university colleges). These are not only responsible for curiosity-driven research, but they are also technically responsible for most of the mission-oriented R&D and related technology transfer. Approximately 30 mission-oriented research institutes account for a small proportion of the total R&D capacity, but despite their relatively modest collective size, the research institutes are largely quite successful intermediaries between research and industrial application, particularly for SMEs, thus playing a vital role in the innovation system.

**The evolution of the research system**

State investment in research is a long tradition in Sweden. Public resources for research have traditionally gone straight to the universities. In the 1940s, however, a system of research councils along American and British lines gradually began to take shape in Sweden. This meant that a system of flexible research funding was introduced. During the 1960s, research resources increased sharply due to the expansion of the higher education system and heavier investments in sectoral research.

Given larger research resources and an increasingly complex financing system, the need for a national research policy arose. In 1979 the government introduced its first research policy bill. In conjunction with this, Parliament decided that a bill of this kind should be submitted to it during each parliamentary term of office. These bills would serve as instruments for long-range planning and coordination of public sector R&D investments.

When Parliament adopted the 1979 research policy bill, it also established the “sectoral research principle,” which has been a key element of Swedish research policy ever since. According to this principle, each sector of society makes an assessment of its need for R&D programs and weighs these against other needs in order to promote the development of that sector.

Most basic research in Sweden takes place at the universities, university colleges and a handful of private universities that make up the Swedish higher education system. These institutions are allocated basic resources for research from the State, but there are also many other sources.

In the 1970s and 1980s, the Swedish public system of financing research developed into a pluralistic system with numerous financiers who were independent of each other. The basic research councils were one part of the system, the many sectoral public agencies with R&D resources another. In addition, the early 1990s saw the establishment of a number of research foundations aimed at financing research in specific areas.
Responsibilities of Parliament and government

The State has overall responsibility for ensuring that Sweden develops and makes use of new knowledge. The State has a special responsibility for guaranteeing freedom of research and for supporting basic research and postgraduate (doctoral) training. Since basic research and postgraduate training are the basis for other development and knowledge transfer, they are vital in meeting the needs of society, including the business sector, for knowledge and skills.

Over the years, basic research has contributed many pioneering scientific discoveries. Modern basic research can hardly be conducted on a reasonable scale without public funding. One reason for this is that the long-term pursuit of knowledge entails a high level of risk, since it is difficult to assess in advance the future usefulness of research findings. State support for basic research is also vital to safeguard the strong scientific tradition of publishing research findings, thereby ensuring that the results of basic research are freely available. One fundamental principle of the Swedish system is that the government and Parliament allocate public funds to the different scientific fields, while researchers decide how the funds in each field should be spent.

The Ministry of Education, Research and Culture has overall responsibility for the coordination of research policy in the Government Offices. It initiates and oversees the preparation of the research policy bills submitted during each parliamentary term of office. Because research resources exist within the scope of all the ministries, the Ministry of Education and Science drafts its research policy bills in active collaboration with other ministries.

The Minister of Education and Science chairs a Research Advisory Board. Its other members are researchers and representatives of the business sector. The government has also appointed a scientific advisor, who is entrusted with promoting the interests of research and its role in society.

As innovation policy embraces several policy fields, a crucial aspect of governance is coordination. Coordination of the Swedish innovation policy is a complex issue. At the ministry-level the question of coordination is handled by extensive use of ad-hoc groups and other temporary constellations.

Organization of State-financed research

State research funds are allocated both by means of direct appropriations to higher education institutions and by means of appropriations to research councils and sectoral research agencies. Research resources thus consist of a fixed portion in the form of appropriations to each scientific field in the higher education system and a flexible portion in the form of funds sought by competing researchers from the research councils, sectoral agencies and research foundations.
Actors that provide policy support and finance innovation activities and R&D

Among the public actors that provide support and financial means for innovation and R&D activities a distinction can be made between research councils, sector agencies, foundations and bodies for policy support. The actors of curiosity driven research control some 56 percent of the public R&D resources, while the corresponding figure for the mission oriented agencies is 42 percent, 20 percent of which was dedicated to defence.

The government’s research policy

More concerted research efforts are required if Sweden is to consolidate its position as a leading research nation. Swedish research must become better at setting priorities and demonstrating excellence in crucial research fields. The new organization for research funding facilitates concentrated programs in important areas, including inter- and multidisciplinary research.

Since 2001 the government has been investing extra funds in a number of priority fields:

- Biotechnology and biological science
- Information technology and IT research
- Materials technology and materials-science
- Environment and sustainable development
- Humanities and social sciences
- Educational science
- Art
- Health and social services research

Research funding system

Brief description

Total Swedish investments in R&D correspond to approximately 4% of GDP in 2003. Industry’s investments in R&D are roughly three times larger than public investments, but the bulk of the industry investments are company-internal. Public investments in R&D correspond to 1% of GDP or approximately SEK25 billion (€2.7 billion). Local authorities contribute another 28% (high estimate; official statistical data not available) while a handful of semi-public research foundations contribute another 6%. Private foundations and international organisations, including the EU, make additional contributions.
National public research funding

Overview

The government annually invests some SEK25 billion (€2.7 billion) in R&D and six semi-public research foundations contribute another SEK1.5 billion (€0.17 billion). Estimates of the contributions from local authorities and county councils range up to SEK7 billion (~€0.8 billion), but official statistics are not available. Of the Swedish government’s direct R&D investment, 56% goes to curiosity-driven research and 42% to mission-oriented R&D (20% to defence-related research and 22% to non-defence-related research). The clear majority of the investment in curiosity-driven research (SEK11 billion; €1.2 billion) is transferred directly to the universities and the university colleges and the remainder is funnelled through three research councils. A range of sector agencies manages the investment that is not directly defence-related.

The main flows of public R&D funding from the government are through:

- Ministry of Education, Research and Culture (52% of government R&D funding); mainly to universities and university colleges, and to research councils
- Ministry of Defence (20%); mainly to defence agencies
- Ministry of Industry, Employment and Communications (13%); mainly to sector agencies

The main beneficiaries of government R&D funding are universities and university colleges, which ultimately receive over 60% of the total, and industry, which receives around 20%.

In recent years, the defence sector has been restructured, resulting in a dramatic reduction in government R&D funding, meaning that the relative proportion of R&D funds to this sector is likely to plummet.

Basic research funding

Universities and university colleges ultimately receive over 60% of the government’s investments in R&D, of which 43% is directly disbursed from the government. The remainder of the government’s investments in curiosity-driven R&D is managed by three research councils:

- **Swedish Research Council** (VR), supporting basic research in all fields of science (€ 283 millions)
- **Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning** (FORMAS) (€ 59 millions)
- **Swedish Council for Working Life and Social Research** (FAS)

VR clearly dominates with a budget approximately double that of FORMAS and FAS together. With few exceptions, grants from the research councils go to universities. Curiosity-driven R&D is also funded by six semi-public research foundations. The two dominant are the **Swedish Foundation for Strategic Research** (SSF; supporting research in natural science, engineering and medicine) and the **Knowledge Foundation** (KKS; supporting research at new universities and university colleges) and to a limited extent by sector agencies, such as **VINNOVA** (supporting research and development in technology, transport and working life) (approximately € 117 millions).

All basic research funding from research councils and sector agencies, as well as most from semi-public research foundations, is allocated through peer-review systems. With few exceptions, funding goes to Swedish organisations.

Thematic priorities and other targeted funds

The most recent research policy bill defines three prioritised research areas, namely life science, engineering and sustainable development to which additional funds will be allocated to further reinforce previous bills’ emphasis on support of these areas.

- The additional funds allocated to the area of life science (medical research) will be distributed through **Swedish Research Council** (VR) and to a lesser degree **Swedish Council for Working Life and Social Research** (FAS), which both use competitive calls and peer reviews.
- The additional funds allocated to the area of engineering (technological research) will be distributed through Swedish Research Council, **VINNOVA** and to a lesser degree SNSB (Swedish National Space Board), which all use competitive calls and peer reviews.
- The additional funds allocated to the area of sustainable development will be distributed through **Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning** (FORMAS), Swedish Research Council and to a lesser degree VINNOVA, which all use competitive calls and peer reviews.

In addition to these prioritised research areas, the bill provides additional long-term funding for centres of excellence in both curiosity-driven and mission-oriented research,
which is allocated through several research councils and sector agencies. Evaluation processes feature competitive calls using international peers. Following ramp-up, this funding will total SEK300 million per annum from 2008 and onwards and grants will be for up to SEK10 million per annum per centre for a period of up to 10 years. The bill further earmarks funds to facilitate academic careers for young people in order to prepare for the fact that 45% of all teaching and research staff at Swedish universities retire within 15 years. The bulk of these funds are allocated directly to universities to facilitate postgraduate education and postdoctoral positions. Further funding is targeted for competitive calls for postdoctoral positions and for a new type of graduate school and is distributed through the three research councils and VINNOVA.

**Institutional funding**

The non-academic research performing organisations are plentiful and very non-homogenous, meaning that it is difficult to provide a general description. There are several government agencies that receive all or most of their funding directly from the government on an annual basis. There are also a few NGOs that receive varying levels of government funding. A somewhat homogenous group are the research receive some base funding from governmental sources €37 million (SEK 350 million), but the nature of such funding and the ways in which it is disbursed varies significantly depending on the institute’s field of responsibility. In some cases, funds are directly disbursed from three ministries, in others through sector agencies and semi-public research foundations. A common trait is that base funding is provided on a level considerably lower than in all comparable nations, meaning that Swedish institutes compete internationally on very uneven terms. In addition to meagre base funding, the institutes compete for R&D funds in open calls from VINNOVA, EU etc. However, industry accounts for on the order of half of the institutes’ budgets (although variations are large).

**Co-funding and indirect funding of private R&D**

Historically, comprehensive public-private partnerships have played an important role in Sweden and have facilitated the development of several successful multinational corporations, but such public-private partnerships have largely ceased due to deregulation and globalisation. Current public-private partnerships are of different nature and considerable smaller in scope. Key policy instruments for public-private partnerships include:

- Academically based competence centres that feature notable industry involvement (such as those funded by VINNOVA, the Swedish Research Council, the Foundation for Strategic Research and the Knowledge Foundation)
- Research-institute based competence centres that feature notable industry involvement (such as those funded by VINNOVA, The Foundation for Strategic Research and the Knowledge Foundation)
- A range of programmes funded by VINNOVA, such as VINNVÄXT, VAMP and AIS as well as thematic programmes
The programmes mentioned in the last bullet typically have in common that they aim to support mission-oriented, pre-competitive R&D in collaboration between R&D providers and industry. Typically, private enterprises make in-kind contributions amounting to 50% of the project budget, while R&D providers receive equally much in public funding. This form of collaboration is generally much appreciated by both industry and R&D providers, but both categories of stakeholders find that funding is insufficient both in terms of overall budget and in terms of it being spread onto too many, too small projects requiring too much bureaucracy.

**Equality between the sexes must improve in research**

Equality between women and men affects all areas of society. Sweden has made significant progress in creating the same formal conditions and requirements for women and men. In practice, however, there are still major inequities between men and women. The government believes that the proportion of women in Swedish research must continue to increase. The small percentage of women in high-level academic posts demonstrates that Sweden has a long way to go before achieving equality between the sexes in research. To keep women in the academic world, they must be given the same opportunities for academic careers as men.

In order to achieve greater gender equality in higher education, institutions of higher education may apply positive discrimination when recruiting staff to graduate schools and to other positions. This means that when competing applicants have equal or nearly equal qualifications, preference may be given to applicants of the underrepresented sex. In addition, supervisors in postgraduate studies will be given training in gender equality and gender perspective issues.

**Research ethics of growing importance**

The great importance of science and technology to society and its evolution makes research ethics an issue of major interest to the general public. Research raises many ethical issues. For example, its methods may be ethically problematic because they involve experiments on humans or animals or be based on combining sensitive individual data. One example is the extensive debate about the ethics of stem cell research. Other ethical considerations are the matters of objectivity and expertise in evaluating research and assessing societal problems. The government believes that researchers must enjoy great freedom in their work, especially when choosing what scientific or scholarly problems to focus on. At the same time, the research community must be open to discussions with the general public on the problems selected and the application of research findings.

A new central agency for research ethics was established in 2004. It decides upon appeals about research ethics received by local ethics boards.
Research performers

Universities

There are 14 state universities and 22 state university colleges in Sweden, as well as three private universities (Chalmers University of Technology, Stockholm School of Economics and Jönköping University). The clear majority of their funding is disbursed directly from the government through the Ministry of Education, Research and Culture. Additional R&D funding is secured in open calls from research councils, sector agencies, research foundation (semi-public and private) and the EU as well as from industry. Most universities and university colleges are in some form of financial difficulty due to reduced funding per student, reduced base funding for R&D and increased costs, most notably for offices and laboratories.

In 2005, 24867 people were employed as teachers and researchers at the universities and university colleges and there were 9882 PhD students (Statistic Sweden).

Swedish universities and university colleges have three missions: to educate, to perform research and to interact with society. The latter, the so-called “third mission” was added in 1977, and includes technology transfer (among other things), and is the subject of ample debate.

Public research organisations

The non-academic research performing organisations are plentiful and very non-homogenous, meaning that it is difficult to provide general descriptions as well as to determine absolute numbers overall or in any subcategory. There are several government agencies engaged in research in fields of national importance, such as Swedish Defence Research Agency (FOI) (with approximately 1250 employees), Swedish Institute for Infectious Disease Control (SMI), Swedish Radiation Protection Authority (SSI) and Swedish Meteorological and Hydrological Institute (SMHI). These organisations pursue so-called commission research.

Private research performers

There are no noteworthy private R&D providers in Sweden (i.e. companies having R&D as their main business concept, however all larger firms invest in in-house R&D, e.g. Ericsson, SAAB), but a plethora of consultancies provide services that may formally be classified as R&D in statistics.

Partnerships

Encouraged by the success of the initial competence centre programme, VINNOVA currently funds 4 new competence centres (now called VINN Excellence Centres) and is in the process of selecting 15 additional centres. On the same note, VINNOVA and the Swedish Research Council are in the process of selecting 4 competence centres (Berzelii centres) focusing on excellence in curiosity-driven research fields and requiring industry
involvement, while the Swedish Research Council and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning similarly are in the process of selecting approximately 20 competence centres (Linneaus grants) focusing on excellence in curiosity-driven research fields but do not require industry involvement. Moreover, together with the Knowledge Foundation and the Swedish Foundation for Strategic Research, VINNOVA is in the process of launching six-year mission-oriented competence centres (Institute Excellence Centres) based at research institutes.

**Important policy documents**


The key priorities set out in the document are the following:

Supporting the development of a strong knowledge base for innovation by:
- ensuring that Swedish education and research are of world class
- concentrating efforts in Swedish profile areas
- seizing the opportunities presented by globalisation

Supporting an innovative trade and industry by:
- strengthening the innovative capacity of existing small and medium-sized enterprises
- increasing the commercialisation of research results and ideas

Supporting innovative public investments by:
- using the public sector as an engine for sustainable growth
- promoting renewal and efficiency in the public sector
- developing infrastructure that promotes renewal and sustainable growth

Supporting innovative people by:
- stimulating entrepreneurship and enterprise
- making the most of people’s skills
R&D and Innovation in Switzerland

Basic characterisation of the research system

Switzerland is a country with a high R&D intensity. The intramuros R&D expenditure of the business sector amounted 2004 to 2.2% of GDP. This is one of the highest R&D intensities among OECD countries. Between 2000 and 2004 the R&D expenditure of the business sector increased by 18% in real terms, which implies an average annual real growth of 4.2%. The increase of R&D expenditure that is financed publicly raised only slightly in this period so that the share of public R&D became smaller, namely about 23% in 2004 (1992: 28%). As it is evident from this figure, private R&D expenditure with a share of 70% of total R&D in 2004 (1992: 67%) plays a prominent role in the Swiss research system. In addition, about 5% of R&D expenditure comes from abroad (1992: 1.9%).

The Swiss research system is guided and monitored by the Cantonal Governments, when it comes to the universities and partly for the universities of applied sciences (UAS), and by the Federal Government, when it comes to the Federal Institutes of Technology (ETH) comprising the ETH Zurich, the EPF Lausanne and the four research institutions (Paul Scherrer Institute (PSI), Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Swiss Federal Laboratory for Materials Testing and Research (EMPA), and Swiss Federal Institute for Environmental Science and Technology (EAWAG) as well as partly for the universities of applied sciences.

Furthermore the Federal Government promotes basic research through the "Scientific Institutions in article 6 and 16 of the Federal Law on Research" (e.g. Swiss Institute for Bioinformatics) and the Council of Swiss Scientific Academies (CASS), which consists of four scientific academies (Swiss academy of Humanities and Social Sciences, Swiss Academy of Medical Sciences, Swiss Academy of Sciences, Swiss Academy of Engineering Sciences). Government agency research is carried out in specific research centres or contracted-out to researchers/scientific institutions and thus also contributes to the research activities in Switzerland.

On an institutional, administrative level the federal research policy is designed and implemented mainly by the State Secretariat for Education and Research (SER) and the ETH-Board as well as the "Steering Committee" (it consists of the directors of the SER, the Federal Office for Professional Education and Technology (OPET), some other federal offices, the Swiss National Science Foundation (SNSF), the Innovation Promotion Agency (CTI) and the ETH-Council) as far as government agency research is concerned. The Swiss National Science Foundation is the most important funding institution for research activities. The Swiss Science and Technology Council (SSTC) is the main advisory body for research policy in Switzerland.
Structure of research system
Brief description

The responsibilities for research and education are distributed between the Federal Government/Parliament and Cantonal Governments/Parliaments. The Cantons are in charge of the universities and partly of the universities of applied sciences (UAS). The Confederation is in charge of the ETH-domain, partly of the universities of applied sciences and of overall innovation promotion.

In order to co-ordinate different levels of government several “bridging” institutions were founded. University policies are co-ordinated through the SUK (supported by OAQ (Centre of Accreditation and Quality Assurance of the Swiss Universities)). UAS policies are co-ordinated through the UAS-Council. According to the “Federal Law on Research” the Swiss Science and Technology Council SSTC is primarily an advisory board for the Federal Council, but it also acts as an advisory council for the Cantonal, thus undertaking a 'bridging' function. The Rectors' Conference of Swiss Universities CRUS and the EDK are co-ordinating and steering Cantonal universities and the UAS by taking into account the work of the respective bridging institutions respectively (see Figure).

At the federal level, the responsibility for policy-making for “research and education” is separated institutionally from that for policy for “industry and innovation”. This is in line with the structure of comparable other European countries (see Arnold et al.(2004)). Evaluation of the Austrian Industrial Research Promotion Fund (FFF) and the Austrian Science Fund (FWF), Synthesis Report, Vienna). The EDI (department of internal affairs) is in charge of research and education policy. The EVD (department of economic affairs) is in charge of innovation and industry policy. The two Departments are co-ordinating among themselves and the EVD their international activities in research and technology (mainly with the EU).

The several Government agencies’ activities in the fields of research and technology are co-ordinated by a common “Steering Committee” (consisting of representatives from the State Sectrariat for Education and Research SER, Federal Office for professional Education and Technology OPET, other Federal Offices, ETH-Board, Swiss National Science Foundation SNSF, and the Innovation Promotion Agency CTI which is headed by the directors of SER (EDI) and OPET (EVD). This committee is the most important platform for public research/innovation policy and co-ordination in Switzerland.

Funding activities for basic research and more applied research (technology transfer) are essentially carried out by the SNSF and CTI respectively. These institutions also play an important (informal in the case of SNSF) role in policy-making and in shaping the Swiss research and innovation system from a public perspective.

The steering and the vertical as well as horizontal co-ordination of the innovation system from a public perspective is mainly carried out by the SER and the "Steering Committee” respectively.
Main research policy setting mechanisms
Government policy making and coordination

The ERT-message is the most important policy paper in Switzerland. It provides background information on the national science and technology system, its challenges and measures to address them. Basically it delivers the reasoning for the necessary changes in law for the federal Parliament in order to improve the framework conditions for research, technology and education. The ERT-message is issued and presented to the parliament by the Federal council. However it is conceptualised by parts of the administration. Representatives of the State Secretariat for Education and Research SER (EDI) and the Federal Office for Professional Education and Technology OPET (EVD) head the “Steering Committee” that mainly carries the work load to create the ERT-message. The “Steering Committee” consists of representatives from the SER, the OPET, other Federal Offices, the ETH-Board, Swiss National Science Foundation SNSF, and the Innovation Promotion Agency CTI.

Cantonal interests in research policy should be considered at least through the SER and the OPET, since representatives of these ministries are part of the “bridging institutions”. The first draft of the ERT-message may also to some extent mirror the interests of stakeholders outside the administration. However they do not have a formal influence at this stage of the process. The Federal council issues the first draft for public consultation (Vernehmlassungsverfahren), which is a typical instrument for Switzerland to consider
the public opinion on law proposals. Pressure groups, unions and employers’ representatives are invited by the government to comment on it. The Federal council may consider the suggestions and issue a second draft of the ERT-message that will be presented to the Parliament for consultation and approval. Thus, the Parliament plays an important role as to research policy.

The SER develops and implements federal policy in the area of science, research, institutions of higher and general education. Its activities are focused on financing the national institutions which promote research, above all the SNSF and the Academies of Science. It also promotes national research institutions and scientific assistance services. On an international level it represents Switzerland in a number of international organisations/institutions (e.g. COST, FP6, CERN, EURATOM).

The ETH-Council steers and designs science policy in the ETH-domain. It consists of two Swiss Federal Institutes of Technology in Zurich (ETH Zurich) and Lausanne (EPF Lausanne) and the four federal research institutions.

The main responsibility of the Cantonal Governments lies in the areas of education, university policy and, as a partner of the central Government, policy for the UAS. The main steering institution for higher education and research taking account of the federal structure of the country is the EDK (Swiss Conference of Cantonal Ministers of Education). The EDK promotes co-operation among the cantons and aims at a common policy for education and culture and a permanent exchange of information and experience. The UAS Council is part of the EDK and focuses on the steering of the UAS and balances cantonal and federal interests in this area.

**Research funding**

**Brief description**

23% of all R&D spending in Switzerland came 2004 from the state (16% from the federal government; 7% from the cantons). The respective figure was considerable higher at the beginning of the nineties (1992: 28%) and decreased continously in the period 1992-2000. 5% of total R&D expenditure came 2004 from abroad (1992: 2%). The business sector contributed 70% of total R&D spending in 2004 (1992: 67%). Thus, the share of privately finaced R&D expenditure has raised in the nineties by 3 percentage points.

Funding from the Federal Government for education/research organisations increased between 2000-2003 and 2004-2007 by 18%. The funding activities comprise:

- the tertiary education sector (ETH-domain, cantonal universities (partly), universities of applied sciences (partly)),
- the main funding organisation (Swiss National Science Foundation SNSF, Innovation promotion Agency CTI),
- the scientific academies (CASS) and the Institutions in art. 6 and 16 federal law on research, and
- the government agency research.
In addition to these funding activities and not included in the table are the governmental funding activities for specific institutions, like the CSEM (Swiss Centre for Electronics and Microtechnology, Inc.) and the Top Nano/IMP (Institute for mechatronic production systems and precision manufacturing). The CSEM received ca. 82 mio. CHF (52 mio. Euro) in the period 2000-2003 and should receive 96 mio. CHF (61 mio. Euro) in the period 2004-2007. Top Nano/IMP/Valorisation received ca. 56 mio. CHF (36 mio. Euro) in the period 2000-2003 and should receive 24 mio. CHF (15 mio. Euro) for the period 2004-2007.

While the funding for SNSF, CASS and Institutions in art. 6 and 16 is provided through the Secretariat for Education and Research SER, the funding for the CTI is provided through the Federal Office for Professional Education and Technology OPET (see figure above). Third-party funding for public research organisations increased between 1995 and 2003. Universities/ETH are raising private funds with increasing success. The proportion of regular public funding decreased from about 80% in 1995 to 78% in 2003 (see Swiss Federal Statistical Office, Indicators of Science and Technology http://www.bfs.admin.ch/bfs/portal/de/index/themen/bildung_und_wissenschaft/indicateurs/st/ind2.indicator.20204.html).

Information on the budgets of the cantonal universities is available only for the period 2000-2003. All Cantonal universities have spent about 2.1 billion. euro in the year 2000 for education and research stemming from their regular canton-financed budgets (including federal subsidies). Another 515 million euro) came from other sources (SNF, other third-party funding sources). In the year 2004 these positions amounted to about 2.5 billion euro and 640 million euro, respectively. Thus, the cantonal expenditures grew by about 18%, funding through third-party sources by about 24%.

Information on the budgets of the universities of applied sciences is available only for the year 2004. The total expenditure of all universities of applied sciences amounted to about 890 million euro for this year. 188 million euro or ca. 22%, came from the federal government, 505 million euro or ca. 58%, from the cantons and 177 million euro or ca 20%, from the business sector.

**National public research funding**

**Overview**

Public research is basically carried out in the following institutions:
- Federal institutes of technology (ETH-Zurich, EPF-Lausanne and 4 research institutions (Paul Scherrer Institute (PSI), Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Swiss Federal Laboratories for Materials Testing and Research (EMPA), Swiss Federal Institute for Environmental Science and Technology (EAWAG)).
- Nine cantonal universities
- Seven universities of applied sciences
- Furthermore the Federal Government funds the “Scientific Institutions in article 6 and 16 of the Federal Law on Research”, i.e. Swiss Centre for Electronics and
Microtechnology (CSEM), Centre Suisse de Recherche et d'Information sur le Vitrail (CSRIV), Institut Dalle Molle d'Intelligence Artificielle Perceptive (IDIAP), Swiss Institute of Bioinformatics (SIB), Institute for Research in Biomedicine (IRB), Cantonal Observatory of Neuchâtel (ON) Swiss Institute for Applied Cancer Research (SIAK), Swiss Tropical Institute (STI), and the “Council of Swiss Scientific Academies” (CASS), which consists of four scientific academies, i.e. Swiss Academy of Humanities and Social Sciences, Swiss Academy of Medical Sciences, Swiss Academy of Sciences, Swiss Academy of Engineering Sciences.

• “Government agency research”. Research is carried out in specific research centres or contracted-out to researchers/scientific institutions.

The table in the overview section provides an overview of federal funding for public research organisations. The budget for two different periods is shown as well as the absolute and relative change for the different ERT (education, research, technology) areas. According to the budget projections for the period 2004-2007 the Federal Government is intending to spend more for investment in ERT-areas (+18%). Funding is re-allocated within the ERT-areas: the budget for Government agencies’ research decreases strongly, while the budgets for all other areas experience an increase.

The table contains detailed information only at the federal level, because more detailed information for the cantonal universities and the regional universities of applied sciences are not easily available.

**Basic research funding**

Beside the funding of the education and research organisations, like ETH, cantonal universities and UAS, basic research is promoted mainly by the Swiss National Science Foundation SNSF. The SNSF is a foundation, which receives the great bulk of its budget from the federal parliament. The SNSF has to line out its strategy for the coming 4 year period, which is important for budget negotiations. However budgets are not individually negotiated, the discussion comprises the whole budget for ERT areas and in relation to other issues, like agriculture or national defense expenditures. The SNSF funding activities comprise targeted and non-targeted funding, while the fields for targeted activities are suggested by the Parliament, e.g. topics for new NCCRs (National Centres for Competence in Research). For the areas of targeted research promotion please refer to the next section.

**Thematic priorities and other targeted funds**

The SNF runs several programmes: National Programmes: National Research Programmes, Priority Programmes, National Centres of Competence in Research. Several international Programmes: Eastern Europe: SCOPES, Eastern Europe: ESTROM, Developing Countries, European Science Foundation (for a description of the research programmes please refer to the SNF). Thematic priorities are strongly depending on the type of programme, lasting from the promotion of new technologies (e.g. biotech).
In recent years the priority programmes were phased out and substituted by the National Centres of Competence in Research (NCCR). Although both types of programmes are focusing on basic research, the NCCR are more strategic in nature. They have a longer life-span (10 years) and aim at essentially strengthen the Swiss research infrastructure (basic research combined with post-graduate education).

**Institutional funding**

The federal government undertakes some institutional funding direct or via authorities. E.g. the Swiss Science and Technology Council SSTC is funded by the federal government as well as the above mentioned CSEM (Centre Suisse d'Electronique et de Microtechnique SA) to some extent. While the SSTC is mainly an advisory board for the Swiss administration and the Government, the CSEM is a privately held, knowledge-based company carrying out: applied research, product development and prototype and low-volume production. The CSEM is mainly active in the fields of micro/nanotechnology, microelectronics, systems engineering, information and communication technologies.

**Co-funding and indirect funding of private R&D**

There are not tax incentives schemes in Switzerland. Research funding in Switzerland focuses strongly on public private partnerships, while the Innovation Promotion Agency CTI is the most important funding institution in this area. Its promotion follows a bottom-up principle: the project partners (academics and business firms) define the projects on their own, with the business side covering at least half of the project costs (i.e. the business partners’ own project related expenditures). CTI funding of the second half is received only by the academic part of the co-operation. The CTI follows a kind of top-down approach also in the case of programmes for specific research areas, for example start-up and entrepreneurship, MedTech/Life Sciences etc.. In contrast to other countries, the CTI does not dedicate a specific amount of money to a programme. It promotes the applied research activities in one of the mentioned fields of knowledge and allocates the budget according to the accepted applications. By promoting only co-operations between business firms and (public-funded) research organisations, the CTI contributes to the intensification of network building between different agents in the Swiss innovation system.

**Research performers**

**Universities**

There are 3 types of universities in Switzerland, i.e. the federal institutes of technology with 4 dedicated research institutions (ETH-domain), the cantonal universities and the universities of applied sciences. Basically all types of universities are autonomous in their funding activities. However they receive great parts of their budget from the federal and or cantonal governments. Comparing regular funding with means from the Swiss
National Science Foundation (SNSF) and other third party funding one can observe the following development: in 1995 the budget of universities/ETH was financed by 80.9% through regular funding, 6.5% was provided by the SNSF and 12.6% was due to other third-party funding. In 2003 the respective figures were 78.5% regular funding, 6.9% SNSF and 14.6% other third-party funding. One observes an increase in other third-party funding, while the share of regular funding has slightly decreased.

Research and technology organisations

Most of the different types of universities or public research organisations have a mixed funding. However the public share is dominant in most of the organisations. The CSEM may be of some special interest for two reasons. Firstly, it is a public private partnership, where great parts of the budget are earned on the "private market". Secondly, there has been a recent change in the ownership structure. The federal government sold 20% of the CSEM to the Federal Institute of Technology Lausanne (EPFL). The EPFL hopes to improve the collaboration between research and industrial application and to contribute to a financial strengthening of the centre. The CSEM investigates the field of microtechnology, nanotechnology, system-engineering and communication technologies. It emphasises applied research and has a clear product focus. Around 40% of its budget is public-funded and the rest has to be financed by third-party funding. The EPFL pays EURO 2.6 mio. for the 20% stake and thus improves the financial background of the centre. In return, the EPFL has a representative in the administrative board and assigns the president of the scientific council of the center. In this way synergies could be realised between the basic research activities of the EPFL and the more applied research activities of the CSEM. From a Swiss perspective, it is an exceptional case that a public research institution takes a stake in a private research institution, even if this is partly public-funded.

Private research performers

The major private R&D spenders in Switzerland are in the following industries: pharmaceutical industry followed by the engineering industry, R&D industry, ICT producer, chemical industry, technology instruments, food, ICT services, insurances, metal.

Measured by the share of scientific publications for the period 1986–2002 the following private enterprises and/or private research organisations are the 'top ten' private research performers in Switzerland: Novartis (28% of all scientific publications of the business sector; 2.5% of all Swiss scientific publications); Roche (17%; 1.5%); Nestlé (6%; 0.6%); Fr. Miescher Institute (Novartis); Roche Centre for Medical Genomics (RCMG); IBM; Ares-Serono; ABB (Switzerland); Glaxo Smith Kline (Switzerland) and Sulzer.
**Important policy documents**

**Multi-Year Programme 2008-2011** - Challenges for Research Promotion and the Answers of the SNSF. Swiss National Science Foundation (SNSF), 2006

This document is the SNFS action programme (four-year plan); the SNFS is the main government agency for funding basic and applied research in Switzerland. It contains detailed information on the distribution of resources to the different research programmes.

**Education and Research in Switzerland** - Priorities of the Swiss Science and Technology Council (SSTC). Swiss Science and Technology Council, 2003.

The SSTC formulates concrete policy measures for nine priority areas:
1. structural reform of the Swiss university system (stronger autonomy and global budgets for every university; creation of a Swiss Academic Council that monitors the university system, advises single institutions, evaluates performance, formulates long-term strategy, etc.);
2. promotion of young researchers (training grants, more tenure-track faculty positions, etc.);
3. targeted promotion of long-term research (correcting the tendency of funding institutions in the last years to support short-term research);
4. strengthening of social sciences;
5. strengthening of clinical research;
6. improvement of knowledge transfer (knowledge transfer should become part of the mission of every Swiss university);
7. bringing together in the same federal department (ministry) the competencies for science, education, culture and technology that are now scattered in various departments;
8. increase of research funding;
9. stronger opening of the university towards the society.
Part IV International best practice

R&D and Innovation in Israel

Israel presents a unique blend of academic excellence, scientific innovation and entrepreneurial experience in basic and applied research through to the various stages of product development. Israel’s 7 universities as well as many colleges and government research centers are leading international academic institutions in such areas as computer science and engineering, electronics and the sciences. High-tech prosperity has also been a consequence of successful government policy through a range of R&D incentives administered by the Office of the Chief Scientist (OCS) at the Ministry of Industry, Trade and Labour.

R&D intensity in Israel in 2001 represented 4.8% of GDP – of the highest ratios alongside 4.27% in Sweden, 3.49 in Finland, 3.06% in Japan, and 2.8% in the USA and has kept the same pace over the last 4 years.

Israel is especially strong in the early stage development of new projects and transforming innovative ideas into marketable products. This entrepreneurial spirit encompasses a wide range of advanced technology sectors from biotechnology and medical equipment to electronics and electro-optics, Information Technology and software, communications and Internet applications, aerospace and new materials, safety and security systems. Many commercial developments are spin-offs from the leading edge defense systems developed in Israel.

Summary information for Israel (all data are for 2004, unless otherwise stated)

- National spending on civilian R&D is the highest in the world, at 4.8% of GDP (EUR 4.6 billion). (2nd is Sweden, with 4.1%). 78% of Israel's R&D spending is in the business sector.
- Israeli companies (428 in number) raised EUR 1,181 million in capital (from all sources), a 45% increase over 2003. Israeli Venture Capitalists raised EUR 584 million. This compares with EUR 1,088 million in the UK and EUR 632 million in France. This places Israel just behind California and Massachusetts, and ahead of any European country.
- 11% of Venture Capital fund investments went to the seed stage; and 28% to the early stage
- Israel was in 19th place in the global competitiveness rankings.
- Out of 100 top private companies in Europe, 20% were from Israel
- Entrepreneurship: Israel scored 7.95, compared to Ireland’s 6.85; and Germany’s 5.3
- Cooperation between Industry and Academia: Israel scored 6.89, compared to Finland’s 7.82 and Norway 6.04.
• The increase in ICT industry output contributed 62% of the total increase in output by the entire business sector in 2003.
• ICT products as a percentage of the total business sector, 2000: 19.9%, compared to 16.5% in Ireland and 15.6% in Finland.
• Quality of University Education: Israel scored 8.05, compared to Finland’s 8.22 and Switzerland’s 7.74.
• Scientists & technicians per 10,000 workers: Israel: 140, USA: 83, Germany: 60.
• University revenues from the commercialisation of research: Weizmann Institute of Science: EUR 48 million, Hebrew University of Jerusalem: EUR 24 million; c.f. MIT: EUR 21 million, Harvard University: EUR 12 million.
• 8.3% of business sector employees work in ICT industries, as opposed to 4.7% in Germany and 4.4% in Spain.

Israel’s R&D Capacity

Academic Excellence
• Some 30% of the total R&D carried out in Israel (including the defense sector) and 45% of civilian R&D takes place at the country’s universities, colleges and R&D centers.
• About half of Israel’s 220,000 students currently in academic programs are studying medicine, the sciences or engineering.

Unique Human Resources
• Israel has 135 academically educated engineers and scientists per 10,000 population compared to 81 per 10,000 in the US.
• There are nearly 70,000 scientists and engineers working in advanced technology industries.
• There are 30,000 scientists and engineers engaged in academic research.
• Immigrants from Russia imported unique knowledge from different areas of science.
• Many scientists and engineers served as army officers and are used to real-time decision making under pressure, team coordination and flexible thinking.

Synergy between Academia and Industry
• Israel’s universities work closely with industry. University researchers have a keen awareness of market needs and hands-on industrial experience. At the same time scientists and engineers in Israeli industry maintain their rigorous academic standards and openness to new ideas, directions and discoveries.
• All 7 universities have their own technology transfer companies, which take out thousands of new international patents each year.
• Most Israeli universities have holdings in technological incubators for start-up companies and have ties with nearby high-tech industrial parks.
• Many of the world’s leading IT and medical equipment companies have set up R&D centers and laboratories in Israel either on or close to Israeli campuses amongst them INTEL, Motorola, Applied Materials.
• Programs to promote projects in various disciplines and enhance contacts between academia and industry, like “MAGNET”, set up by the Office of the Chief Scientist of the Ministry of Industry, Trade and Labor, to form consortia of university research departments and advanced technology companies.

Israeli R&D and innovation policy making and delivery structures

The structure of Israel's R&D system is centred on the Office of the Chief Scientist (OCS) of the Ministry of Industry, Trade and Labour, which is responsible for implementing technological R&D support programmes at both the domestic and international levels. Industrial competitive R&D, regulated by the Law for the Encouragement of Industrial R&D (1984), constitutes the main government-encouraged innovation-related activity. There is also a generic R&D programme, Magnet (a Hebrew acronym), which aims at encouraging generic, pre-competitive R&D efforts undertaken jointly by industrial and academic consortia. In addition, a biological incubators programme has now been established: Tnufa provides support to the individual entrepreneur in their initial efforts to build a prototype, register a patent, prepare a business plan and so on. The government seed fund Heznek shares the risk involved in innovative R&D projects with the Venture Capital industry. International R&D activities under the OCS include a set of bi-national funds; a set of bi-national agreements for joint R&D by companies in each of the two signatory countries; participation in the European FP6 programme and EUREKA; Tamir, a programme aimed at encouraging R&D cooperation between multinationals and their Israeli subsidiaries.

The 1984 basic law on R&D, which created the Office of the Chief Scientist, is the central legal basis for government support of industrial R&D and of its innovation policy in more general terms. According to the law, the broad aims of public support measures are:

• The creation of work places in industry and the employment of scientific and technology professionals
• The creation of value added for the Israeli economy, defined as the value over and above that accruing to those directly involved in the industrial R&D; i.e. spill-over effects
• The development of an advanced industry, using and expanding the scientific and technology base and human resources in Israel
• The improvement of the balance of payments by manufacturing and export of advanced technology products.

The contributions of the OCS programme over the last 20 years has been instrumental in enabling Israel to export products in the related sectors worth EUR 40.3 billion per year and allowing some 70 Israeli companies to be publicly traded on NASDAQ. Without the various OCS programmes, Israel’s high-tech industry would look completely different. Objectives and specific targets within the framework of government innovation policy primarily concern the total government disbursements to R&D and related activities.
Additional qualitative objectives include the development of a strong biotechnology sector as well as the development of the nano-technology sector and of the internal security sector.

The following chart shows the structure and activities of the OCS. The OCS is a single-level organisation with no intermediate levels that directly manages its main activity of supporting industrial R&D, while programme managers manage each of the other programmes. Each bi-national fund has its own management body.
The OCS grants reflect the abilities and the interests of Israeli industry. In 2003, for instance, the distribution of OCS conditional grants was: Communications: 36.5%; Life Sciences, 22%; Software, 17.3%; Electronics, 9.1%; Electro-optics, 8.1%; Chemicals, 2.6%; Other, 4.4%.

There is no high-level coordination structure such as an R&D and innovation council in Israel. All R&D and innovation policy issues, including policy implementation, fall within the purview of the Ministry of Industry, Trade and Labour acting through the Office of the Chief Scientist at the Ministry.

One coordination body, the National Council for Civilian Research and Development, was established in 2004. However, its budget is very provisional and very small and does not allow for any significant activity. This institution has never taken a leading role in setting national priorities in science, technology and innovation, in coordinating ministries, etc. This function is instead carried out by the OCS.

**Israel’s leading R&D sectors**

*Information & Communications Technology*

Israel is one of the world’s leading centres of IT and communications technology. The country’s strength in these sectors extends from a strong research oriented university base, through to product development for national security and aerospace programs and onto a powerful business sector containing both dozens of well-established enterprises and hundreds of start-ups.

In the European Commission’s Report on Science & Technology Indicators (2003), Israel was identified as having the world’s best citation impact in computer science research. In 2002 the annual turnover in the ICT sector was $12.4 billion, of which more than $8
billion of export representing 45% of Israel’s industrial exports. 65% of all employees (54,800) in the ICT sector are engineers (40%) and technicians (25%).

**Life Sciences, Genomics and Biotechnology for Health**

Israel is one of the world’s major centers of R&D in biotechnology and the life sciences. Some 35% of all civilian research activities in Israel are focused on biotechnology and the life sciences. The country’s traditional strengths in medicine, science and agriculture are reflected in research carried out at Israel’s universities, colleges, specialized institutes and major hospitals which host over 800 research projects in the life sciences fields which have the most potential for industrial realization.

The country’s entrepreneurial skills are enabling many promising projects to be developed into marketable products. There are some 175 Israeli biotechnology companies: start-ups, small and medium-sized firms that are involved in such areas as biopharmaceuticals, agro-bio, diagnostics and the development of other medical devices.

The country has an exceptionally strong academic base in these disciplines with 900 senior faculty members in the country’s seven universities in biotechnology related departments and a third of all Ph.D. graduates receiving their doctorates in biotechnology and life science topics. One Israeli university is a member of the global academic consortium working on the Human Genome project and in addition to bio-informatics the country’s academics are developing groundbreaking technologies in leading edge areas such as the inter-face between biology and physics and the development of nanotechnologies for use in biotechnology.

Nowhere is the close relationship in Israel between academia and industry more evident than in biotechnology. The **Office of the Chief Scientist** (OCS) at the Ministry of Industry, Trade and Labor, operates various programs in biotechnology which include:

- **Setting up Technological Incubators** – In total, 40% of all Israeli biotechnology enterprises began life in one of these technological incubators, and over 50 biotechnology projects are currently housed in these incubators, representing 20% of all projects. The universities have technology transfer companies and are heavily involved in biotechnology projects in the national network of 24 technological incubators where four biotechnology start-ups in these incubators recently received awards for excellence.

- “**MAGNET**” program, which forms consortiums of academic researchers and industrial companies to develop generic pre-competitive technologies. Consortia currently exist for: *Pharma-logic, Cell therapy and stem-cell derived products, Image guided therapy and agro-bio genomics, DNA markers, Drug and kits design and development, Algae, Hybrid seeds and blossom control, Biotechnical infrastructure for enhancing flora.*

- "**MAGNETON**” - promoting technology transfer from academia to industry,
• “NOFAR” - dedicated to biotechnology, providing pre-seed funding at an early research stage for projects bridging pure and applied research and which have academic potential.

Aeronautics & Space

Israel has created one of the most advanced and sophisticated aerospace industries in the world. It’s aerospace capabilities stem from the country’s defense necessities and the need to develop self-sufficiency in leading edge systems. These systems have been developed both at universities, government R&D facilities and large government-owned companies. Israel also has an independent space launch capability. This supports and enables capabilities in commercial communications satellites as well as satellites with high-resolution electro-optical cameras to provide commercial digital imagery services.

In recent years commercial applications from these systems have been developed and an increasing number of companies in the private sector have entered these markets. Moreover, the growing development and marketing costs have compelled Israeli companies to seek cooperation with overseas partners.

Research support for the Aerospace Industry is conducted at the Aeronautical Research Centers at the Technion and at Tel-Aviv University. Research is divided into different groups of activities and departmental laboratories: Aerodynamics; Propulsion and combustion; Flight Control; Structures; Turbo and Jet Engine; Design for manufacturing; Aerospace Systems.

Nanotechnology

Israel aims at being among the major players in the various fields of Nanotechnology. To achieve this goal the Israeli government established the Israeli Nanotechnology Initiative (INI) which objectives are:

• Promote the establishment of a local Nanotechnology based industry, which will make an impact on the economic growth of Israel.
• Formulate a long-range Nanotechnology program for research and technology development in the academy and industry and promote the establishment in Israel of a world-class infrastructure to support it.

The Nano Function Material (NFM) program under MAGNET, is a consortium of industries and academic institutions in Israel seeking new ways for the fabrication and use of nanoparticles. The goals of the NFM are:

• Extend the uses of existing products using new concepts and technologies based on Nano particles
• Explore the new ways to prepare Nano particles for a variety of applications.
• Combine efforts from different disciplines to shorten the time from an idea to commercialization of Nano products.

Six of the country’s universities have established nanotechnology centers.
Energy and Environmental Technologies

The driving forces for the development of solar energy technologies and water recycling and desalination, stem from the geographic conditions of Israel – abundance of sunny hours, 50% of arid zone and lack of oil resources.

Israel is also a leader in research applications of other renewable energy sources including wind energy and generating energy from industrial and biological waste, it has developed desalination technology - the reverse osmosis process, which can desalinate seawater for less than 50 cents per cubic meter.

In addition to energy and water treatment Israeli firms have developed on-site compact sewage systems methods for the treatment of sewage, medical and biological waste, toxic waste, and municipal sludge and solid waste. Enterprises have also developed technologies for toxin monitors for air and water, and the prevention of industrial air pollution.

In total more than 200 Israeli companies have developed technologies and products related to energy and the environment.

Research is led by the country’s seven universities, as well as a range of academic colleges and government R&D centers. Promising and diverse research projects in the area of solar energy have already produced some unprecedented developments in the field of solar energy. Research projects are taking place in the Ben Gurion National Solar Energy Center, the Ben-Gurion University (parabolic troughs and a parabolic dish) and the Weizmann Institute (solar furnace and central receiver tower), the latter with the active participation of industry.

Israel’s main areas of expertise

Solar Energy
The Israeli company Solel is a leader in solar thermal power/energy plants and solar collectors. Its technology has set global standards for utility solar plants and high temperature parabolic troughs.

Photovoltaics
Israel is also a world leader in photovoltaics with among other projects an innovative method for producing silicon solar cells either from high efficiency, single crystal cells or amorphous silicon thin layers. New thin-film materials are also being investigated for potential PV use.

Geothermal Energy
While geothermal energy is not strictly speaking a renewable resource, the vast amounts of geothermal water beneath Israel’s Negev desert and in other parts of the world dose make it worth exploiting. Geothermal power plants, up to 130MW, have been developed and this warm saline water resource has proven effective in growing crops like tomatoes and melons.
The Israeli company Ormat is today the basis for dozens of geothermal power plants ranging from 200 kW to over 130 MW all over the world.

**R&D in the United States of America**

**Basic characterisation of the research system**

The USA has been the world leader in research and development for many years. For that sole reason it has been included in the present compilation.

The US has a highly decentralised and diverse research system. Research and development policy, investment and implementation functions are shared among multiple actors. These actors include:

- the US Office of the President and the executive branch of departments and agencies (which develop policy, administer programmes, and adjudicate regulations);
- the US Congress (which conducts policy making, has budgetary responsibility and provides oversight);
- the Judiciary (which reviews the legislative and regulatory framework);
- state governors, executive agencies, and legislative branches (which engage in similar activities to their national counterparts at the state level);
- private sector firms (which conduct R&D);
- national laboratories and universities (which conduct research and engage in technology transfer);
- professional and scientific societies, and private non-profit policy analysis and advocacy organisations.

R&D funding comprises a $312 billion system in the United States as of 2004, more than twice the size it was in 1990. The system is flexible and has seen a transition from clear divisions of research labour to a blurring of boundaries. Traditionally federal agencies in the executive branch, under the oversight of Congress, provided public R&D funding to universities, which conducted basic training and research. Large private sector labs conducted applied research. Today, state governments develop new R&D programmes to enhance capabilities in their local universities while national programmes, though larger in dollar amount, have been less able to flexibly respond. The private sector, which accounted for 64 percent of all R&D expenditures in 2004, funds more near-to-product development than basic or applied research. Universities undertake applied research roles and are increasingly investing in technology transfer through licensing offices, incubators, and joint programs with industry.

There are multiple intermediary and tech transfer mechanisms in the US system including supplier-customer industry relationships, industry consortia, and university technology transfer programmes. Policy making in the R&D area has increasingly been led by private non-profit organisations that bring together government agencies, business executives, university presidents, and other stakeholders. These policy organisations and
intermediaries each address aspects of the multiple challenges facing the US research system, including the education of scientists, the funding of research, the societal impacts of emerging technologies, the regulatory and intellectual property regime, and the research competitiveness issues of the US research position relative to other nations.

Brief description

The Office of Science and Technology Policy (OSTP) is located in the Executive Office of the President and has a mandate to advise the President and others on the effect of science and technology policy on domestic and international affairs. OSTP also acts as an inter-agency coordinating body. Funding through the federal departments and agencies in the executive branch as a result of Congressional authorisations. The Executive Branch of the government includes 12 federal departments and 18 federal agencies that fund research. This funding is authorised by the US Congress. The top departments and agencies based on their R&D budgets are the Department of Defense, Department of Health and Human Services, NASA, Department of Energy, and the National Science Foundation. Several agencies operate research laboratories. For example the Department of Energy operations 10 national laboratories. The federal judiciary may review policies in the national research enterprise. State and local governments also provide funding for research that impacts their local economies. Research is performed by universities, private firms, federal laboratories, and other nonprofits. Sources of funding for research include the federal government, private sector firms, state and local government, and private non-profit foundations. The federal government receives policy advice on research from many organisations including non-profit research boards such as those of the National Academies, the American Association for the Advancement of Science and the Council on Competitiveness.
Organogram of the US research system structure

Main research policy setting mechanisms

Government policy making and coordination

Policy setting of the R&D agenda in the US comes through the budget process. While the US does not have a formal R&D budget or particular treatment of R&D within the budget, the President's budget does include R&D expenditures. R&D is indicated either in line items or as regular expenditures.

In addition, R&D priorities are typically set by federal agencies based on their specific missions. Federal departments and agencies with the most substantial R&D expenditures include the Department of Defense, Department of Energy, Department of Health and Human Services, NASA, Department of Energy, and the National Science Foundation. Coordination among these and other agencies is guided by memoranda on R&D priorities from:

- The Office of Management and Budget (OMB) which helps to prepare the President's budget.
- The Office of Science and Technology Policy (OSTP), which has primary responsibility for advising the President on science and technology policy, is involved in coordination efforts with federal departments and agencies, state and
local governments, higher education, the private sector, other organisations that comprise the science community, and other nations. The director of the OSTP is also holds the title of Science Advisor to the President.

- The National Science and Technology Council (NSTC), which is chaired by the President and comprised of the Vice President, the Science Advisor, and the chief executives of all federal departments and agencies with significant science and technology responsibilities. NSTC serves in interagency coordination and national goal-setting capacities.

Proposed budgets are prepared by agencies and submitted to OMB, which results in the President's budget request to Congress. The President's budget request to Congress usually takes place in the month of January. Congress reviews all budget requests and holds hearings with agencies. For R&D issues, the House Committee on Science and the Senate Committee on Commerce, Science and Transportation are important, in addition to the House and Senate Appropriations Committees. Congress marks up and passes appropriations bills for these agencies, and these bills are sent to the President for signature or veto. In the past, Congress and the President usually agreed to a budget prior to the beginning of the new fiscal year. But in recent years, such agreement has taken place much later. Once the two branches reach agreement, agencies make decisions on allocation of resources based on this legislation.

**Stakeholders in the policy process**

The main formal mechanism for research policy setting begins with the Executive Office of the President. The administration's budget developed by the Executive Office of the President includes research priorities, which are then debated, revised, and added to by Congress. Private sector firms and state governments are important stakeholders as well. They usually set their own priorities to reflect the particular needs of their companies and their local environments, but their decisions are often influenced by federal level. This is especially true of state governments in those instances where state is set to match federal research grants.

**Other actors in policy implementation and communication**

The main agencies for the implementation of research policy in the executive branch of government are the Defense Advanced Research Projects Agency (DARPA), which is a central research and development organisation for the Department of Defense (DoD); the National Institutes of Health, which are the main research providers within the Department of Health and Human Services; the Office of Science of the Department of Energy; NASA; and the National Science Foundation. Outside of the formal boundaries of the federal government, there are multiple private, nonprofit organisations that play important roles in research policy setting and communications. These include the National Academies, the American Association for the Advancement of Science (AAAS), the State Science and Technology Institute (SSTI), the Council on Competitiveness, the Association of American Universities, and the Association of
University Technology Managers (AUTM). For example, the National Academies include the National Research Council, the National Academy of Science, National Academy of Engineering, and the Institute of Medicine. The National Academies were chartered as private non-profit institutions by Congress to provide advice on science, technology, and health policy issues to the federal government and the public. The activities of the National Academies receive funding through grants and contracts from federal departments and agencies. Another example is AAAS, which is a private non-profit professional association for scientists and researchers. AAAS publishes the peer reviewed journal science, tracks federal R&D spending, provides expert advice on scientific policy issues, and disseminates information on human resources and education in scientific and technological fields.

Research funding system

Brief description

The US research funding system is large, with total money spent on R&D by the public and private sectors standing at $312 billion in 2004. The system also is decentralized and loosely coordinated. The main sources of funding are government and private industry and the main producers of research are industry and university. Sixty-four percent of R&D funding in 2004 came from private industry and 30 percent from the federal government. Private industry performed 70 percent of all research in 2004 and 7 percent of federal funding went to private industry to conduct R&D. Universities performed 16 percent of R&D in 2004; however, when only basic research is considered, 60 percent of basic research was performed by universities. Sixty-seven percent of all university research was funded by the federal government in 2004. The federal government funds more extramural research than it conducts in-house; only about 30 percent of federal funding goes to federal R&D performers. R&D funding from state and local government was approximately $3 billion in 2004. (Source: NSF, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series)).
Overview

The federal governments provide the lion's share of non-privately funded research. Research budgets are established annually guided by the President's proposed budget. Awards are typically made by executive departments and agencies through solicitations which can either be regularised through annual requests for proposals or distributed on a special ad hoc basis. In 2006 nearly $130 billion was invested in R&D at the federal level.
Basic research funding

Basic research accounts for about 20 percent of all R&D in the United States or approximately $28 billion. More than 60 percent of all basic research is funded by the federal government. Based on research performance, 60 percent of all research is performed by universities. Industry accounts for more than 15 percent of all basic research funding and performance. Private non-profit foundations and other organisations are major participants in the basic research system, providing nearly 10 percent of all basic research funding. (Source: NSF, Division of Science Resources Statistics, Science and Engineering Indicators, 2006.)

Thematic priorities and other targeted funds

Defence is the largest R&D thematic priority of the federal government, accounting for 57 percent of the federal R&D budget. This percentage does not include defence procurement contracts, some of which may devote a portion of the contract to R&D even though it is not accounted for as such. Defence R&D covers a range of research areas and industry sectors such as information technology and medicine. Health is the second largest category, comprising 23 percent of R&D expenditures. The next largest are space (7 percent) and general science (6 percent). The biggest recent increases by dollar amount based on the 2007 President's budget are defence, space, and general science. In specific interagency areas, nanotechnology R&D increased by 127 percent from 2001 to 2007; nanotechnology R&D in the 2007 budget was $1.3 billion. (Source: OMB R&D data, Budget of the U.S. Government FY 2007.)

Institutional funding

Private non-profit organisations funded research to the tune of $8.5 billion in 2004 and performed research costing more than $15 billion. More than half of the funding that goes to private non-profit organisations comes from the federal government. One-third of the federal funding to private non-profit organisations is for the operation of federally funded research and development centres.

Co-funding and indirect funding of private R&D

R&D performed by private sector firms is stimulated by various public mechanisms, including tax credits and public-private partnership agreements. The National Science Foundation estimates that research and experimentation (R&E) tax credit claims were roughly $6.4 billion in 2001; these levels have varied widely from year to year. Cooperative research and development agreements (CRADAs) assist companies in utilising federal resources; there were nearly 3000 CRADAs in 2003. Small mostly high technology firms received funding for early stage technologies through the Small Business Innovation Research programme, which awarded nearly $1.7 billion in 2003.
Private funding

Intramural

The private sector accounts for 64 percent of all R&D funding and 70 percent of all R&D performed. Private industry is the source of nearly $200 billion in R&D. Most of the private R&D is conducted by automotive manufacturing, chemicals, computer products and services, and aerospace companies. Company R&D is typically performed in-house, though the percentage of research performed through contracts to another private sector company is small but increasing (less than 6 percent of total private sector R&D). According to the NSF Science and Engineering Indicators 2006, "The average annual growth rate of contracted-out R&D from 1993 to 2003 was double the growth rate of in-house company-funded R&D, after adjusting for inflation, indicating an increasing role for external sources of technology. For manufacturing companies, contracted-out R&D grew almost three times as fast as R&D performed internally."

Extramural

Although most private sector research funding is intramural, the federal government is an important source of funds in the US system, particularly for basic and applied research. Federal funding accounts for approximately 11 percent of all private research funding. Most of this funding comes from the Department of Defense. Most of the firms that conduct federally funded research are in the aerospace and defence manufacturing or scientific and engineering R&D services industries. These three industries together account for nearly 80 percent of all federally funded research.

Charitable foundations/Not-for-profit funding

Charitable foundations are increasingly important in research funding in the US, especially in the biosciences area. There are more than 20,000 foundations in the United States. The top foundations by asset size are the Bill and Melinda Gates Foundation, Ford Foundation, J. Paul Getty Trust, Robert Wood Johnson Foundation, Lilly Foundation, and the Kellogg Foundation. For example, The Bill and Melinda Gates Foundation has a $29.1 billion endowment, and has committed $10.2 billion for grants since its inception in 2000. The foundation is particularly active in the global health arena. In addition to these large global grant-making foundations, the US also has community-level foundations that underwrite projects within local regions. Foundations typically follow traditional grant and solicitation approaches to making funding awards, although they typically do not require the lengthy proposals that some government agencies stipulate.

Research performers

Universities

There are 5700 universities and colleges in the US academic system. Of these, about 625 universities and colleges conduct R&D. There is no federal administrative control of
universities in the US: public university systems are generally supervised by states, while private universities are chartered under their own legal statutes. There are several ways to classify US universities. The most common way is based on whether the institution is public four-year or above, private not for profit four-year or above, private for-profit four year or above, and so on. Another common categorisation is the Carnegie classification, which distinguishes doctoral/research universities extensive; doctoral/research universities intensive; Masters colleges and universities 1; Masters colleges universities 2, and lower level classifications.

Historically research has been concentrated in a small number of academic institutions. The top 10 universities conducted 17 percent of all R&D in 2003; this percentage represents a decline from 1983 levels as a wider set of institutions are entering into the academic R&D area. One of the major controversies in academic R&D concerns the movement of universities into more applied research areas and whether this movement will threaten the nation's competitiveness in basic research. In addition, assessments of US academic publications in science and technology relative to those of other nations have found that the historic leading position of US institutions is diminishing. However, overall, the leading US research universities remain as role models that are widely studied in the US and globally, and US research universities generally rank well in independent international comparisons.

Public research organisations

There are more than 600 major federal laboratories in the US and perhaps nearly 700 smaller federal laboratory facilities. In total, federal laboratories account for more than one third of federal R&D spending and employ about 60,000 scientists and engineers. Examples of large federal laboratories include Sandia National Laboratory, Oak Ridge National Laboratory, and the Naval Research Laboratory. The Federal Laboratory Consortium for Technology Transfer (FLC), formed in 1974, with more than 700 federal laboratory members, aims to promote the transfer of federal laboratory research results and technologies to the private sector.

A number of large federal laboratories are organised as federally funded research and development centres (FFRDCs). These allow federal departments or agencies to own infrastructure but contract with private sector or universities to accomplish important R&D oriented tasks. Nine federal departments or agencies support FFRDCs: the Department of Defense, Department of Energy, Department of Health and Human Services, Department of Homeland Security, NASA, National Science Foundation, Nuclear Regulatory Commission, Department of Transportation, and Department of the Treasury. As of May 2006, there were 37 FFRDCs. Strengths of FFRDCs include flexibility in developing research and development project teams and in technology transfer to the private sector. Key issues related to FFRDCs involve the lack of competitive bidding, close relationships with government contractors, and the affect these may have on the quality of R&D.
Research and technology organisations

There are a number of R&D consortia in the US research system. Some of these are funded completely by private sector members, while government funding helped to start others. One of the most well known is Sematech, which was formed as a consortium of semiconductor firms and the federal government in the mid-1980s in Austin Texas. Sematech received federal funding until 1996 but now no longer does. The consortium has added global participants, and developed specialised subsidiaries in areas such as advanced materials. In some cases, R&D consortia disband because their industry sectors experiences downturns or because the participants no longer feel that the technology requires leading-edge pre-competitive research. For example, the Microelectronics and Computer Technology Corporation (MCC) - the first research consortia to be formed by computer manufacturers as a response to international competition by Japanese firms - was later disbanded because of the changing nature of the industry.

Private research performers

The top private research performers in the US fall into the technology hardware and equipment, automotive, pharmaceuticals/biotechnology, capital goods, consumer durables, software services, materials, and telecommunications services industries. Of these, software services and pharmaceuticals/biotechnology are typically the most R&D intensive. Most sectors increased there level of R&D expenditures from 2002 to 2004, although there was a decline in R&D expenditures in technology hardware and equipment industries. The top US owned companies based on R&D spending in 2004 included Ford, Pfizer, General Motors, Microsoft, Johnson and Johnson, IBM, Intel, Merck, Hewlett-Packard, Cisco, and Motorola. (Source: IEEE Spectrum, December 2005). Current concerns focus on the need for US firms to be more innovative, including more engagement in R&D, in order to compete in a global economy.

Partnerships

Industrial partnerships in the US have served as an important way to share the cost of non-competitive R&D. Nearly 500 technology alliances involving US-owned firms were reported in 2003, accounting for the largest share of industrial technology alliances worldwide. US-European alliances were the second most common source of industrial technology alliances, following US-to-US firm alliances. Source: National Science Foundation, Science and Engineering Indicators 2006, Chapter 4: Research and Development; Funds and Technology Linkages.

Important policy documents

Innovate America. US Council on Competitiveness, 2004. Non-governmental document The rationale of the document is to make the case for the importance of innovation and the need to have multipronged policies and activities to promote it that involve government, business, and academia.
The National Nanotechnology Initiative at Five Years: Assessment and recommendations of the National Nanotechnology Advisory Panel. President's Council of Advisors on Science and Technology, 2005.
The purpose of this report is to review the National Nanotechnology Initiative (NNI) for the Executive Office of the President. The report assesses the strategic direction of the NNI in light of trends in nanotechnology and global competition in the field. The report comments on NNI programme activities, management, coordination, implementation, and whether the programme is adequately addressing societal, ethical, legal, environmental, and workforce issues.

To help maintain the nation's economic competitiveness and improve the quality of life of the world's population, engineering education in the United States must anticipate and adapt to dramatic changes in engineering practice in the coming decades. The Engineer of 2020 report recommends ways to improve engineers' training and prepare them for the complex technical, social and ethical questions raised by emerging technologies.

America's Pressing Challenge, National Science Foundation, 2006.
Pre-college education in science, technology, engineering, and mathematics (STEM) is essential for the long-term prosperity and security of the U.S. Recent international assessments demonstrate that U.S. student performance is weak at higher grade levels of the precollege system. Recognizing this crisis, this document identifies priorities for ensuring a world-class education in STEM, and urge all Americans to join this national commitment to a world-class STEM education, the foundation for future U.S. science and technology-based prosperity and security.

The US must take strategic actions to enhance the science and technology enterprise if it is to maintain leadership in the 21st century. The report relates to research public spending and policy mixes and human resources in S&T.
R&D and Innovation policies in the South Eastern Asian countries

The South Eastern Asian countries are very diverse, and thus their research and innovation policies (and lessons for Europe) need to be addressed by grouping them into three sub-groups:

1. The leading countries, notably Japan, South Korea, Taiwan and Singapore, in many areas challenge European competitiveness. They are growing rapidly and are investing in new technologies with a long term horizon. From these examples, European countries can learn much about governance, institutional arrangements, and specific support schemes.

2. The emerging Chinese market is of interest to monitor in order to identify the pace of its change and the areas, where it is expected to become a global player either as an aggressive exporter or as an attractive place for inward investments. To a lesser extent, the same applies for India.

3. The three remaining countries, namely Malaysia, Thailand and Indonesia are of interest for their efforts to build a national R&D and innovation system, which may be partly of interest as examples for the cohesion countries and new member states.

In summary the nine countries can be characterised as follows:

<table>
<thead>
<tr>
<th>NIS</th>
<th>R&amp;D and innovation performance and challenges</th>
</tr>
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<tbody>
<tr>
<td>Japan</td>
<td>All organisations in place, with a major reform under way and focus on IPRs, university-industry linkages and commercialisation of research results</td>
</tr>
<tr>
<td></td>
<td>Competitive in high-tech, less so in soft, new technologies and with a need to renew the productive structure and improve corporate governance and macroeconomic conditions</td>
</tr>
<tr>
<td>South Korea</td>
<td>All organisations in place, with a major reform under way and focus on university-industry linkages</td>
</tr>
<tr>
<td></td>
<td>High performance of major companies but need to diversify, create new companies and face potential competition from China for markets and investments</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Taiwan All organisations in place, with a major reform under way and focus on university-industry linkages and special emphasis on human capital</td>
</tr>
<tr>
<td></td>
<td>Top performance in the electronics cluster; political challenges and the need to organise economic cooperation with China</td>
</tr>
<tr>
<td>Singapore</td>
<td>All organisations in place, with a major reform under way and focus on local entrepreneurship</td>
</tr>
<tr>
<td></td>
<td>Highly performing system but in need to diversify and reduce dependence on FDI</td>
</tr>
<tr>
<td>China</td>
<td>Long term reform to combine the previous centrally planned system with modern structures</td>
</tr>
<tr>
<td></td>
<td>Create the necessary conditions to continue with growth, high tech inward investment and balance the regional distribution of growth</td>
</tr>
<tr>
<td>India</td>
<td>Emerging competitive high-tech poles in the South but massive problems elsewhere</td>
</tr>
<tr>
<td></td>
<td>High performance affecting only a fraction of the country and its population; balanced regional development and elimination of poverty remain the major challenge</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Systematic efforts to put a NIS in place but still with major deficiencies in the corporate sector</td>
</tr>
<tr>
<td>Thailand</td>
<td>Increasing discussions and efforts to put together an NIS but with still very limited resources</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Increasing discussions and efforts to put together an NIS but with still very limited resources</td>
</tr>
</tbody>
</table>

National objectives and policy trends in the country group

In the developed countries policy reforms emphasise commercialisation of academic knowledge:

**Japan** is going through a major reform of governance with emphasis on the commercialisation of academic knowledge, through institutional reorganisation and incentives, and on intellectual property regimes.

**China** is also going through a major reform characterised by the transformation of big monolithic organisations into market oriented institutions. Emphasis is placed on the R&D system, focusing on promising technologies and on the attraction of foreign direct investment and entrepreneurship.

**Korea** has adopted and implemented various policy programs to promote and facilitate private sector R&D and innovation such as tax incentives and financial assistance; it is now focusing on highly competitive markets through a National Plan for S&T and a 21st century incentives scheme aiming at G7 status.

In **Taiwan**, the government’s initiative to create Science based Industrial Parks and Industrial Technology Research Institutes was a critical factor for the innovation performance of the country. The semiconductor industry is the country’s main strength.

In **Singapore**, innovation has become a focus. The main aim is to transform Singapore from an “efficient city” to an “innovative nation”, in which the effect of innovation policies is not limited and innovation culture permeates all the economy and the society. The government continues to support S&T and entrepreneurial friendly policies in order to achieve further growth and development of the economy in a long term basis. Singapore has set a number of priorities to achieve by the year 2018.

In **Malaysia**, although the need to establish a national policy on innovation is recognized by the Government, until now, there is no a stand-alone Innovation Policy in the country. However, innovation appears as key component in all current Malaysian Policies and Plans. Vision 2020 focuses on 9 strategic challenges to be overcome by 2020, the sixth of which is the challenge of establishing a scientific and progressive society, innovative and forward-looking, which is not only a consumer of technology but also a contributor to the scientific and technological civilisation of the future.

Although the need of a national policy on innovation is recognized by the **Indian** Government, as is shown by the newly established National Innovation Foundation, until now there is no a stand-alone Innovation Policy in the country. However, innovation
appears as a key component in all current Policies and Plans in India. In India, the current policy of the government is contained in the sector Science and Technology of the tenth Five Year Plan (2002-2007).
Policy priorities and the corresponding means are more limited in Thailand and Indonesia.

**Comparative overview of national R&D and innovation systems**
Political and economic evolution has shaped the NIS of the 9countries very differently:

**Japan: a major reform of industrial policy with emphasis on university-industry cooperation**

Japan has a number of organizations active in R&D and innovation policies linked traditionally to its historically very successful industrial development model. The poor performance of the Japanese economy during the 1990s led to structural changes in the NIS, using the US as a basic model to imitate. The current challenge that Japan faces, is the effective utilization of the S&T system as a key-player for sustainable economic growth and this has now become a political priority. Hence, an intense reform of science and technology policies is taking place in the country over the past few years, focusing on commercialization of new knowledge.

**Innovation policy making and delivery structures**
Innovation governance in Japan was always centralized, and after reorganization in the early 21st century is now crystallizing as follows:

**The institutional framework of Japan**

![Institutional Framework Diagram](image-url)
The Ministry of Education, Culture, Sport, Science and Technology (MEXT): In the course of administrative reform during 2001 (January 2001), there was a rearrangement on the structure of the ministries in charge of research and innovation. The Science and Technology Agency (STA) merged with the Ministry of Education forming a new ministry called MEXT. MEXT is primarily responsible for research and development policies in Japan.

The Ministry of Economy, Trade and Industry (METI): is in charge of promoting industrial R&D policies (SME innovation policy, promotion of regional innovation clusters, R&D tax credit etc.). R&D promotion policies concerning other economic sectors (such as agriculture, environment, construction, transport etc.) are managed separately by the ministry in charge of each respective sector, making up of almost 7% of Japanese government’s S&T spending.

The New Generation and Industrial Technology Development (NEDO): is also funding research.

The Council of Science and Technology Policy (CSTP): is established within the Cabinet Office as a central advisory body tasked with the formulation of S&T policy. Its mission is not only investigating and discussing basic S&T policies, but also resource allocation for implementing these policies. Promoting co-operation between science and technology and scientific research is also among CSTPs main tasks.

The Bureau of Science and Technology Policy (BSTP) runs within MEXT, as a secretariat of CSTP, while being responsible for planning and drafting basic S&T policies. Backed with BSTP, CSTP has become more influential in facilitating inter-ministerial budgets and human resources in S&T policies in Japan. An evidence of CSTP’s fast-growing influence is the fact that during 2003, for the first time, CSTP has examined budget proposals submitted by ministries and agencies ranking them in order of priority, establishing his firm position in terms of directing national S&T policy. Other Councils of great importance is the National Institute for Science and Technology Policy (NISTEP), affiliated with MEXT and involved in issues concerning the relationship between science, technology and society. It also supports companies in innovation management policies. The Science Council of Japan (SCJ) provides advice and recommendations on S&T policy when requested by the Cabinet Office. For that reason, the Science Council of Japan is affiliated with a large number of international academic institutions.

Last but not least, the Japan Society for the Promotion of Science (JSPS) and the Japan Science and Technology Agency (JST) are both financed from MEXT and are responsible for competitive funding of research (Grants-in-Aid program). Almost two thirds of the government budget for science and technology is allocated to the Ministry of Education, Culture, Sports, Science and Technology (MEXT). After reorganization of the national public system of administration in 2001, coordination powers of the Prime Minister were strengthened. There has been little room for coordination across ministries, except for the selection and adjustment of budget proposals performed by the Ministry for Finance. This “bureaucratic sectionalism” has been widely recognized and criticized and given its own label “tatewari”, which roughly means “vertical division”. Some steps have been taken to overcome tatewari and to achieve a better integration and coordination of government S&T policy. Since 1995 also other ministries than the Ministry of Education have begun to support research at
universities, although this still represents a small part of their total R&D-budgets. While an overwhelming part of policies and activities are concentrated at the central level, there is recently a clear effort to decentralise and give prefectures an active role. This is reinforced in the context of the cluster programmes recently launched by MEXT and METI.

**Structure of research system**

**Brief description**

Science and Technology Policy is set in the Cabinet Office by the Council for Science and Technology Policy (CSTP). The CSTP sets the Science and Technology Basic Plans, which set sectoral priorities in terms of key research fields and the level of funding for science and technology activities. The Science and Technology Basic Plan is budgeted at 160.8 Billion Euro (25 trillion Yen) or 1% of GDP, assuming nominal growth rate of 3.1% over the 2006 to 2010 period and the overall government budget programme is set on an annual basis by the Ministry of Finance (MOF). The fiscal year begins on 1st April and the formulation for the budget will begin during the previous summer. Once the budget has been approved by the Diet, the Japanese Parliament, the budget is distributed from the cabinet to the heads of the ministries and agencies, according to the value decided. The CSTP meets on a monthly basis and reviews science and technology performance, as set out in the Law for establishing the Cabinet Office (Law 89, 2001). The prioritisation of research fields shapes the budgetary activities of agencies and Ministries involved in implementing science and technology policy and programmes.

The Ministry of Economy, Trade and Industry (METI) plays a key role with regard of policies for industry, industrial competitiveness, and the regional economy. The Japan Patent Office (JPO) which sets the rules and regulations regarding intellectual property is an agency of METI. Key agencies such as the Institute of Physical and Chemical Research (RIKEN), the National Institute of Advanced Science and Technology (AIST), the New Energy and Industrial Technology Development Corporation (NEDO) are all independent administrative agencies that maintain relations with METI.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) plays a key role in determining the structure of the education and research and development systems of Japan, and the National Institute of Science and Technology Policy (NISTEP), which is the key body for maintaining and analysing data on science and technology is an agency of MEXT. The Ministry of Internal Affairs and Communications (SOUMU) plays a key role in shaping the government administrative structure through policies related to policy evaluation, communications and the publication of governmental data and statistics, as well as budgetary matters.

Other Ministries such as the Ministry of Health, Labour and Welfare (MHLW), Ministry of Agriculture, Fisheries and Food (MAFF) or the Ministry of Land, Infrastructure and Transport (MLIT), which houses the Japan Meteorological Agency (JMA), also play specific roles in setting regulatory frameworks and policies for areas under their jurisdiction. The Defence Agency is a major sponsor of governmental research and has
5% (1,891 billion yen) of the science and technology budget. Funding is distributed via the Ministries to the Independent Administrative Institutions (IAIs) such as key funding bodies like the Japan Science and Technology Agency (JST) and Japan Society for the Promotion of Science (JSPS) as well as the National Universities, which receive most of their budget from the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Outside of the governmental domain, industrial R&D in Japan is the major source of funding for R&D with 74.8% of GERD. Flows and interactions between the public and private sectors remain weak however. Despite the growth in collaborative research projects and contract research between the higher education sector and the private sector, the proportion of funding is comparatively low with around 2.5% of university budgets deriving from industrial sources. Personnel flows between the different sectors of the innovation system are also small (NISTEP 2005).

**Main research policy setting mechanisms**

**Government policy making and coordination**

The Council for Science and Technology Policy (CSTP) was established in January 2001 within the Cabinet Office as one of the top councils based on the Law for Establishing the Cabinet Office (2001, Law No. 89). The CSTP, which frequently refers to its role as that of a "watchtower", is composed of the Prime Minister, relevant Ministers, including Ministers for the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Economy, Trade and Industry; as well as other experts from academia, including the Science Council of Japan (SCJ), and experts from industry. The CSTP discusses basic concepts for science and technology policy on a monthly basis and prioritises all national science and technology policies, which are then implemented by the various Ministries and Agencies.

The Science and Technology Basic Plans, implemented on the basis of the Science and Technology Basic Law, are a major instrument for coordinating the research system through the allocation of funds to specific areas of research. Each ministry, research institution, and funding programme follows the key areas outlined in the plans.

While there has been centralising tendencies through the establishment of the CSTP, there is also greater diversity and autonomy within the research system. Independent Administrative Institutions (IAIs), which includes key research centres such as the Institute of Physical and Chemical Research (RIKEN), the New Energy and Industrial Technology Development Organization (NEDO) and Advanced Industrial Science and Technology (AIST) have all been granted autonomy to set their own research agenda and develop their own management systems on the basis of the Independent Administrative Institution Law (1999). The National Universities have also experienced similar reforms following the passage of the National University Incorporation Law (2003). Similar to the IAIs, the national universities now develop their own research and strategic plans and policies.
Research funding system in Japan

Brief description

As is clear from the Organogram, the major funder of R&D in Japan is the business enterprise sector where around 75 percent of GERD is performed. Government funding of GERD is comparatively small, at around 18 percent. GERD by the private non-profit sector is around 3 percent. GERD financed from abroad is less than 1 percent.

In terms of governmental budgetary allocation processes for research expenditure, under the Japanese Constitution, the Cabinet has the right to prepare and submit the budget to the Diet, the Japanese Parliament. The Ministry of Finance has general jurisdiction over public finance including budget formulation, and within the Ministry, the Budget Bureau is in charge of drafting the budget. The fiscal year in Japan begins on 1st April, and the budget formulation process begins during the summer of the previous year. In the initial stage, each Ministry submits its budget request to the MOF by the end of August. About a month before these budget requests, the Cabinet approves the "Guidelines for Budget Requests." The guidelines set out expenditure ceilings for major programs such as public works and social security for the next fiscal year's budget request. Since each Ministry must prepare its budget request within the limits of these guidelines, each Ministry is required to determine the priorities of the various expenditure items before submitting its request. Following the submission of budget requests, budget examiners of the Budget Bureau in the MOF start a series of hearings with each Ministry and Agency on the details of the budget requests. The budget examination process continues until around December, when the Cabinet releases the "Guidelines for formulation of the budget." Following this decision, a draft of the Draft Budget is finalized by the MOF and is presented to each Ministry and Agency before the Cabinet authorizes the final Draft Budget. For approximately a week, final negotiations regarding the budget requests are held between MOF and each Ministry and Agency on the basis of MOF's draft. After
necessary add-ons and adjustments to the MOF's draft, the Draft Budget is approved by the Cabinet and is finalized, usually at the end of December. The Cabinet submits the Draft Budget to the Diet for further deliberation, usually in the latter half of January. After approval of the budget by the Diet, the budget is distributed from the cabinet to the heads of the ministries and agencies, according to the value decided by the Diet.

**National public research funding**

**Overview**

Research funding information for Japan is provided by the Council for Science and Technology Policy (CSTP). Funding for Science and Technology has increased from 239 Million Euro (3.58 Trillion Yen (Fiscal Year 2005)) to 254 Million Euro (3.8 Trillion Yen (Fiscal Year 2006)) and is distributed through the various Ministries of State in accordance with the Third Science and Technology Basic Plan.

For 2006, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) provides the most funding for science and technology, with 63% of the total science and technology budget (159 Million Euro; 23,967 billion Yen); the Ministry of Economy, Trade and Industry (METI) delivers 16.4% of the budget (41.5 Million 99,921 Euro; 6,231 billion Yen), followed by the Self Defence Agency (SDA) at 5% (12.6 Million Euro; 1,891 billion Yen), the Ministry of Health, Labour and Welfare 3.9% (9.8 Million Euro; 1,480 billion Yen), the Ministry of Agriculture, Fisheries and Food 3.7% (9.3 Million Euro; 1,406 billion Yen), the Ministry of Land, Infrastructure and Transport (2.2%).

**Basic research funding**

Article Two of the Science and Technology Basic Law explains that basic research should proceed on the basis of balanced interaction with applied research and developmental research. The First Science and Technology Basic Plan (1996-2000) particularly emphasized the importance of basic research for Japan, and this theme was also emphasized strongly in the Second Science and Technology Basic Plan (2001-2005).

Budgetary analysis provided by the National Institute of Science and Technology Policy (NISTEP) and Mitsubishi Research Institute found that in the five years prior to the First Science and Technology Basic Plan, expenditure on basic research had been around 33.8% of the science and technology budget (18.5 Billion Euro/2.7 Trillion Yen)*. During the First Science and Technology Basic Plan period (1996-2000), expenditure on basic research increased to 37.1% of the science and technology budget (22 Billion Euro/3.3 Trillion Yen). Within the Second Science and Technology Basic Plan (2001-2005) expenditure on basic research increased to 38.5% of science and technology expenditure (21.3 Billion Euro/3.2 Trillion Yen) (NISTEP 2005).
Basic research programmes are delivered chiefly by the Japan Society for the Promotion of Science (JSPS) and Japan Science and Technology Agency (JST).

* 1 Euro = 149 Yen

**Thematic priorities and other targeted funds**

Japan has introduced thematic priorities on the basis of the Science and Technology Basic Law, implemented through three basic plans covering 1996-2000, 2001-2005, and 2006-2010.

The Third Science and Technology Basic Plan is costed at 160.8 Billion Euro (25 Trillion Yen) over fiscal years 2006 to 2010. The four primary prioritised fields within the Third Science and Technology Basic Plan (Life Sciences, Nanotechnology and Materials, Information and Communications, the Environment) and the four secondary prioritised fields (energy, manufacturing technology, infrastructure and the frontier) have seen their share of the budget increase from 38% in FY2001 to 46% in FY2005.

For 2006, the budget for each of the prioritised fields is 9,920 million Yen. Of this, the proportion by field is:
- Life sciences: 337. million Euro (5,056 billion Yen)
- Information and Communications: 134 million Euro (2,095 billion Yen)
- Environment: 71.4 million Euro (1,703 billion Yen)
- Nanotechnology and Materials: 67.2 million Euro (1,066 billion Yen)

**Institutional funding**

In 2003, 9.3 percent of research expenditure was performed by non-academic organisations. The Independent Administrative Institutions (IAIs), which have been granted greater autonomy from government following the Independent Administrative Institution Law include the Institute of Physical and Chemical Research (RIKEN), Advanced Industrial Science and Technology (AIST) and New Energy and Industrial Technology Development Organisation (NEDO).

**Co-funding and indirect funding of private R&D**

Co-funding and public funding of private R&D in Japan is minimal. According to the OECD Main Science and Technology Indicators, the level is around 0.8% (2003), this has decreased from 1.8% in 1995.

**Research performers**

**Universities**

There are 3 types of university in Japan:
National University Corporations (87 Institutions)
Public Universities (86 Institutions)
Private Universities (553 Institutions)

In terms of the division of labour by institution type, the National Universities are the major performers of science and technology in Japan, with a higher number of researchers engaged in the physical sciences, engineering, agriculture and health. Most medical schools, for instance, are based at the national universities. The private universities, by contrast, are more heavily involved in the humanities and social sciences and more engaged in undergraduate education, where they provide 73.7 percent of such education; at postgraduate levels by contrast, the private universities provide 37.4 percent of tuition for Masters degree provision and 24.1 percent at doctoral levels. Public universities are mostly run at the local level and are similar to private universities in terms of activities.

All National Universities were transformed into National University Corporations in 2004, on the basis of Law 112 (2003). This signalled a major change in the governance and direction of the universities. Management capacity has been strengthened through developing vice-president systems and encouraging participation in university management by people with external experience. The universities have developed strategic objectives and policies through the use of Medium term (6 year) plans for which they will be accountable to external evaluation committees. The universities will be expected to play a larger role in information dispersal and engagement with society. 23.8 percent (910 million Euros) of the budget of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) is for management expense grants and facilities maintenance grants at the National Universities.

Public research organisations

Most Public Corporations and National Institutions were transformed into Independent Administrative Institutions (IAIs) in 2001 and 2003 following the passage of Law 130 in 1999. There are now 113 IAIs (in 57 of them staff are non-public servants) and some of the key actors in the Japanese research system such as the Institute of Physical and Chemical Research (RIKEN), the National Institute of Advanced Science and Technology (AIST), the New Energy and Industrial Technology Development Corporation (NEDO) are IAIs. Some remain as part of the government, such as the National Institute of Science and Technology Policy (NISTEP).

Private research performers

As of 2004, 74.8% of GERD is performed by industry in Japan. Considering this importance, industrial R&D activities are a key element of the R&D and innovation system. Over the course of the 1980s and 1990s, where the Japanese economy was beset by slow economic growth and high levels of corporate debt, a number of studies suggested that total factor productivity (TFP) at the macro level had decreased, particularly in the manufacturing sector. While TFP growth has increased over recent
years across most sectors of the economy due to greater product market competition, openess, and R&Dand through corporate restructuring efforts to reduce excessive debts, capital capacity and employment levels, concern remains surrounding the idea of a ‘dual Japan’ where some industries are internationally competitive, such as electrical machinery, automobiles and instruments, while others are more domestic oriented and less competitive, such as those in the food, lumber and fabricated materials sectors. Competitive pressures in key sectors such as electronics, manufacturing, with competitors from other countries, is a key challenge facing Japanese industry and the national innovation system, with policy makers citing the importance of an economy driven by the ‘twin-motors’: manufacturing and services.

**Partnerships**

Significant reforms have been undertaken over recent years that have changed the nature of interactions between research performers. The introduction of legal mechanisms and policy guidelines by government has formalised methods of interaction, especially between universities and industry. In preparation for incorporation in 2004, many universities drafted policies and regulations to structure previously informal relationships. The share of external funding of total intramural expenditure on R&D in the business sector declined from 4.3% in FY1980 to 3.0% in FY1992, but gradually increased to 5.1% by FY2000 and 7.9% by FY2002. The main types of partnership between different partners (in this case industry and the national universities) are as follows:

- Collaborative Research (2000: around 4000 cases; 2003: around 6000 cases)
- Contract Research (2000: just over 6000 cases; 2003: 7000 cases)
- Donations (2000: 56,071 cases (497 Trillion Yen); 2003: 58,463 (556 Trillion Yen)

**Important policy documents**


Five cross-cutting fields relate to:

* **People:** Development and promotion of human capabilities
  - Nurturing of people with specialist skills in IT, Production, services etc.
  - Tuition with University-Industry Links (senior high school, college, professional schools with practical education)
  - Strengthening of tuition of production, science and engineering at elementary and middle schools
  - Support for exchange and interchange with talented people from Asian countries

* **Means of Production: Infrastructure**
  - After review of depreciation system, expedition of of measures for renewal of production system
  - Functional enhancement of gateway harbours for the Asia

* **Finance: Monetary Cirulation**
  - Through the Electronic Credit Law, promoting personal property, credit and collateral loans
- Enlargement of East Asian Asset Backed securities
- Introduction of Japanese style security bonds (JDR)

*Users: Technology*
- Promotion and creation of advanced university-industry innovation for next generation automobiles, environment, aircraft, countermeasures against cancer through medical equipment.
- Promotion of cluster policy
- Swift study of patenting and internationalization of standards

*Wisdom: Economic Power*
- Promotion of Intellectual Assets (corporation law, LLP, new trust laws)
- Based on international competition, clarification and study of anti-monopoly law
China: A rapidly and profoundly reorganizing system

After WW II the Chinese R&D and innovation system was based on the Russian model. Its structure was vertical, with autonomous and isolated actors lacking horizontal cooperation. S&T activities were generated in Public Research Institutes (PRIs), while production activities were undertaken exclusively by State Owned Enterprises (SOEs) and the two functions were completely separated. Under this system, S&T outputs from PRIs were freely transferred to SOEs and there was no incentive for research and development at the enterprise level.

In 1985, in line with the Resolution of the Central Committee of the Communist Party of China to reform from a centralized planning system to a market based economy, the structural reform of the science and technology system was enacted with a series of innovation system reforms and the NIS of China entered a transition phase, which is still ongoing. The Chinese government has introduced several initiatives to facilitate interactions among innovation players. Therefore, several policy actions concerning innovation system reforms aimed at introducing proper incentive systems for both science and industry to improve their innovation performance. These initiatives had a clear impact on the structure, dynamics and performance of China’s newly conceptualized national innovation system.

The main actors of the system are:

**Government:** All major R&D and innovation related policies and measures originate from the government with the Ministry of Science and Technology playing a leading role. Other government departments still play an important role in China’s S&T reform. In the late 1990’s, the Chinese government introduced a new policy triggered by the PRC Technology Transfer Promotion Act in 1996 and Regulations on Technology Transfer for PRIs in 1998. Most national innovation investments came from the national plans of Science and Technology, used systematically as a mechanism for promoting innovation in key areas and as a means to fund R&D and high tech development.

**Universities & Research Institutes:** Since the reforms, China’s universities and research institutes have been forced to link to the market and act like corporations. PRIs and universities are given greater autonomy on selling their research outputs, while institutional funding from the government is reduced. Investment from government was greatly reduced as an incentive for research institutes to satisfy enterprises. In China more than a thousand universities are operating, with the Beijing University and Tsinghua University being the most important ones. Universities contributed with only 10.6% to the national R&D spending in 1999. China’s universities are the primary performers of basic research; they represent half of the national basic research expenditure and employ over one half of the researchers engaged in basic research nationally. In the Chinese innovation system, PRIs including the Chinese Academy of Science play a relatively important role. The Chinese Academy of Sciences (CAS) is the best example of commercialization and privatization. In 1999, the R&D expenditure of research institutes represented 43.4% of national R&D spending, while that of enterprises was 41.6%. By the end of 2003, there were a total of 116 institutions directly under the supervision of
CAS, among which there were 89 research institutes, 3 educational institutions, 12 administrative organs at the Headquarters and Branch levels of the Academy, 7 supporting departments, 2 media and publications institutions and three other types of institutions. The institutions employ a total of about 44,000 people, among them there are about 30,000 research and technical personnel, about 5,000 administrative personnel and about 9,000 workers. CAS had created a total of 18,000 new posts, of which the research posts accounted for 83% (CAS Annual Report, 2004). The statistical data shows that the Chinese Academy of Science is the major beneficiary of China’s government funds for S&T.

In March 2005 the CAS adopted an interdisciplinary approach announcing the set up innovation bases in the next five years, which could combine research forces of different CAS institutes. These innovation bases are part of the ongoing Knowledge Innovation Programme (KIP) undertaken by CAS which started in 1998 and is currently at its second stage called “Phase of All-round Implementation (2001-2005)”.

The business enterprises:
China has plenty of entrepreneurial opportunities due to its large internal market and recent reforms, but it lacks entrepreneurs to meet the market demand. Three types of companies need to be considered separately in order to conclude on their innovative behaviour:

- State Owned Enterprises’ reforms have been implemented in the 1990’s, and market based competition resulted in greater pressures for R&D activities, efficient production processes and competitive products. In the transition period of the innovation system reform towards a network type one, some firms have improved their technological capabilities and started collaborating with universities and PRIs.

- Foreign owned companies are not actively engaged in networking activities. A substantial number of foreign owned companies include only overseas production sites using technology from parent companies abroad. However, in the last years many of the biggest US and European multinationals started investing in local R&D labs, in particular foreign investment enterprises in China increase rapidly. This proves a changing pattern and the domestic market climate appears to exercise a significant influence on the R&D activities of foreign investment enterprises.

- In the process of public research institute reforms, a substantial number of spin-off companies emerged. Many universities and PRIs set up companies. In institutional terms the complexity concerning the ownership of university-affiliated enterprises has not been fully solved. These spin-offs are becoming an important component of China’s NIS. Encouraging universities to spin off technology-based enterprises is an effective measure for urging universities to interact with industries and promote technology diffusion. Spin-offs in China are particularly interesting as the government is keen to encourage Chinese students abroad to come back and set up companies in high technology areas. More than 5,000 university spin-offs exist in China, illustrating that the innovative technology embedded in spin-off enterprises in China’s innovation system represents a large-scale transfer from universities and institutes to industries. Most of those companies are in Beijing, and those operated either by Peking University or Tsinghua University account for more than 30 percent of the income. In the mean time, they retain their mission of providing practical training to university students.
**Financial organizations:** China’s capital markets are immature, making it difficult to collect sufficient R&D funds from the private sector, and thus forcing the government to play a pivotal role in financing R&D activities. Consequently, China suffers a shortage of R&D investment. Meanwhile, bank loans for S&T activities, since the “Notice of Bank’s Loans for Technology” lessened the shortage of national S&T investment, and have successfully supported over 10,000 items of new technology development.

**Innovation Intermediaries:** Another aspect of the Chinese R&D and innovation system is the development of regional innovation systems with the help of high tech development zones. There are 53 such zones, a kind of high tech parks where all NIS actors coexist and various tax and fiscal incentives are in effect. These zones are modelled after the most successful one, Zhongguancun, and are mostly located in coastal and border areas that have attracted large flows of FDI. The High Tech Development Zones serve as platforms for technology transfer, clustering and incubation. The China Association for Science and Technology (CAST www.cast.org.cn) is a non-profit, non-governmental organization of Chinese scientific and technological workers. Functioning as a bridge with the government, CAST has developed into a federation of 165 national professional societies, including 30 provincial branches and totalling 4.3 million members throughout China. The main tasks of CAST are to organize academic exchanges, to popularize scientific knowledge, to voice the opinions and demands of scientific and technological workers, and to be involved in evaluation and continuing education.

**The institutional framework of China**

![Institutional Framework Diagram]

**China** is a case of particular interest because of the effort to undertake reforms without totally rejecting its socialist background. All major organisations are the result of
reorganisation of pre-existing institutions based on the model of the Soviet Union but over
the last two decades, the S&T system evolved into a Chinese version of Western models,
with some distinctive characteristics. The key organizations listed below now administer
most civilian science and engineering research in China, although the Ministries of
Defence, Health, Agriculture and the State Forestry Administration and other economic
agencies also have significant research operations under their direct management.

The **State Steering Committee on S&T and Education**, founded in 1998, is the highest
ranked innovation policy coordination body, within the State Council. The State Council
Premier carries out a role in the coordination of government policy as a decision maker
for national strategy for S&T and education fields and coordinates the innovation policy
in the ministry and local level.

At ministerial level, **the Ministry of Science and Technology (MOST - [ww.most.gov.cn](http://www.most.gov.cn))**
created in 1998, is regarded as having a high competence with regard to the design and
implementation of innovation policy. Through its executive body, it implements several
programs to fund basic and applied R&D, serve enterprises, especially SMEs to innovate,
manage and promote the science parks and incubators throughout China and develop
human resources in the S&T field. Other ministries are also involved in the process of
policy making mainly through the allocation of specific funds. Thus, the Ministry of
Education oversees and funds all universities in the country, while the Ministry of
Finance is responsible, along with MOST, for the Innovation Fund for Small technology
based firms.

The **National Natural Science Foundation of China (NSFC - [www.nsfc.gov.cn](http://www.nsfc.gov.cn))** was
founded in February 1986 with the approval of the State Council, for the management of
the National Natural Science Fund. NSFC directs, coordinates and financially supports
basic research and applied basic research and reports directly to the State Council. The
main funds of NSFC are allocated by the Government. NSFC employs 184 staff
members, while its budget for 2004 was 200 million €.

**Innovation policy objectives in China – national programmes**

While China does not have any innovation specific policies, many policies implemented
by the Chinese government are closely related to innovation, or have themes related to
innovation. Most of China's policies and Programmes are focused on R&D and S&T,
generally aiming at establishing an advanced R&D base in key areas, facilitating high
tech development, technology transfer and diffusion of research into the economy.

First started in 1982, the **National Program for Key Science & Technology Projects** is
critical component of the Five-Year Plans for the national economic and social
development. It is updated every five years and submitted for approval by the National
People's Congress. Its strategic objectives are: to find solutions to the scientific and
technological bottlenecks in the medium and long-term national economic and social
development; promote the modernization of traditional industries and the optimization of
industrial structures; support development of high technology and its industrialization;
 improve the quality of national economic development and people's life; and enhance the
nation's S&T capacity.

The **Torch Programme** is a guidance programme for developing new/high tech
industries in China. It was approved by the State Council and is implemented by the
Ministry of Science and Technology. The purpose of the programme are to implement the
strategy "Promote the development of the country with science and education", carry out
the general policy of reform and opening to the outside world, bring into full play the
advantages and potential of China's scientific and technological forces, take market for
orientation, promote the commercialization of new/high tech achievements,
industrialization of new/high tech goods and internationalization of new/high tech
industries.

The National Basic Research Priorities Programme (Climbing Programme) is
organized and implemented as a programme of key projects for the basic research of the
country, aimed at the subjects that are concerned with the overall situation of and play a
promoting function to the scientific and technological, economic and social development
of the country,

The National Development Research Programme was formulated in 1995 in order to
implement the strategy "Promote the development of the country with science and
education" and the strategy of sustainable development. It is a programme of activities in
the implementation of the Chinese strategy of sustainable development and a national
scientific and technological research on social development, aimed at promoting the life
quality of people and the quality of people themselves, improving the environment for
people's survival and development, adjusting the relations between people and the nature,
promoting the scientific and technological progress of social undertakings and related
industries, and promote the coordination between of economy and society and the
sustainable development. This is a rolling programme, mainly a guidance programme in
nature, for scientific and technological development and is planned to be implemented in
the period form 1996 to 2010.

The National Science and Technology Achievements Spreading Programme is an
important scientific and technological programme approved by the State Council. The
purposes of the programme is to mobilize and organize the technological works and all
the forces of society to apply advanced, mature and appropriate scientific and
technological achievements to the development of national economy,

At present, the second high-tech research and development programme of China for
the 21st century is being formulated. There are totally eight fields and 20 subjects with
the 863 programme, in which the Ministry of Science and Technology is responsible for
organizing implementation in the six fields of biology, information, automation, energy,
materials and marine technologies.

The State Council Information Office published on April 21, 2005, a white paper titled
on IPR Protection is the first to be published since 1994.

From June 2003, the State (National) Steering Committee of S&T and Education has
been leading in designing and developing an outline document “2006-2020 Chinese
National Science and Technology Development Plan”.

R&D and innovation system in Korea

In Korea there is an emerging third-generation R&D and innovation model. The science, technology and innovation (STI) policies and activities in Korea in the 1960s and 1970s are characterized by the first-generation linear model. In the 1980s, many Government Research Institutes (GRIs) were established and consortia among private companies, GRIs, universities and/or the government were formed. The 1980s and 1990s were characterized by the second generation NIC supporting big conglomerates. The third-generation model emphasizes ‘coherency’ of STI policies in terms of goals, means, harmonization, time and space. The third-generation model is characterised by the integration in terms of national policies of the whole of the economy and society as well as regional economic integration. The Deputy Prime Minister of Science & Technology who is in charge of the whole micro-economic policy in Korea and the establishment of the Office of STI within the Ministry of Science & Technology in Korea is the leading example of the third-generation model. Korea is becoming one of the global leaders in innovation with policies aiming at achieving G7 status by 2015.

The main actors are:

**Government:** The Ministry of Science and Technology, the Ministry of Commerce, Industry and Energy and the Ministry of Communications (www.mic.go.kr) are the key policy departments, financing over 64% of the government R&D programs in 2002. An increasing share of the country’s government R&D expenditure has been spent for industrial technology development (from 27.8% in 1998 to 32.5% in 2002) while at the same time, the share of total expenditures on the advancement of knowledge has been declining over the past few years (from 20.2% in 1998 to 17.5% in 2002).

**Universities and Research Organisations:** A broad number of universities operate within the country, conducting research studies and programs with the Seoul National University (www.snu.ac.kr) and Pohang University of Science and Technology (www.postech.ac.kr) among the most research intensive ones. Other universities involved in research include Korea University (www.korea.ac.kr), Sogang University (www.sogang.ac.kr), Pusan University (www.pusan.ac.kr) and Hanyang University (www.hanyang.ac.kr). More international collaborations with other universities such as MIT and Stanford University are also emerging over the past few years. Like Japan Korea seeks internationals models and cooperation more in the US than in Europe. Current policies aim at strengthening ties and modernizing the almost 150 Centres of Excellence (COE) in Korea: Science Research Centres (SRCs), Engineering Research Centres (ERCs), and Regional Research Centres (RRCs). These COEs were created to implement programs encouraging basic research in major universities. The SRCs and ERCs, founded, in May 1989, focus on the innovative research in basic sciences and new technologies, while the RRCs, which started in 1995, emphasize cooperative research between regional universities and local industries. The SRCs and ERCs are selected on the basis of creativity and research capability. In the selection of RRCs, both research capability and contribution to the regional economy and community are important factors. Once the centres are selected, they receive government
funding for nine years provided that the interim evaluation, which is done every three years, shows good progress. So far, 36 SRCs, 47 ERCs and 37 RRCs have been selected and funded. The total number of these public research centres is expected to increase beyond 150 in the future. The Korea Advanced Institute of Science and Technology (KAIST) led to the establishment and management of 33 KAIST research centres such as BioMedical Research Centre. The management of research centres (SRC/ERC) designated by science foundations such as Functional High Polymer Materials Research Centre and other 62 general research centres and research labs.

**Business and financing:** The business sector is dominated by a small number of conglomerates; these are research intensive and are increasingly capturing world markets with innovative products. Business research expenditure as a share of gross research expenditure (BERD/GERD) and launching of new products and processes is very high. Additionally, SMEs are also supported by the Small and Medium Business Administration of Korea (SMBA, www.smba.go.kr). Its main aim is to promote entrepreneurship and facilitate collaboration between SMEs and research establishments or among themselves. Invest KOREA is the Korean national investment promotion agency (IPA), established with the sole purpose of facilitating the entry and successful establishment of foreign business into Korea. The agency delivers an extensive post-establishment service designed to promote the rapid settlement of foreign corporations in Korea and ensure they maximize the benefits of the Korean investment environment to the fullest extent. The scope of the agency ranges from business consultation, market research and partner searches to accessing grants, administrative processing and resolving difficulties with government and mediating in labour disputes.

**The institutional framework of Korea**
Science and Technology Policy starts in Korea in the late ‘60s with the establishment of the Korea Institute of Science and Technology and the Ministry of Science and Technology. MOST (www.most.go.kr) is responsible for implementing the national coordination of S&T efforts within the country. This includes R&D initiatives, human resource development and education, internationalization policies, as well as coordinating activities amongst the science based ministries and government-supported research institutes. MOST oversees compliance with the various national initiatives. Technology development, support of scientific research and technology forecasting are its major priorities. A Science and Technology Framework Act adopted in 2001 governs the current policies. Through the new act the government is trying to streamline the entire system to make it more effective. In order to set priorities for the allocation of S&T budgets, and to effectively review and coordinate national S&T policies and R&D programs, the government established the National Science and Technology Council in January 1999. The NSTC is chaired by the President of the Republic of Korea and is composed of the ministers of S&T related ministries and representatives from the S&T community. A second advisory board, the Presidential Council on Science and Technology (PCST), is primarily comprised of non-governmental scientific experts and corporate leaders representing various areas of science and technology. The PCST, formerly was quite irrelevant to the centrally-controlled, government-driven central planning exercise, however, it is becoming more important as policies change.

The Centre of Innovation Policy (CIP) was established in December 2004 as the result of a broader reorganisation of the Science and Technology Policy Institute (STEPI). CIP’s role is to support the Government's innovation policy settings and studies. Two former research teams -R&D Policy Team and S&T Human Resources Team- have been merged and abolished to the Centre for Innovation Policy. The roles of the Centre for Innovation Policy are as follows:

• Long-term vision and goals of national science and technology
• General and sectoral plans for national S&T policy
• Policy measures for industrial innovation
• National R&D structure analysis
• National R&D planning and performance analysis
• Priority settings for national R&D investment
• Policy measures for training and use of S&T human resources
• Prediction on supply and demand of S&T human resources

The Ministry of Commerce, Industry and Energy (www.mocit.go.kr) is responsible for a large number of innovating activities and projects. Its current priorities are in the field of restructuring the electricity industry (division of the distribution and retail sector, establishment of six generation companies in Korea and promotion of privatisation schemes).

The current National R&D Programs, building on consecutive programmes and experiences since the ‘70s, include the 21st Century Frontier R&D Program, the Creative Research Initiative (CRI), the National Research Laboratory (NRL), the
Biotechnology Development Program, the Nanotechnology Development Program, the Space and Aeronautics Program and so on.

The **21st Century Frontier R&D Program** was launched in 1999 in order to develop scientific and technological competitiveness in newly emerging areas. The government planned to invest a total of US$3.5 billion over a period of ten years in this program that would comprise twenty three projects in new frontier areas, such as bioscience, nanotechnology and space technology. Twenty-three projects have already been launched as of September 2003. The most outstanding feature of the program is that **each project director is given full autonomy in managing the program**. The project director is responsible for designing the details of the research projects, supervising sub-projects, and allocating the funds.

**The Creative Research Initiative (CRI)**, which was launched in 1997, symbolizes the policy shift in S&T development in Korea “from imitation to innovation.” It aims to strengthen the national potential for technological competitiveness through creative basic research. The grant is awarded to researchers on the basis of creativity and originality of their proposals. Principal investigators, selected on the basis of creativity, leadership, research experiences, etc., have exclusive authority over and responsibility for managing the projects. Fifty-seven CRIs across the nation are under way ($500 thousand per project per year).

**The National Research Laboratory (NRL)**, which was launched in 1999, aims at exploring and fostering research centres of excellence, which will play a pivotal role in improving technological competitiveness. The government annually funds each individual project totaling approximately $250 thousand for five years. The government supports over 444 NRLs across the nation in which 278 are in academia, 114 in research institutes and 52 in industry.

With an ambitious vision of becoming one of the leading nations in the world in this field within the next 10 years, the government launched the **Nanotechnology Development Plan** in 2001 under the framework of the national R&D program. In order to establish and expand the R&D infrastructure in this field, the government has also launched several action plans, including the establishment of a **Nano-fabrication Centre**. As symbolic gesture, the government declared the year 2002 the year of nano-bio science, and allocated a total budget of $170 million in this area, which was a 193% increase over the previous year. Based on the plan, the government launched several ambitious projects in such areas as nano-electronic and nano-photonic devices.

The government formulated "**Biotech 2000,**" which is the basic plan for the **development of biotechnology**. The plan was put into action under the co-sponsorship of the Ministry of Science and Technology; the Ministry of Education and Human Resources; the Ministry of Agriculture; the Ministry of Health and Welfare; the Ministry of Commerce, Industry and Energy; the Ministry of Environment; and the Ministry of Maritime Affairs and Fisheries. The plan is being executed in three stages over a period of fourteen years. It is currently in its third stage (2002-2007). Through the plan, Korea aims to attain technological competitiveness in the areas of biotechnology, with a view to joining the ranks of the G-7 by the year 2010.

**The Space and Aeronautics Program**, which was initiated in 1990, aims to acquire core and fundamental technologies in key areas of space and aeronautics. As a result of the
program, three satellites have been launched already, and one science satellite is waiting to be launched in the end of September 2003. As of September 2003, and one multi-purpose satellite, one science satellite, and two geostationary orbit satellites are being developed. According to the National Long Term Space Development Plan, revised in 2000, seventeen satellites will be launched, including four communication satellites, seven multi-purpose satellites, and six scientific satellites by the year 2015.

Korea also has a very ambitious programme supporting S&T infrastructure. In order to promote R&D activities in the private sector, the Korean government has provided tax incentives and support measures since the early 1970's. Under the Industrial Technology Development Promotion Law and other laws, private enterprises that reserve funds for technology development, technical information, R&D manpower and facilities, etc. for three years are given tax deduction. The International Joint Research Program, first launched in 1985, has served as a major financial source for international joint research based on bilateral, inter-governmental and inter-institutional agreements. Thus far, the program has funded 1,896 joint projects. The international joint projects have been small in scale, and have been used more as a means to facilitate international scientific interactions i.e. scientific exchanges than as projects for serious research and development. The international joint research projects have also been very concentrated on a limited number of countries, such as Japan, U.S.A, Germany, France, Russia, China and the U.K. The program is now being restructured so it can facilitate international joint R&D.

In 2002 the National S&T promotion and development Plan (2002-2006) was adopted with a 2003 Revised version of the National S&T promotion and development Plan (2003-2007). The Korean government also set a target to double national R&D investment during the period 2001-2007. Research manpower will also be increased from 180 000 to 250 000 during the same period. It is also important for the Korean government, apart from strengthening S&T capability, to facilitate the transition to knowledge-based society.
Taiwan: Emerging key multinational corporations and improving university-industry linkages

Taiwan has a rapidly evolving R&D and innovation system gaining global competitiveness. The integrated circuit industry has been emblematic of the country’s catching up process. Taiwan has become the fourth largest IC producer and the second largest IC designer in the world, accounting for 72.9% world market share in chip foundry operations. There is a tradition in government intervention and the system is trying to adopt a modern innovation policy. The responsibilities of Science and Technology R&D and innovation are divided among several governmental agencies such as The Executive Yuan, the Council for Economic Planning and Development (CEPD) and the recently introduced Centre for Economic Deregulation and Innovation (2002). The National Science Council (www.nsc.gov.tw) of the Executive Yuan1 established in 1959 is the highest government agency responsible for promoting the development of science and technology. It has created and supervises a broad network of research laboratories mainly in high tech areas.

Universities and Research Organisations: The country’s universities are conducting research programs in a large variety of scientific fields focusing on high tech. Among others, the National Chiao Tung University (www.nctu.edu.tw) includes the Microelectronics and Information Systems Research Centre (www.eic.nctu.edu.tw), the Centre of Telecommunication Research (www.ctr.ntcu.edu.tw) and the Brain Research Centre (www.brc.ntcu.edu.tw) among others. The National Taiwan University (www.ntu.edu.tw) as well as the Kung Shan University of Technology (www.ksut.edu.tw) are also among the most research intensive universities.

There are important research institutes, such as:

- The Industrial Technology Research Institute (ITRI) is a non-profit R&D organization engaging in applied research and technical service now a 6000 people operation, which serves as the technical centre for industry and an unofficial arm of the government's industrial policies in Taiwan.
- The Institute for Information Industry (III) is a non profit organization under the sponsorship of the Ministry of Economic Affairs and the private sector. Its mission is to develop and promote the information industry.

Intermediaries in the country’s research and innovation system include three main Science-based Industrial Parks in Taiwan. The Hsinchu Science-based Industrial Park (HSIP) (http://www.sipa.gov.tw/en/sevices-1.html) with a positive growth record, the Taiwan Science-based Industrial Park (TSIP) was established under the approval of the Executive Yuan in February 1995 as part of a major effort to upgrade industry in Taiwan's southern area, with a view to balancing high-tech development throughout the island (http://www.stsipa.gov.tw/webportal/eng/index.htm) and in 2001, plans were made to establish the Central Taiwan Science Park in central Taiwan, on two sites located in Taichung and Yunlin counties totalling 402 hectares. In 1999, the National Bureau of Standards was reorganized into the Intellectual Property Office (TIPO) of the Ministry of Economic Affairs. The mission of TIPO is to encourage creation and innovation, research and development and technology transfer in order to maintain global competitiveness for
Taiwan’s industries (http://www.tipo.gov.tw/eng/). Taiwan is successful in cluster innovation environment but lies behind in innovation linkages. It has a dense network of research centres and technology promoting infrastructure: In the private sector, the largest and most influential manufacturers association is TEEMA, the Taiwan Electrical and Electric Manufactures Association. The main objectives of TEEMA are to assist the government in the planning of technological industry policies, to conduct research on available hi-tech talent, to serve as the bridge in communicating among the industries and the government and in particular, to listen to the wishes of the Small and Medium Enterprises. Also, TEEMA assists the government to map out long term cross-strait policy.(http://www.teema.org.tw/index.asp).

**Business and Financing:** The business sector is very dynamic, composed originally by inward investment and cheap labour but adapting rapidly, partly thank to icroelectronics and demonstrating a great success in the global market with the creation of few but very successful multinationals, like Acer and BenQ. Although GERD/GDP increased rapidly in the past and is above the EU average it recently slowed down and only private sector R&D spending continued to rise rapidly (Ting-Lin Lee at al, 2005). Small and medium enterprises dominate the production system. Government efforts include innovation policy models for promoting the knowledge-based society. However, R&D intensity is lower in Taiwan compared to Japan and Korea.

**The institutional framework of Taiwan**

![ institutional framework diagram](http://example.com/diagram.png)

**In Taiwan, the Executive Yuan** is the most important actor in the country’s S&T and
Innovation development system. Besides the Executive Yuan, the Office of the president is the only administration in Taiwan that can share the power of making S&T policies and is also independent of the Executive Yuan. The **Council for Economic Planning and Development (CEPD)** is responsible for drafting overall plans for national economic development, evaluating development projects, proposals and programs (http://www.cepd.gov.tw/english/). In 2002, the **Centre for Economic Deregulation and Innovation (CEDI)** was created in order to further expand the work of economic liberalization, internationalization, and re-engineering. CEDI Services also engage in a thorough study of the national economic and financial regulatory system. The **National Science Council** (http://www.nsc.gov.tw/en/organization.asp) of the Executive Yuan established in 1959 is the highest government agency responsible for promoting the development of science and technology.

In **Taiwan**, the government’s initiative to create Science based Industrial Parks and Industrial Technology Research Institutes was a critical factor for the innovation performance of the country. The semiconductor industry is the country’s main strength as the Hsin-chu Science Park cluster is among the top in the world. However, Taiwan lacks of strong linkages between universities and industries, still being the country’s main weak point in S&T system.
R&D and innovation in Singapore

Singapore’s economy is one of the top competitive economies in the world. It was ranked the second most competitive economy in the world by the World Competitiveness Yearbook in terms of business and government efficiency and infrastructure. Singapore, possibly because of its small size effective government, market orientation and early economic success has a good innovation performance captured by the good innovation linkages index, ranking just after Japan, indicating a well functioning national innovation system.

In 2003, Singapore’s expenditure on R&D totalled $3,424 million, which was 2.15% of Singapore’s gross domestic product (GDP). Expenditure on R&D manpower was 45% ($1,538 million) of total R&D expenditure, while other operating expenditure accounted for 42% ($1,438 million) and capital expenditure for 13% ($448 million). Private sector expenditure on R&D accounted for 60.8% ($2,081 million) of total expenditure on R&D, and amounted to 1.31% of GDP, in 2003. The government sector, higher education sector and the public research institutes each accounted for about 13% of total expenditure on R&D. 47% of total R&D expenditure was on experimental development, 36% on applied research, and 17% on basic research. 58% of total R&D expenditure was in the fields of engineering and technology, 14% in the natural sciences (excluding the biological sciences), 15% in the biomedical and related sciences, 1% in the agricultural and food sciences, and 13% in other areas.

The current main aim is to transform Singapore from an “efficient city” to an “innovative nation”, in which the effect of R&D and innovation policies is not limited and innovation culture permeates all the economy and the society. The government continues to support S&T and entrepreneurial friendly policies in order to achieve further growth and development of the economy in a long term basis. Singapore has set a number of priorities to achieve by the year 2018 such as:
• Globalization of the economy where Singapore should be involved in the global network with linkages to all major economies of the world
• Promotion of creativity and entrepreneurship
• Diversification of the economy where growth is powered by two main engines: manufacturing and services

Government: The country has a strongly established government role in organizing the R&D and innovation policy. Singapore’s Economic Development Board (EDB), set up in 1961, is the leading agency that plans and implements strategies to sustain Singapore as a competitive global hub for business and investment (http://www.sedb.com/). While there is no dedicated science ministry in Singapore, the Ministry of Trade and Industry (MTI) is the parent ministry for S&T activity (http://www.mti.gov.sg/). Government agencies like the IDA, A*STAR and SPRING Singapore lead in efforts to develop science, technology and innovation. As a general rule, coordination of S&T is handled in the public sphere by A*STAR, the Agency for Science, Technology and Research. All major policies with respect to innovation are formulated and implemented by this agency.
Universities and Research Institutes: Key actors are the Nanyang Technological University (www.ntu.edu.sg/) with a modern triple mission encouraging innovation and university industry cooperation and the Singapore Science Park, which was set up under a government initiative in 1980 to provide new infrastructure needed to promote R&D in Singapore. To make it more responsive to market conditions and the needs of R&D companies, the management of the Science Park was privatised in 1990 and is now owned and managed by Ascendas Pte Ltd (www.sciencepark.com.sg/). A*STAR is one of the major players in research activities in Singapore having established a large number of research institutes in cutting-edge technologies. Research institutes include a large number of subjects, all of them in high tech industries and some with ambitious interdisciplinary approaches, namely Bioinformatics Institute (BII), Bioprocessing Technology Institute (BTI), Data Storage Institute (DTI), Genome Institute of Singapore (GIS), Institute for Infocom Research (I2R), Institute of Bioengineering and Nanotechnology (IBN), Institute of Chemical and Engineering Sciences (ICES), Institute of High Performance Computing (IHPC), Institute of Materials Research and Engineering (IMRE), Institute for Microelectronics (IME), Institute of Molecular and Cell Biology (IMCB), Singapore Institute of Manufacturing Technology (SIMTech).

Intermediaries: The Intellectual Property Office (IPOS), established in 2002 to provide the infrastructure, platform and environment for the greater creation, protection and exploitation of IP (www.ipos.gov.sg/). Important actors for forging links are SPRING Singapore (Standards, Productivity and Innovation Board) established in April 2002. The mission of SPRING Singapore is to raise productivity so as to enhance Singapore's competitiveness and economic growth (www.spring.gov.sg/).

Business and Financing: Singapore’s initial research activities were affected by the presence of large multinational companies (MNCs) that were operating in the country. Technologies were transferred from MNCs to local companies and firms (Hang, 2004). The economy is dominated by subsidiaries of large multinationals, acting as hubs for the broader region but is also rapidly developing a nexus of local SMEs.
In Singapore, R&D and innovation policy implementation is highly centralised. Planning and implementation of innovation policy strategies is carried out by Singapore’s Economic Development Board which was set up in the early 1960s. Lacking a dedicated science ministry, the main government body responsible for S&T activity in Singapore is the Ministry of Trade and Industry (MTI). The Agency for Science, Technology and Research (A*STAR) is also responsible for the formulation and implementation of innovation policies in Singapore. The agency comprises the Biomedical Research Council (BMRC), the Science and Engineering Research Council (SERC), the Corporate Planning and Administration Division (CPAD), the A*STAR Graduate Academy (A*GA) and the commercialisation arm, Exploit Technologies Pte Ltd (ETPL). Both BMRC and SERC promote, support and oversee the public sector R&D research activities in Singapore. Both Councils fund the A*STAR public research institutes which conduct cutting-edge research in specific niche areas in Science, Engineering and Biomedical Science (http://www.nstb.gov.sg/astar/index.do).
India: a dual economy

India has a dual economy with effervescent activities in the South participating in global hi-tech production and attracting off-shoring from the leading OECD countries, but also a major share of the population living below the poverty line. Despite recent growth GDP per head is so low that India is still benefiting from a least developed country status in the World Trade Organisation. The government plays a major in the R&D and innovation system - acting as the main policy and decision maker. However, lacking a clear plan on innovation, the government’s efforts are concentrated mostly on the creation of an S&T base in the country rather than taking a precise approach on innovation. One Ministry, the Ministry of Science and Technology has the responsibility for organizing, coordinating and promoting S&T activities in the country, as well as international cooperation. Almost all of the organisations dealing with innovation in India are under the aegis of this Ministry. Another major R&D&I system actor are the Universities and Research Institutions which are numerous and very active research-wise. However, their linkages and collaboration with the private sector are very weak. Not even collective research bodies, such as the Council of Scientific and Industrial Research, have managed to tighten the industry-science links. One of the reasons for this lack of cooperation between science and industry is the fact that the private sector in India is relatively inactive. Private enterprises, having been protected from competition for a long period of time, had no reason to develop the necessary innovation culture. The presence of the private sector in India’s NIS is only visible through clustering efforts and a small number of NGOs which are actively trying to link private enterprises to various NIS actors.

Business and financing: The role of the financial Institutions in India is, for the most part, restricted to financing innovation schemes promoted by the NGOs or the major governmental organisations.

Intermediaries: Intermediaries in the R&D&I include:
• The National Science & Technology Entrepreneurship Development Board (www.nstedb.com) promotes high-end entrepreneurship for S&T manpower as well as self-employment by utilizing S&T infrastructure and by using S&T methods. Over 100 organizations, mostly academic institutions, R&D organizations, agencies specializing in entrepreneurship development training and also some voluntary agencies, have been initiated and supported by NSTEDB.
• The Special Assignment Unit on Technology Transfer under the Department of Science and Technology
• The National Innovation Foundation (NIF) was set up in March 2000, by the Department of Science and Technology (DST), as an autonomous society. The NIF is pursuing the mission of making India Innovative and a global leader in sustainable technologies. The purpose is scouting, documenting, spawning, augmenting, adding value, protecting intellectual property rights, disseminating on commercial as well as non-commercial basis. Focus is on the contemporary unaided technological innovations as well as outstanding examples of traditional knowledge from individuals and communities.
India, despite its poverty and late start, has the advantage of a more mature institutional set up, compared to other countries in the region, because of the British tradition. However, R&D and innovation specific institutions are very few and are related to S&T. A strong central ministry with a plethora of councils, boards and societies, is the main government body charged with innovation policy making.

The Ministry of Science and Technology (www.mst.nic.in) in charge of the Department of Science and Technology, the Department of Scientific and Industrial Research, and the Department of Biotechnology is the main organisation governing STI in India. Its objective is to promote new areas of Science & Technology and to play the role of a nodal department for organizing, coordinating and promoting S&T activities in the country, as well as international cooperation. Under MST, the newly established National Innovation Foundation is the only governmental institution whose sole purpose is the promotion of innovation in the country.

Under the three departments of the ministry, a large number of councils, boards, organization and autonomous institutions operate to consult the ministry and implement policies. The most important and more closely related to innovation are:
• TIFAC, an autonomous organisation under the Department of Science and Technology aims to keep a technology watch on global trends and formulating preferred technology options for India.
• The Technology Development Board, which provides financial assistance for promoting indigenous technology.
• The Science and Engineering Research Council (SERC) is an apex body through which the Department of Science and Technology promotes R&D programmes in newly emerging and challenging areas of science and engineering.
• The National Council for Science and Technology Communication, aimed at the popularization of science and promotion of a scientific attitude and a scientific temperament among people.

Important policy documents

The current policy of the government is contained in the sector Science and Technology of the tenth Five Year Plan (2002-2007).

Other major policies/plans regarding R&D&I are: TECHNOLOGY VISION 2020 (http://www.tifac.org.in/do/vis/vis.htm) is the umbrella strategy that lays out the objective that Malaysia will become a fully developed country by the year 2020 in terms of technological development. TIFAC had taken up the challenge of delivering a Technology Vision for India for 2020 to provide directions for national initiatives in Science & Technology and a strong basis for a policy framework not only for investment but also for the development of an integrated science and technology policy both at the state(s) and national levels.

The Science & Technology Policy 2003 (http://www.tifac.org.in/news/policy.htm) provides a road map for integrating science and technology directly with societal concerns. Keeping in view these broad objectives, it is essential to spell out an implementation strategy that will enable identification of specific plans, programmes and projects, with clearly defined tasks, estimates of necessary resources, and time targets.

The Home Grown Technology Programme (http://www.tifac.org.in/do/hgt/hgt.htm). The HGT Programme is a major mechanism of TIFAC for supporting the commercialization of technologies developed by indigenous R&D. The HGT Programme promotes Indian capabilities for development of contemporary & novel products and process. In the process, it catalyses research & development efforts in the country and fosters closer linkages between R&D/technology institutions and the industry.
References and source materials


European Research Area – Science, Technology and Innovation Key Figures 2005


*European Innovation Scoreboard 2005*


Abbreviations and Symbols

© ................................................................................................................. Copyright sign
® ................................................................................................................ Registered sign
% ....................................................................................................................... percentage
- .............................................................................................................. not applicable or real zero or zero by default
: ..............................................................................................................not available
0 .............................................................................................................. less than half of the unit used
1000s ........................................................................................................ thousands
1990-92 .................................. period of several calendar years (e.g. from 1.1.1999 to 31.12.2004)
b................................................................................................................... break in series
:e ............................................................................................................. confidential value
e ................................................................................................................ estimated value
f ................................................................................................................... forecast
i ................................................................................................................... more information in explanatory notes
p ................................................................................................................ provisional value
r ...................................................................................................................... revised value
s ................................................................................................................ Eurostat estimate
u ................................................................................................................ unreliable
:u .............................................................................................................. extremely unreliable data

A
AAGR ................................................................. Annual Average Growth Rate
AGR .................................................................................................. Annual Growth Rate
AVI ..................... Aviation (High-tech group, based on International Patent Classification)

B
BERD..................................................... Expenditure on R&D in the Business enterprise sector
BES .......................................................................................... Business enterprise sector

C
CAB ................................................. Computer and automated business equipment
(High-tech group, based on International Patent Classification)
CBSTII......................... Common Basis for Science, Technology and Innovation Indicators
CD-ROM ........................................................................ Compact Disc Read-Only Memory
CEC................................................................................... Commission of the European Communities
CIS .............................................................. Community Innovation Survey
CTE ................................................................................... Communication technology
(High-tech group, based on International Patent Classification)
CV ........................................................................................ Curriculum Vitae

D
DG................................................................. Directorate-General
DG-RTD .......................................................... Research Directorate-General
DNA/RNA .............................................. Deoxyribonucleic acid/Ribonucleic acid

E
EC ......................................................... European Community/Communities
ECU/EUR ........................................ Ecu up to 31.12.1998/Euro from 1.1.1999
EEA......................................................................................... European Economic Area
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>K</td>
<td>Knowledge-intensive services</td>
</tr>
<tr>
<td>KS</td>
<td>Knowledge-intensive services</td>
</tr>
<tr>
<td>L</td>
<td>Labour Force Survey</td>
</tr>
<tr>
<td>LKIS</td>
<td>Less knowledge-intensive services</td>
</tr>
<tr>
<td>LSR</td>
<td>Lasers (High-tech group, based on International Patent Classification)</td>
</tr>
<tr>
<td>M</td>
<td>Micro-organism and genetic engineering (High-tech group, based on International Patent Classification)</td>
</tr>
<tr>
<td>MGE</td>
<td>Micro-organism and genetic engineering</td>
</tr>
<tr>
<td>Mio</td>
<td>Million</td>
</tr>
<tr>
<td>Mio EUR</td>
<td>Million of euro</td>
</tr>
<tr>
<td>MSTI</td>
<td>Main Science and Technological Indicators - OECD</td>
</tr>
<tr>
<td>N</td>
<td>Nomenclature for the analysis and comparison of science budgets and programmes</td>
</tr>
<tr>
<td>NAC</td>
<td>National currency</td>
</tr>
<tr>
<td>NACE</td>
<td>General industrial classification of economic activities within the European Communities</td>
</tr>
<tr>
<td>NewCronos</td>
<td>Eurostat's statistical reference database</td>
</tr>
<tr>
<td>NHRSTU</td>
<td>Unemployed non-HRST</td>
</tr>
<tr>
<td>NUTS</td>
<td>Nomenclature of territorial units for statistics</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
</tr>
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<td>OHIM</td>
<td>Office of Harmonisation for the Internal Market</td>
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<td>OHIM</td>
<td>Office of Harmonisation for the Internal Market</td>
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<tr>
<td>OHIM</td>
<td>Office of Harmonisation for the Internal Market</td>
</tr>
<tr>
<td>O</td>
<td>Office of Harmonisation for the Internal Market</td>
</tr>
<tr>
<td>p.a.</td>
<td>Per year (per annum)</td>
</tr>
<tr>
<td>PATSTAT</td>
<td>Patent statistics database (provided by the EPO)</td>
</tr>
<tr>
<td>PNP</td>
<td>Private non-profit sector</td>
</tr>
<tr>
<td>PPS</td>
<td>Purchasing power standard</td>
</tr>
<tr>
<td>PSL</td>
<td>Personnel</td>
</tr>
<tr>
<td>R</td>
<td>Research and Development</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>S</td>
<td>Summary Innovation Index</td>
</tr>
<tr>
<td>SII</td>
<td>Semi-conductors (High-tech group, based on International Patent Classification)</td>
</tr>
<tr>
<td>SME</td>
<td>Small and medium enterprises</td>
</tr>
<tr>
<td>S&amp;E</td>
<td>Science and Engineering</td>
</tr>
<tr>
<td>SE</td>
<td>Scientists and Engineers</td>
</tr>
<tr>
<td>S&amp;T</td>
<td>Science and Technology</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organisation</td>
</tr>
<tr>
<td>UOE</td>
<td>Unesco/OECD/Eurostat</td>
</tr>
<tr>
<td>USPTO</td>
<td>United States Patent and Trademark Office</td>
</tr>
<tr>
<td>V</td>
<td>Venture Capital Investments</td>
</tr>
</tbody>
</table>
Countries
EU-25
BE .................................................................Belgium
CZ .................................................................Czech Republic
DK .................................................................Denmark
DE .................................................................Germany
EE .................................................................Estonia
EL .................................................................Greece
ES .................................................................Spain
FR .................................................................France
IE .................................................................Ireland
IT .................................................................Italy
CY .................................................................Cyprus
LV .................................................................Latvia
LT .................................................................Lithuania
LU .................................................................Luxembourg
HU .................................................................Hungary
MT .................................................................Malta
NL .................................................................the Netherlands
AT .................................................................Austria
PL .................................................................Poland
PT .................................................................Portugal
SI .................................................................Slovenia
SK .................................................................Slovakia
FI .................................................................Finland
SE .................................................................Sweden
UK .................................................................the United Kingdom
Candidate countries
BG .................................................................Bulgaria
FYROM ........................................................Former Yugoslav Republic of Macedonia
HR .................................................................Croatia
RO .................................................................Romania
TR .................................................................Turkey
Other countries
CA .................................................................Canada
CH .................................................................Switzerland
CN .................................................................China
IS .................................................................Iceland
JP .................................................................Japan
LI .................................................................Liechtenstein
NO .................................................................Norway
RU .................................................................Russia
US .................................................................United States