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## Executive Summary

With the election of a new government in October 2011 the political landscape in Denmark shifted. The new government is based on a coalition between Social Democrats, the Social Liberals and Socialists. The programme of the new government is targeting among others policy for higher education and innovation. The government will map Denmark's global strength positions regarding knowledge clusters, competencies and enterprises. This will be the basis for developing an innovation policy which is combining global challenges with Danish competencies. The government will develop Denmark's first innovation strategy based on a collaboration between the Minister of Science, Innovation and Higher Education, the Minister of Business and Growth and relevant sectoral ministries. The new government has the following research policy goals:

- The government will retain the 1% Barcelona target as a baseline;
- More basic funding for universities to improve the long-term planning;
- The establishment of a national partnership between universities, business sector and public authorities for exploiting research results for the good of the society. This includes the development of cooperation models between public science and the business sector, which should be meritorious for researchers' careers.

In 2010, Denmark's gross domestic expenditure on R&D (GERD) was 3.06% of GDP, well above the average for the EU-27, of 2.0%. Business enterprise for R&D expenditure (BERD) increased from 1.8% of GDP in 2007 to 2.08% of GDP in 2010, while the share for EU-27 reached 1.23% in 2010. While Government Intramural Expenditure on R&D (GOVERD) has been stable on a low level: 0.06% of GDP in 2010 compared to a share of 0.27% for EU-27, the share of Higher Education Expenditure on R&D (HERD) of GDP increased from 0.68% in 2007 to 0.9% in 2010, compared to 0.49% of GDP for EU-27 in 2010.

R&D funding has increased considerably over the last decade, providing a valuable input for knowledge production. The availability of high quality research infrastructure has been addressed in policy actions over several years. The access to human resources in science and technology has been addressed by changing funding priorities for education at the PhD level. R&D funding is provided by several actors, such as the Danish National Research Foundation, the Council for Independent Research, the Council for Strategic Research, the Council for Technology and Innovation, the Danish Advanced Technology Foundation, and several sectoral RD&D programmes. The main knowledge producers in the Danish R&D system are the universities along with a few government research institutes and a network of private, non-profit R&D organisations.

Denmark is one of the innovation leaders with above average performance according to the Innovation Union Scoreboard 2010. It has been grouped together with the peak performers Sweden, Finland and Switzerland in the Union Competitiveness Report. However, there are several challenges to be addressed.

- R&D intensity in the business sector

In 2009, Denmark still had a lower R&D intensity than the peak performer reference group. Certain barriers to private R&D investments may explain this: a shortage of capital, the increased relocation of business R&D activities to countries with a lower

level of salaries and nearer to the market of the respective companies, and a lack of government incentives.

- Shortage of highly skilled labour

The shortage of highly skilled labour and a lower share of new doctoral graduates are both critical for growth in high-tech sectors. Barriers to immigration may endanger the attraction of foreign researchers. Growing unemployment is one of the societal challenges and may endanger the goals of increased employment of R&D personnel in SMEs and it may have a negative impact on the possibilities for employees to keep their knowledge base updated.

- Cooperation between public science and the business sector which aims to turn research results into viable businesses

The Danish business sector rarely invests in R&D conducted at universities or public research organisations. Only the GTS-system is well functioning as a R&D provider for the business sector. Turning public research results into business opportunities requires more investments in own RD&I, R&D collaboration with public research organisations and purchase of research results from public research organisations, especially universities. Although the number of privately funded R&D projects at Danish universities has increased from 2007 to 2010 with 14 per cent, the volume of private R&D funding of Danish universities is with 21 per cent still rather low, which is the same share as in the two years before:

- Commercialisation of public research results

One of the weaker points in the Danish innovation system in relative terms is the patent intensity, which is at a lower level than in the reference countries Sweden, Finland and Switzerland. The Danish universities, with the exception of the Technical University of Denmark (DTU) and the Aalborg University, have only modest rates of commercialisation of research results.

Securing long-term investments in R&D has been one of the priorities of the Danish National Reform Programmes and the Globalisation Strategy for Denmark. The agreement on the implementation of the Globalisation Fund secured the long-term prioritisation of R&D from 2007 to 2012. The universities' income from commercialisation activities has decreased with 5.5 per cent from 2007 to 2010. This reflects the basic division of labour between universities and the GTS-system, the latter providing a wide range of R&D-related services. To avoid unfair competition with the private sector, budgetary provisions allow Danish universities only to engage in commissioned research, when this is directly linked to the basic activities of the university.

An analysis of the strengths and weaknesses of the Danish research and innovation system provided the basis for this strategy. In 2010 the Council for Technology and Innovation developed a long-term action plan for promoting innovation in Denmark which describes the main innovation policy initiatives under the Ministry of Science, Technology and Innovation for the period 2010–2013. This action plan includes many of the policy measures proposed also in the government report "Strengthened innovation in business". This list of specific initiatives proposed there was considered and the results of the discussions laid the ground for the new National Reform Programme (NRP). In May 2011 the new NRP was published. The NRP gives a summary of the main challenges for Danish society and announces a series of political reforms to address these challenges. The following challenges relating to innovation policies have been highlighted:

- low productivity growth;
- international competitiveness is under pressure;
- renewal and innovation are lagging;
- few new growth companies;
- requirements for increased efficiency in the public sector.

It can be concluded that the new government will probably succeed in addressing the first two challenges (R&D intensity in the business sector and shortage of highly skilled labour), but the remaining challenges require much more systematic efforts, such as the intended, but still somewhat vague, “national partnership between universities, business sector and public authorities”.

There are several policy routes being taken to stimulate public and private R&D investments. Their balance has not shifted over the last years.

1. *Promoting the establishment of new indigenous R&D performing firms*

One target for Danish innovation policy under the former government was the commercialisation of public research that results in new, R&D intensive firms. In reply to the financial crisis the public funding available for the innovation incubator programme (pre-seed and seed capital for early stage start-ups) has been increased by 50% for the period 2010–2012. However, the economic crisis requires more coordinated action because enhanced university IPR policies may disturb inter-sectoral knowledge exchange.

2. *Stimulating greater R&D investment in R&D performing firms*

The former Ministry of Science, Technology and Innovation introduced several measures to foster R&D collaboration between public research organisations and business enterprises. The introduction of a new business R&D tax-incentive in 2012 will also contribute to increase the R&D intensity in the business sector.

3. *Stimulating firms not yet performing R&D*

The national aim of increasing R&D personnel in the business sector, especially in SMEs, is a great challenge. The shortage of highly skilled labour is critical for growth in high-tech sectors. Specific goals for increasing such employment have been accomplished, such as the goal that 12% of small enterprises and 70% of medium sized enterprises should employ R&D personnel. The new government has a focus on higher and further education to address the shortage of highly skilled labour.

4. *Attracting R&D-performing firms from abroad*

Foreign direct investments (FDI) were not prioritised by the former Danish government, but the new government wants to change this.

5. *Increasing extramural R&D carried out in cooperation with the public sector*

In general, direct public funding of private firms is not prioritised, whereas R&D collaborations between PROs and business enterprises have been more of a focus in Danish innovation and research policy. However, only the GTS-system has functioned well as a R&D provider for the business sector.

6. *Increasing R&D in the public sector*

Danish policy is concentrated on improving the framework conditions for R&D in the public sector.

The Danish policy mix is well aligned with the ERA pillars and objectives. This alignment has been set as an explicit goal by the Denmark's government in several recent policy documents.

The Danish policy mix for closing the gap between Denmark and the peak performers regarding R&D intensity has been developed over time in the right direction, but needs some further improvements. The reintroduction of tax-incentives is one step in the right direction. However, innovation policy has to ensure that not only high-tech firms are in the centre of policy attention and that low-tech firms are also included, as the voucher programmes has already practiced. The shortage of highly skilled labour has been addressed by a right mix of policies and will over time probably improve. The proposed "national partnership between universities, business sector and public authorities" should be implemented with concrete and coordinated policy actions. It is still too early to say if the new government will succeed here. Commercialisation of public research results requires a better entrepreneurial culture and education at Danish universities. The new strategies do address this, but it remains unclear if they will succeed. The improved coordination of initiatives has proved to be important.

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# 1 Introduction

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Denmark is a small country – covering 43,098.31 km<sup>2</sup> – with only 5.56 million inhabitants or 1.1% of the total EU-27 population. Denmark's Gross Domestic Product (GDP) reached €226,887.1m in 2010. That equates to €42,500 per inhabitant compared to an average of €24,400 per inhabitant for the EU-27 overall (Eurostat November 2011). The real average growth rate of GDP for 2008–2010 was -1.8%, at a lower rate than the -0.6% average across the EU-27. The decline of 5.8% in 2009 was especially significant for the slowdown in the annual growth rate (Eurostat November 2011). The unemployment rate increased significantly from 3.3% in 2008 to 8.5% in January 2011, but has fallen now to 6.9% in September 2011. In comparison the unemployment rate for the EU-27 increased from 7.0% in 2008 to 10.0% in September 2011 (Eurostat November 2011).

In 2010, Denmark's gross domestic expenditure on R&D (GERD) was 3.06% of GDP (estimated value given by Eurostat November 2011), well above the average for the EU-27, of 2.0%. Business enterprise for R&D expenditure (BERD) increased from 1.8% of GDP in 2007 to 2.08% of GDP in 2010, while the share for EU-27 reached 1.23% in 2010 (estimated values for 2010 given by Eurostat November 2011). While Government Intramural Expenditure on R&D (GOVERD) has been stable on a low level: 0.06% of GDP in 2010 compared to a share of 0.27% for EU-27, the share of Higher Education Expenditure on R&D (HERD) of GDP increased from 0.68% in 2007 to 0.9% in 2010, compared to 0.49% of GDP for EU-27 in 2010 (estimated values given by Eurostat November 2011).

R&D funding has increased considerably over the last decade, providing a valuable input for knowledge production. The availability of high quality research infrastructure has been addressed in policy actions over several years. The access to human resources in science and technology has been addressed by changing funding priorities for education at the PhD level.

R&D funding is provided by several actors, such as the Danish National Research Foundation, the Council for Independent Research, the Council for Strategic Research, the Council for Technology and Innovation, the Danish Advanced Technology Foundation, and several sectoral RD&D programmes (see Figure 1).

The main knowledge producers in the Danish R&D system are the universities along with a few government research institutes and a network of private, non-profit R&D organisations. Some of the Danish universities have a high standing in international comparisons. The University of Copenhagen is one of the most important universities in the ERA. It is ranked 43 among the world's best universities in the 2011 Shanghai ranking list of universities, and with 10th place in Europe it is the best in Northern Europe. The Aarhus University is ranked 86 on this ranking list.

A report on bibliometric research performance indicators for the Nordic countries shows a clear increase in the publication output from Denmark (Schneider 2010). When applying fractionized publication counts, Denmark's publication output has increased from 29.120 papers in the 1999-2003 to 32.448 in the 2004-2008 (Schneider 2010, p. 11). When considering the impact of Danish publications it appears that they achieve a very high citation rate, ranking just behind Switzerland, the USA and the Netherlands (Schneider 2010, p. 23). A bibliometric report on Nordic universities shows that the volume of Danish university publishing increased with 13% from the period 2000–2004

(22,915 papers) to the period 2005-2009 (25,973 papers) (Piro 2011, p. 24). The report provides some key measures of human resources in the Nordic universities. In 2009 Danish universities had 13,394 scientific personnel and a student-staff ratio of 7.5, which is the lowest ratio of the Nordic countries (Piro 2011, p. 8).

Compared with the world average, Danish scientific publications are highly specialised in clinical medicine, biomedicine and agriculture (Schneider, 2010). Denmark has a lower scientific specialisation in chemistry, material science, physics, mathematics, ICT and engineering, and Denmark is close to world average in geosciences and social sciences.

The Danish economy has a specialisation profile characterised by a mixture of low-technology branches such as food, furniture, textiles and toys (Kallerud, 2008) and more knowledge-intensive service areas, such as software consultancy or supply and engineering consultancy. The manufacture of pharmaceuticals & medicinal chemicals and software consultancy and supply are the largest sectors regarding intramural R&D expenditures. It is important to mention developments in the manufacturing industry; especially the R&D expenditure by high-tech and low-tech enterprises. Between 2001 and 2006, Denmark increased the knowledge-intensity in both high-tech/medium high-tech and medium and low-tech sectors. "Denmark shows changes in its economic structure with an increasing weight of the high-tech sector electrical machinery. However, a decreasing knowledge-intensity in more traditional sectors of the Danish economy, such as food products or machinery & equipment, should be noticed as well as the decreasing weight of many of the high and medium-high tech sectors... (particularly noticeable for the Radio, TV and communication equipment sector)" (European Commission, 2011, p. 4).

The technical specialisation of Denmark as measured by patent specialisation is changing. When analysing patent applications to the EPO by priority year and by IPC sections it becomes clear that some technology fields have gained more attention, such as: mechanical engineering and here especially machines or engines for liquids, wind, spring, weight, or miscellaneous motors; and electricity, and here especially generation, conversion, or distribution of electric power and electric communication techniques. This trend shows Danish activities in the field of wind energy technology, smart grid, energy efficiency and related technologies. Patent specialisation in the field of human necessities is still the most important technology field, but its importance is decreasing, only the field of medical or veterinary science; hygiene keeps its position at the same level (data provided by Eurostat November 2009).

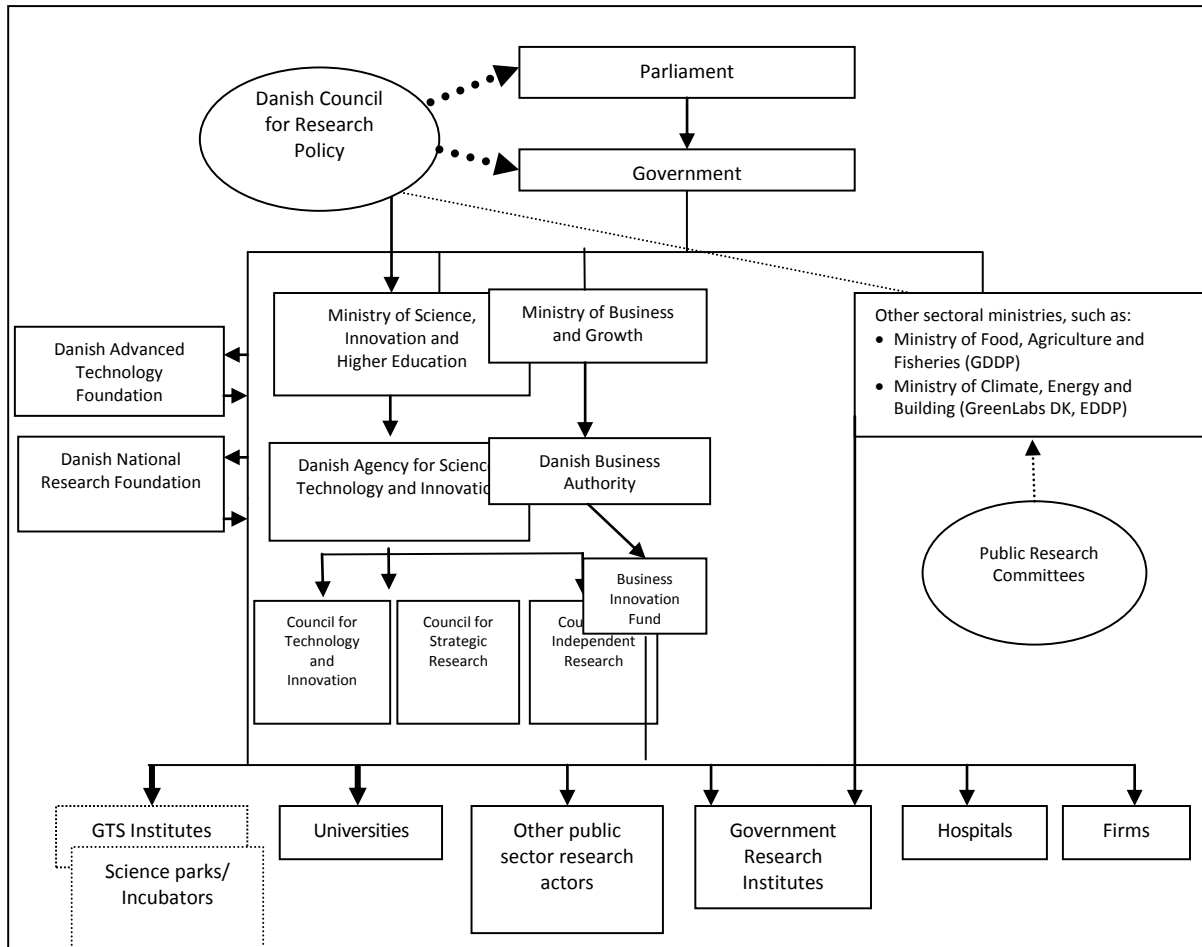
The main responsibility for research and innovation is placed within the authority of the Ministry of Science, Innovation and Higher Education (former Ministry of Science, Technology and Innovation). The Ministry of Business and Growth has certain tasks related to business development, and several sectoral ministries – the Ministry of Climate, Energy and Building, the Ministry of Food, Agriculture and Fisheries, the Ministry of Environment, the Ministry of Finance and the Ministry of Foreign Affairs – have larger RD&D programmes. The ministries have specific agencies which implement the respective policies. Regions do not play a decisive role in the R&D governance process. The main research performers in the public sector are the universities. The GTS-institutes (Advanced Technology Group) are the main collaboration partners of the private sector.

The business enterprise sector is the main R&D performer, funded mainly by the business sector and performing 68% of total R&D in 2010. In 2010, Danish industry invested 1.84% of GDP in R&D (estimate provided by Eurostat December 2011). The

main public research performers are concentrated in the university system, performing 29% of the total R&D in 2010. Approximately 87% of publicly supported R&D takes place in that form. There are now eight universities: Copenhagen University, Aarhus University, the Technical University of Denmark, the University of Southern Denmark, Aalborg University, Roskilde University, Copenhagen Business School and the IT University. The universities are organised under their own stakeholder organisation, Universities Denmark.

The following figure gives an overview of the Danish research and innovation system.

**Figure 1: Cooperation structure of the Danish research and innovation system**



Source: Amendment of Figure 1 in the TrendChart Mini-Country Report (Klitkou 2011b).

## 2 Structural challenges faced by the national system

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Denmark is one of the innovation leaders with above average performance according to the Innovation Union Scoreboard 2010 (INNO METRICS 2011, p. 27). It has been grouped together with the peak performers Sweden, Finland and Switzerland in the Union Competitiveness Report 2011 (European Commission, 2011, p. 2). However, there are several challenges to be addressed.

### 1. *R&D intensity in the business sector*

In 2009, Denmark still had a lower R&D intensity than the peak performer reference group. Taking Gross domestic expenditures on R&D as a proxy for R&D intensity Denmark achieved 3.02%, while the reference group achieved 3.41%. Denmark had a much better result than the European Union (2.01%) and also a better result than the United States (2.77%) (European Commission, 2011, p. 2). However, the average annual growth of public expenditure on R&D is falling behind both the reference group and the European Union (European Commission 2011, p. 3).

The share of business enterprise expenditure on R&D (BERD) as percentage of GDP has increased markedly over the last decade, with an average annual growth rate since 2000 that is even higher than the reference group, the European Union and the United States (European Commission 2011, p. 3). However, the share is still much lower (2.02%) than for the reference group (2.41%) (European Commission, 2011, p. 2). The Innovation Union Competitiveness Report highlights that knowledge-intensity in more traditional sectors of the Danish economy is decreasing, such as food products or machinery & equipment. In addition, the weight of several of the high and medium-high tech sectors in the overall Danish economy is decreasing (particularly noticeable for the Radio, TV and communication equipment sector) (European Commission, 2011).

Certain barriers to private R&D investments may explain this lower share of BERD as percentage of GDP compared to the reference group. One explanation is shortage of capital; another explanation is the increased relocation of business R&D activities to countries with a lower level of salaries and nearer to the market of the respective companies. The lack of government incentives may be a third factor contributing to this problem. A former tax-incentive for business R&D was abolished in 2006 (Klitkou, 2009). The introduction of a new business R&D tax-incentive in 2012 will address this barrier.

These barriers to private R&D investments may also be a reason for the lower innovativeness of the Danish business sector. The new National Reform Programme (NRP) points out that a number of indicators suggest that Danish businesses are less innovative than their foreign competitors (Danish Government, 2011b, p. 19). Here the NRP highlights especially that productivity growth has been lower than in many comparable countries (Danish Government 2011b, p. 5).

### 2. *Shortage of highly skilled labour*

The shortage of highly skilled labour is critical for growth in high-tech sectors (Klitkou 2011a, p. 4). The share of new doctoral graduates is at a lower level than in the reference countries Sweden, Finland and Switzerland, but slightly higher than for EU-27 (European Commission, 2011, p. 2). Students have to be encouraged to move more rapidly into and through tertiary education (OECD, 2009).

Barriers to immigration may endanger the attraction of foreign researchers (Klitkou and Kaloudis, 2009, p. 46). The low share of non-EU doctorate students compared to EU-27 confirms this assessment (European Commission, 2011, p. 2).

Growing unemployment is one of the societal challenges emphasised by the European Commission in its recommendations for Denmark. This may endanger the goals of increased employment of R&D personnel in SMEs and it may have a negative impact on the possibilities for employees to keep their knowledge base updated (Klitkou 2011a). The increased unemployment is connected to the financial crisis: Danish unemployment more than doubled from 3.4% in 2008 to 7.6% in 2010, in comparison to the EU-27 of 7.0% in 2008 and 9.7% in 2010.

### *3. Cooperation between public science and the business sector which aims to turn research results into viable businesses*

The TrendChart report for 2011 identified improving cooperation between public science and the business sector as one of the challenges for innovation policy in Denmark in the next two years (Klitkou 2011b, p. 16). "The Danish industry has a high absorptive capacity and R&D intensity compared to the European average. However, the linkages between industry and public research organisations need further strengthening. The limited purchase of R&D results from universities and the limited licensing of university patents, are two indications for the same weakness" (Klitkou and Kaloudis, 2009, p. 44). A recently published report on cooperation between private enterprises and universities concluded that universities mainly cooperate with larger companies, larger companies both in terms of value added and in terms of number of employees, and that these firms are very satisfied with the cooperation (Oxford Research, 2011).

The Danish business sector rarely invests in R&D conducted at universities or public research organisations (according to Eurostat data). Currently, only the GTS-system is well functioning as a R&D provider for the business sector.

Turning public research results into business opportunities requires more investments into research, development and innovation by the larger business enterprises. This means investments in own RD&I, R&D collaboration with public research organisations and purchase of research results from public research organisations, especially universities. Joint research and development projects with public research organisations have a positive impact on the productivity of the participating enterprise (Frosch and Alslev Christensen, 2011). And the public research organisations have to become better at marketing their research to the business sector.

Current innovation policy has its main focus on facilitating innovation in SMEs in collaboration with GTS-institutes. Recent Danish research has shown that companies with own R&D departments collaborate more with public research organisations and are more innovative (Frosch and Alslev Christensen, 2011). A challenge will be to retain RD&I activities of larger enterprises in Denmark or to attract foreign companies to Denmark. The strengthening of markets and innovation culture is connected to these issues. Funding for policy measures oriented towards such activities has to be strengthened (Klitkou 2011b, p. 16).

### *4. Commercialisation of public research results*

One of the weaker points in the Danish innovation system in relative terms is the patent intensity, which is at a lower level than in the reference countries (European Commission, 2011, p. 2). The Danish universities, with the exception of the Technical University of Denmark (DTU) and Aalborg University, have only modest rates of



commercialisation of research results. In recent years the share of patent applications being exploited (through licenses, options, assignments and spinouts) has increased, as universities have become more professional and selective in regard to patenting. The universities' income from commercialisation activities has decreased with 5.5 per cent from 2007 to 2010 (Statics of Universities Denmark, 2010, table A). This reflects the basic division of labour between universities and the GTS-system, the latter providing a wide range of R&D-related services. To avoid unfair competition with the private sector, budgetary provisions allow Danish universities only to engage in commissioned research, when this is directly linked to the basic activities of the university.

An expected side-effect of the merger of the majority of the independent research institutes with the universities was to strengthen the universities' capabilities to commercialise research results. "As a result of the restructuring of the public research sector, most of the applied research institutes have merged with universities" (Klitkou and Kaloudis 2009, p. 46). Many of the universities, however, are less experienced with commercialisation of their research results.

A problem is that university IPR policies may disturb inter-sectoral knowledge exchange. IPR issues have been experienced to be a barrier in cooperative R&D projects (Valentin and Jensen, 2007). Over the last years technology transfer has been strengthened and possible conflicts of interests have been addressed in standard agreements on IPR and in strategic collaboration agreements between universities and industry partners. In 2009 the commercialisation strategy of the Danish Council for Technology and Innovation (DCTI) suggested that the remaining obstacles in the field of commercialisation are not primarily related to the technology transfer system and legislation (DASTI, 2009). DCTI recommended fostering an innovative culture and changing the mindset at the universities via incentive systems, research management and entrepreneurship training.

Summing up, we can say that Denmark is facing four major structural challenges:

1. Denmark has a lower R&D intensity than the peak performer reference group. The knowledge-intensity in more traditional sectors of the Danish economy and the weight of several of the high and medium-high tech sectors in the overall Danish economy are decreasing. This chapter highlighted certain barriers to private R&D investments.
2. The shortage of highly skilled labour is critical for growth in high-tech sectors. Students have to be encouraged to move more rapidly into and through tertiary education. Barriers to immigration may reduce the inflow of foreign researchers. Growing unemployment is one of the major societal challenges for Denmark. This may endanger the goals of increased employment of R&D personnel in SMEs and it may have a negative impact on the possibilities for employees to keep their knowledge base updated.
3. Cooperation between public science and the business sector needs to be improved. The limited purchase of R&D results from universities is an indication for this weakness. Currently only the GTS-system is functioning well as a R&D provider for the business sector. A challenge will be to retain RD&I activities of larger enterprises in Denmark or to attract foreign companies to Denmark.
4. Commercialisation of public research results has to be improved. The merger of the majority of the independent research institutes with the universities was planned to strengthen the universities' capabilities to commercialise research results, but most of the universities only have limited experiences with and

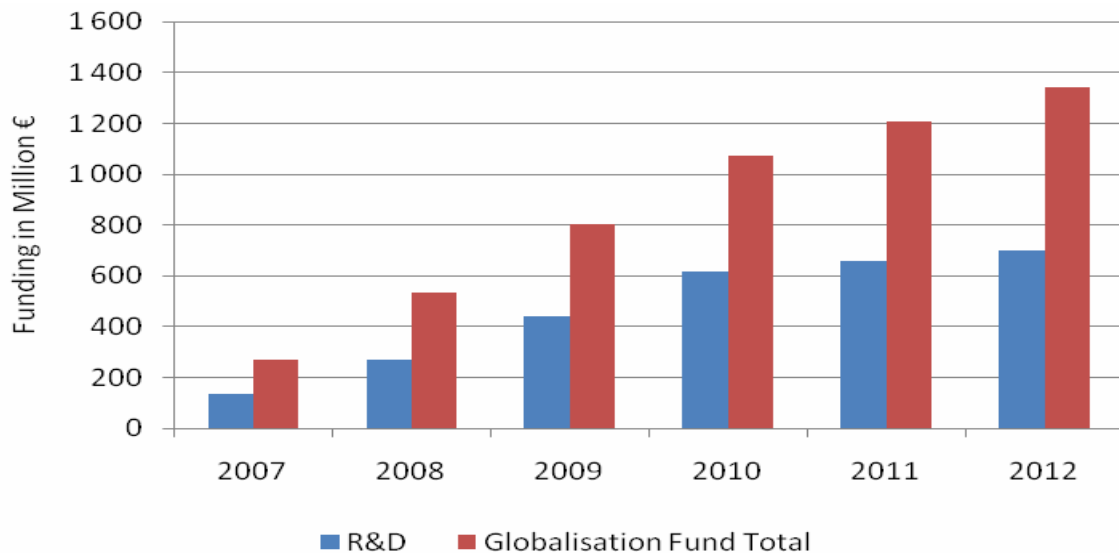
capacities for patenting, licensing, start-up companies and other commercialisation efforts. University IPR policies may disturb inter-sectoral knowledge exchange. IPR issues have been experienced to be a barrier in cooperative R&D projects.

### 3 Assessment of the national innovation strategy

#### 3.1 National research and innovation priorities

Securing long-term investments in R&D has been one of the priorities of the Danish National Reform Programmes and the Globalisation Strategy for Denmark. The agreement on the implementation of the Globalisation Fund secured the long-term prioritisation of R&D from 2007 to 2012 (figure 2).

**Figure 2: Distribution of the Globalisation Fund 2007-2012.**



Source: Denmark's National Reform Programme: Second Progress Report (Danish Government, 2007)

An analysis of the strengths and weaknesses of the Danish research and innovation system provided the basis for this strategy. In 2010 the Council for Technology and Innovation developed a long-term action plan for promoting innovation in Denmark which describes the main innovation policy initiatives under the Ministry of Science, Technology and Innovation for the period 2010–2013 (DASTI 2010b; DASTI 2011d). This action plan is an update of the former action plan for the period 2007–2010. It includes many of the policy measures proposed also in the government report “Strengthened innovation in business” (Danish Government, 2010b). This list of specific initiatives proposed there was considered and the results of the discussions laid the ground for the new National Reform Programme (NRP). In May 2011 the new National Reform Programme (NRP) was published (Danish Government, 2011b). The NRP gives a summary of the main challenges for Danish society and announces a series of political reforms to address these challenges. The following challenges relating to innovation policies have been highlighted:

- low productivity growth;
- international competitiveness is under pressure;

- renewal and innovation are lagging;
- few new growth companies;
- requirements for increased efficiency in the public sector.

Low productivity is especially an issue in services, while manufacturing and the public sector achieve higher productivity growth rates. The NRP explains the low productivity with following factors:

- improved employment rates of less skilled people;
- weak innovation performance by Danish enterprises;
- slow growth in service industries and construction.

With the election of a new government in October 2011 the political landscape in Denmark shifted. The new government is based on a coalition between Social Democrats, the Social Liberals and Socialists. The programme of the new government is targeting among others policy for higher education and innovation (Regeringen, 2011). The government will map Denmark's global strength positions regarding knowledge clusters, competencies and enterprises. This will be the basis for developing an innovation policy which is combining global challenges with Danish competencies. The government will develop Denmark's first innovation strategy based on collaboration between the Minister of Science, Innovation and Higher Education, the Minister of Business and Growth and relevant sectoral ministries (Regeringen, 2011, p. 21). The government will also analyse existing innovation measures for deciding how innovation capacity may increase. In March 2012 the Danish government started work on the innovation strategy which aims to "significantly reduce the turnaround from public investments in research, development, innovation and education to growth and job creation in the labour market" (Danish Ministry of Science, Innovation and Higher Education 2012).

The usage of analytical reports and evaluations has been strengthened substantially over the last years by the Danish Agency for Science, Technology and Innovation (DASTI). For instance, there have been reports on the impact of policy measures (DAMVAD 2011; DASTI 2011c; Frosch and Alslev Christensen, 2011). In 2010 and 2011 several new Danish research studies evaluated the productivity effects of RD&I policy schemes and corporate investment in RD&I (Alslev Christensen, 2011).

The planned interaction between the different ministries for developing an innovation strategy is indeed a new development, as we see it. There are many policy measures in different ministries targeting improved innovation. The former Ministry of Science, Technology and Innovation addressed Danish innovation policy and implemented some high impact policy measures, such as the Danish competence and innovation network scheme which is a national cluster programme, the Danish Innovation Consortium scheme, Industrial PhD Programme GTS-network, the GTS Advanced Technology Group (Alslev Christensen 2011, p. 22ff.). However there were also many minor policy measures with lower impact and the interaction with other ministries with relevant innovation policies was not so well developed. In the new government the Minister of Science, Innovation and Higher Education has become one of the members of the Government Coordination Committee, which was not the case before.

The new government has the following research policy goals (Regeringen 2011, p. 22):



- The government will retain the 1% Barcelona target;
- More basic funding for universities to improve the long-term planning;
- The establishment of a national partnership between universities, business sector and public authorities for exploiting research results for the good of the society. This includes the development of cooperation models between public science and the business sector, which should be meritorious for researchers' careers.

In 2008 a bottom-up process of consultation on research priorities resulted in a catalogue of strategic research fields, named RESEARCH2015 with 21 strategic research fields distributed over six key research areas. The research fields were used to decide political priorities for strategic research areas for the last three years. Since spring 2011 a new bottom-up process has started and it is expected that this will lead to a new catalogue of strategic research priorities – RESEARCH2020 – in 2012. The new government has signalled that it will reduce the number of research priorities (Regeringen, 2011).

Some societal challenges are especially important for Denmark, such as climate change and the demographic changes. The main societal challenges are addressed by research funding via the Danish Council for Strategic Research (DCSR), but also by sectoral RD&D programmes. The council finances research based on politically defined programmes focused on the following thematic priorities: sustainable energy production and use of energy; food, nutrition and health; and, nanotechnology, biotechnology and ICT.

Over the last three years there has been increased policy focus on promoting innovation partnerships, policy measures which support the combination of research and innovation and on innovative regions or clusters. For maximising regional and social benefits, innovation in the public sector has been strengthened. Denmark has developed policy focus on developing, demonstrating and testing innovative technologies in the field of energy and environment, the food sector, agriculture, fishery and aquaculture, and the welfare sector. This policy focus will contribute to increased R&D intensity in these business sectors.

Growing unemployment is one of the societal challenges emphasised by the European Commission in its recommendations. Denmark's unemployment rate increased significantly from 3.3% in 2008 to 8.5% in January 2011, but has fallen now to 6.9% in September 2011 (Eurostat November, 2011). On the other hand, demographic ageing has started to affect labour supply, accentuating the need for reforms to stimulate participation in work and hours worked.

As the ERAWATCH Country Reports for 2009 and 2010 have shown, there are several policy routes being taken to stimulate public and private R&D investments.

#### *1. Promoting the establishment of new indigenous R&D performing firms*

One target for Danish innovation policy under the former government was the commercialisation of public research that results in new, R&D intensive firms. The framework conditions for new R&D intensive firms were addressed in several policy schemes for improved framework conditions and were implemented in 2008. Progress has been made in the development of Gazelle enterprises (Siune & Aagaard, 2008), but the economic crisis requires more coordinated action because enhanced university IPR policies may disturb inter-sectoral knowledge exchange.

#### *2. Stimulating greater R&D investment in R&D performing firms*

The former Ministry of Science, Technology and Innovation introduced several measures to foster R&D collaboration between public research organisations and business enterprises, with the overall aim of stimulating greater R&D investments in the private sector. These policy measures are intended to enhance the R&D intensity of Danish firms and are administered by the Danish Council for Technology and Innovation. The introduction of a new business R&D tax-incentive in 2012 will also contribute to increase the R&D intensity in the business sector.

### *3. Stimulating firms not yet performing R&D*

The national aim of increasing R&D personnel in the business sector, especially in SMEs, is a great challenge. The shortage of highly skilled labour is critical for growth in high-tech sectors. Specific goals for increasing such employment have been accomplished, such as the goal that 12% of small enterprises and 70% of medium sized enterprises should employ R&D personnel (DASTI, 2010a). The new government has a focus on higher and further education to address the shortage of highly skilled labour.

### *4. Attracting R&D-performing firms from abroad*

Foreign direct investments (FDI) were not prioritised by the former Danish government, but the new government wants to change this.

### *5. Increasing extramural R&D carried out in cooperation with the public sector*

Direct funding of firms is not prioritised, but R&D collaborations between PROs and business enterprises have been more of a focus in Danish innovation and research policy, for stimulating greater R&D investments in the private sector. However, only the GTS-system has functioned well as a R&D provider for the business sector. It remains to be seen how the new government with its proposed national partnership between universities, business sector and public authorities will change this.

### *6. Increasing R&D in the public sector*

Danish policy is concentrated on improving the framework conditions for R&D in the public sector. The National Reform Programmes and the Globalisation Strategy both focus on increased public R&D funding.

It can be concluded that the new government will probably succeed in addressing the first two challenges (R&D intensity in the business sector and shortage of highly skilled labour), but the remaining challenges require much more systematic efforts, such as the intended, but still somewhat vague, “national partnership between universities, business sector and public authorities”. The new innovation strategy should also be based on a critical evaluation of the merger of Danish universities and applied research institutes. It should investigate the degree to which this merger strengthened or weakened collaboration between public science organisations and the business sector.

## **3.2 Trends in R&D funding**

The financial and economic crisis has an impact on the Danish business sector: The intramural R&D expenditure of the business sector decreased from 2008 to 2009: from €4,684m in 2008 to €4,487m in 2009. Because of the decrease of the GDP the share of BERD of GDP increased nevertheless: from 2.01 in 2008 to 2.02 in 2009, but the share of R&D performed by the business sector as percentage of GERD decreased with three per cent points in the same period. These indicators are still in the range of the national investment targets: GERD reached 3.1% of GDP in 2010 and the BERD contributed probably with two thirds of this.

**Table 1: Basic indicators for R&D investments in Denmark**

	2008	2009	2010	EU average 2010
<b>GDP growth rate</b>	-0.8	-5.8	1.3	2,0
<b>GERD as % of GDP</b>	2.87	3.02	3.1	2.0
<b>GERD per capita</b>	1,223.8	1,218.4	n.a.	490.2
<b>GBAORD (€ million)</b>	1,990.719	2,199.820	2,311.093	92,729.05
<b>GBAORD as % of GDP</b>	0.85	0.99	0.99	0.76
<b>BERD (€ million)</b>	4,683.745	4,487.293	n.a.	151,125.56
<b>BERD as % of GDP</b>	2.01	2.02	n.a.	1.23
<b>GERD financed by abroad as % of total GERD</b>	n.a.	0.26	n.a.	N/A <sup>1</sup>
<b>R&amp;D performed by HEIs (% of GERD)</b>	27.2	30.0	n.a.	24.2
<b>R&amp;D performed by PROs (% of GERD)</b>	2.6	2.9	n.a.	13.2
<b>R&amp;D performed by Business Enterprise sector (as % of GERD)</b>	69.9	66.8	n.a.	61.5

The main share of government funding is traditionally channelled via *institutional funding of universities*: Institutional funding of universities has increased continuously over the last years: from €1,663m in 2008, to €1,789m in 2009 and €1,883m in 2010. In 2011 the universities received €2,011m institutional funding over the Government budget (all values in 2011 exchange rate). In 2008 and 2009 universities received also independent (non-programme) funding via the UNIK initiative: €35m in 2008 and €39m in 2009. These financial means came about because of the Globalisation agreement in 2006, and this extra funding ended in 2009, this however was planned and not caused by the financial crisis (Sources: State budgets for 2008–2011).

The most important *competitive funding* instruments are managed by the two research councils, the Danish Councils for Independent Research (DCIR) and the Danish Council for Strategic Research (DCSR). The funding via the research council system increased from 2008 – €292m – to €350m in 2010, but decreased in 2011 to €306m. There are also other public research funds: in 2011 €292m came from such funds (DASTI, 2011e). However, the institutional funding is competitive and the universities have to agree upon development contracts with a set of indicators for a certain time period and they get measured according to the fulfilment of these goals.

*Collaborative funding* is available when research projects include the participation of industrial participants. The share of the required private co-funding differs between the funding schemes, but is lowest for SMEs. Incentives

R&D funding is mainly given as a *subsidy*. *Tax-incentives* will be reintroduced in 2012. There have been notable increases in funding for Danish organisations working on innovation, such as for the Danish National Advanced Technology Foundation, the Council for Technology and Innovation, the Business Development Finance and the funding of energy research, development and demonstration under the Ministry of Climate and Energy. Examples of sectoral funding are the Energy development and demonstration programme, the GreenLab.dk programme and the Green development and demonstration programme.

<sup>1</sup>8.4 (2009), 9.04 (2005)

Public-private partnerships have become very important over the last few years. The Danish government has gradually developed an institutional and regulatory framework to support this trend. The Danish government has established a new fund, the Renewal fund, which is focused on public-private partnership.

The Structural Funds (SF) will be deployed only where there is a lack of national funding, and where such intervention is crucial to improving regional competitiveness. In the period 2007–13 Denmark has allocated €613m, a clear decrease compared to the previous programme period. Basic research activities will not receive financial support from the SF. However, SF investments will support the improvement of transfer of knowledge. The focus is primarily on the interaction between research and innovation. There is no support foreseen for international collaboration between research institutions or for large research infrastructure. Denmark has launched two operational programmes: 'Innovation and Knowledge', which will receive €255m from the European Regional Development Fund; and, 'More and Better Jobs', which will receive about €255m from the European Social Fund. The funding from the ERDF will be matched by the same amount from the Danish government (Klitkou, 2012).

### **3.3 Evolution and analysis of the policy mixes**

#### *The role of research and innovation*

Design and implementation of policy actions relating to education and skills, entrepreneurship and industrial policy are not coherent. More coordinated policy actions are needed. Diverging political responsibilities in different ministries may be one explanation. The former Ministry of Science, Technology and Innovation had innovation as one of its main tasks, but industrial policy has been for a responsibility of the former Ministry of Economic and Business Affairs. Formerly education was divided between the former Ministry of Science, Technology and Innovation and the Ministry of Education. In the new government higher education will be the responsibility of one ministry, the Ministry of Science, Innovation and Higher Education. This will give better opportunities for coordinated policy actions. The integration of innovation policy with industrial policy and other sectoral policies, however, should be improved and embodied at highest political level to overcome non-aligned policy.

Current research and innovation policy is strongly oriented towards addressing major societal challenges. Some societal challenges are particularly important topics in Denmark, such as climate change and the demographic changes. The decision to invest in research and innovation reflects the need to restructure the Danish economy towards more knowledge-intensive industries addressing major societal challenges and strengthening the competitive advantage of Danish industry and universities. In fields such as renewable energy, environment, food, health and ageing, research and innovation are key instruments to enhance competitiveness and to create new jobs.

#### *Design and implementation of research and innovation policies*

There is a broad set of political initiatives which address societal challenges, especially in sustainable development, energy and climate. However, there has been a tendency to develop multiple new strategies without having enough stakeholder backup and by that risking the realisation of those strategies. Fewer and better coordinated strategies might improve the impact of such policy actions.

Several governmental strategies have strengthened the R&D specialisation of Denmark in food, biotechnology, climate and energy, such as the Climate Adaptation Strategy, the Danish Business Strategy on Climate Change, the Green Growth agreement, the Environmental technological action plan 2010–2011 and the Energy Strategy 2050.

The Climate Adaptation Strategy (2008) included a research strategy and the establishment of a coordinating unit for research in climate adaptation to ensure that Danish climate research addresses adaptation issues to a greater extent and to promote cooperation and knowledge-sharing among the research centres.

The Danish Business Strategy on Climate Change (2009) shows ways of exploiting growth opportunities arising from climate change by developing, disseminating and utilising Danish climate-related solutions. The strategy focuses on entrepreneurship, commercialisation, demonstration and public-private cooperation on green solutions.

The Green Growth agreement (2009) states that a high level of environmental, nature and climate protection goes hand in hand with modern and competitive agriculture and food industries. The agreement includes research and innovation initiatives within agricultural and food sectors aimed at making them more dynamic, and including environmental technologies related to the industry. The Green Development and Demonstration Programme (GDDP) was established as a follow-up of this.

The Environmental technological action plan 2010–2011 of the Danish Government (2010a) has a focus on new environmental technological solutions that can relieve global environmental problems whilst also ensuring increased Danish exports and more Danish jobs.

The Energy Strategy 2050 of the Danish Government (2011c) sets out a strategy aimed at making Denmark independent of fossil energy sources by 2050. The strategy identifies three tracks, and one of them is research, development and demonstration, followed up by large demonstration and preparation for the market and finally the utilisation and integration in the transport and energy system. The government is going to review “the public research, development and demonstration initiatives in the climate and energy area in order to support the transition to fossil fuel independence as well as the needs of the business community. Ways to improve coordination and interaction between relevant programmes and councils will also be identified” (p. 40).

Demographic changes and especially the ageing of the population are also important societal challenges for Denmark. They imply the need for better welfare solutions, some of them can be technical solutions. Innovation policy has attempted to create favourable conditions for the development of welfare solutions (Økonomi- og Erhvervsministeriet and Indenrigs- og Sundhedsministeriet, 2011).

#### *Broad innovation policy*

Demand-side innovation policy has become more relevant over the last three years. It is a “hot” issue in relation to public-private partnerships and in the welfare sector. Innovation in the public sector has been strengthened by the introduction of the Business Innovation Fund and the Danish Public Welfare Technology Foundation – Investments in Public Welfare Technology.

#### *Public investment in research and innovation*



Public investments in research and innovation have been prioritised and budgeted over the last years to ensure predictability and long term impact. In the field of high quality knowledge infrastructure Denmark had some weaknesses, but multi-annual programmes have improved this situation (DASTI, 2011a).

#### *The role of excellence in research and education policy*

Research funding is increasingly allocated on a competitive basis. Universities are benchmarked on the basis of internationally recognised criteria and development contracts with the Ministry of Science, Innovation and Higher Education and research projects are selected on the basis of the quality of proposals and expected results, subject to external peer review. Universities apply open recruitment methods. The legal, financial and social frameworks for research careers, including doctoral studies, have some weaknesses related to different practices at the Danish universities. Danish universities lack competence in career planning and their tradition of favouring temporary positions and Postdoc positions is not conducive to attracting the best researchers or to returning Danish researchers (DASTI, 2011b). A new programme, Sapere Aude, is targeting the career of young researchers. There are incentives in place to attract leading international researchers.

#### *Education and training systems*

The share of human resources in science and technology is almost 52%, which is far above the average for EU-27 (40.5%). However, there is a lack of highly-skilled labour, which creates an obstacle to a knowledge-based society. The number of graduates in science, technology, engineering and mathematics has increased over the last years, but is still not sufficient. The recruitment of doctorate students has increased from 2,061 in 2008 to 2,603 in 2010. However, highest growth rates are in Agricultural and veterinary sciences (38%), Medical science (34%) and Social science (30%), while Natural science (27%) and Technical science (19%) fall behind.

In 2010 a strategy for education and training in entrepreneurship was developed in a partnership between the former Ministry for Science, Technology and Innovation, Ministry of Culture, Ministry of Education and the Ministry of Economic and Business Affairs (DASTI, 2010d). The Danish Agency for Science Technology and Innovation sponsors the initiative Young Enterprise Denmark providing entrepreneurship training for students at universities and other educational institutions.

#### *Partnerships between higher education institutes, research centres and businesses*

Several R&D funding instruments favour partnerships between universities, research institutes and enterprises. Such instruments are for example SPIR – Strategic Platforms for Innovation and Research, Strategic Research Centres, Strategic Research Alliances, Innovation networks programme and Innovation Consortia. Many instruments have been opened up to international participation which supports international collaboration.

#### *Framework conditions for business investment in R&D, entrepreneurship and innovation*

Denmark has developed a policy focus on turning knowledge into business by supporting commercialisation of public research results (proof of concept, venture capital and risk capital). The Growth Foundation, a state investment fund which provides venture capital to entrepreneurial growth companies; budget: with its DKK 7.7 billion (approx. EUR 1.03 billion) since 1994, the fund has supported more than 4,000 companies with venture capital. However, the framework conditions for SMEs have to be

strengthened (Danish Government, 2010b). Access to better qualified R&D personnel and opportunities for cooperation with research and educational organisations are important framework conditions for innovation and business investments in R&D. With the reintroduction of R&D tax-incentives in 2012 business investment in R&D will be strengthened.

#### *Public funding of research and innovation in businesses*

There are many support schemes available addressing market failures in the provision of private funding for innovation, particularly for SMEs. They have proved to have some positive impact (Alslev Christensen, 2011). However, these support schemes should be bundled into fewer and more effective schemes.

#### *The public sector a driver of innovation*

The innovativeness of the public sector has great importance for the innovativeness of the business sector. There has been an increased focus on easing the bureaucratic burden of the private sector by further digitalisation of public services. Denmark has implemented policy initiatives related to public procurement of green innovations and in the health sector.

### **3.4 Assessment of the policy mix**

The production of analytical reports and evaluations has been strengthened substantially over the last years by the Danish Agency for Science, Technology and Innovation (DASTI). For instance, there have been several reports on the impact of policy measures (Alslev Christensen 2011; DAMVAD 2011; DASTI 2011c; Frosch and Alslev Christensen, 2011; Klitkou, 2011b). These reports show that the policy measures had a significant impact on productivity, production, export and employment of Danish companies. New initiatives that target private R&D investments include increased public procurement of eco-innovations, support for large demonstration facilities, the launch of the Renewal Fund and a risk capital fund. The decreasing knowledge-intensity in traditional business sectors can be explained by the lack of financial incentives. A former tax incentive for business R&D was abolished in 2006 (Klitkou, 2009). The introduction of tax incentives for business R&D expenditures in 2012 will probably provide a greater incentive for investing in R&D. Another explanation for the decreasing knowledge-intensity in traditional business sectors is the political focus on high-tech firms while policies supporting an increased innovativeness in low-tech firms might provide much greater effects.

It is clear that an important prerequisite for sustaining growth in the prioritised sectors is a critical supply of human resources. Especially engineers are perceived as being essential for a future growth of new knowledge intensive sectors. The Danish government has focused on this challenge for a number of years and the issue is pervasive in policy debates and documents. The shortage of human resources in S&T and here especially of engineers has been addressed by stakeholders in the private sector. The government has addressed this problem especially via education policy. For example changes were made to conditions for enrolment in university education and as a result of this policy the number of newly enrolled students increased significantly over the last years and the numbers of PhD candidates in engineering doubled from 2003 to 2010. The successful Industrial PhDs programme has contributed to an increased absorptive capacity in the private sector. Education is also a key priority for the new

government. The government has as a goal that 25% of a youth cohort will complete a long-cycle higher education programme in 2020 (Regeringen, 2011, p. 8).

In 2007 the government set specific goals for increasing the employment of R&D personnel in the Danish business sector, such as the goal that 12% of small enterprises and 70% of medium sized enterprises should employ R&D personnel. In 2010 could be reported that both goals have been accomplished (DASTI, 2010a, p. 23). Important policy instruments which support this process include the Industrial PhD programme and the Knowledge Pilots. Job-training is accepted as a standard and successful procedure for the continuous development of skills. Life-long learning has been a policy priority for several years in the National Reform Programmes. The former Ministries for Education and the Ministry of Science, Technology and Innovation coordinated their activities related to the strategy for life-long learning. Denmark is a country with a flexible, mobile labour force and it also has a long tradition of on-the-job training and funding schemes. In this policy context, the Quality Reform (agreed in 2007) further institutionalised the processes for upgrading of skills, qualifications and further education amongst the labour force. Approximately €633m has been allocated for 2008–2011 to measures aimed at improving possibilities for enhancing skills of employees in the public service sector.

The match between university education and society's competence needs has become more a target in recent policy actions: in August 2011 the former Minister of Science, Technology and Innovation established a Council to advise the Minister on the interaction between university education and society's needs for skills. It remains to see what the new government will do in this field.

The former Ministry of Science, Technology and Innovation introduced several measures to foster R&D collaboration between public research organisations and business enterprises, with the overall aim of stimulating greater R&D investments in the private sector. However, only the GTS-system is well functioning as a domestic R&D provider for the business sector. Current innovation policy is facilitating innovation in SMEs in collaboration with GTS-institutes. Policy measures are intended to enhance the R&D intensity of Danish firms and are administered by the Danish Council for Technology and Innovation. These policy measures are Innovation consortia, Innovation networks, Knowledge voucher and Research voucher for SME and the Knowledge Pilot Initiative. Danish firms collaborate more with foreign universities than with Danish universities (Danmarks Forskningspolitiske Råd, 2011). However, those firms which cooperate with Danish universities, mainly for applied research projects, assess the cooperation as positive (Oxford Research, 2011). These are mainly larger companies and not small firms. Funding for such cooperation projects comes mainly from public sources. Support for SMEs has become more important in the economic crisis. And most of the policy measures introduced newly by the former Ministry of Science, Technology and Innovation and the sectoral ministries require collaboration or favour collaborative proposals (SPIR, GreenLabs DK, EDDP, GDDP).

In 2010 a new initiative for the strengthening of entrepreneurial universities was launched. This initiative is supported by the Danish Growth Council, the Danish Enterprise and Construction Authority and DASTI. The initiative might strengthen cooperation between universities and the business sector, but results of this initiative are not yet reported. Another initiative targets education in entrepreneurship. Since 2003 Denmark has policy focused on turning knowledge into business by supporting commercialisation of public research results. Policy measures support proof of concept, and secure venture capital and risk capital. However, the rather low patent intensity of



Danish universities, with the exception of the Technical University of Denmark (DTU) and Aalborg University remains a challenge if increased university patenting is the goal. Technology transfer offices at the different universities have very different framework conditions, the formation of spin-off companies is rather low and only the DTU has actually made significant profits from licensing. This can also be an indication for possible conflicts between universities and industry: industry players argue that universities claim too high profits.

**Table 2: Assessment of the Policy mix**

Challenges	Policy measures/ actions	Assessment in terms of appropriateness, efficiency and effectiveness
<b>Lower R&amp;D intensity than the peak performer reference group</b>	R&D collaboration with GTS-system, Knowledge Voucher and Research Voucher for SMEs, Knowledge Pilots, Renewal Fund, Tax incentive for business R&D (2012)	Decreasing knowledge-intensity in traditional business sectors is not prevented by existing policy measures – focus on high-tech firms and SMEs may be too narrow.  Low-tech firms should be targeted.  The Renewal Fund is an appropriate measure for supporting on-going business development in sectors of high societal importance.  Reintroduction of tax incentives for business R&D will probably strengthen R&D intensity.
<b>Shortage of highly skilled labour</b>	Industrial PhD programme Enrolment at universities Strategy for life-long learning	Awareness campaigns, industrial PhDs and changes in enrolment at universities are effective measures and will over time probably succeed.
<b>Cooperation between public science and the business sector</b>	Strengthening GTS-system Innovation consortia, Innovation networks, Knowledge and Research voucher. Knowledge Pilots, SPIR, Strategic Research Centres, Strategic Research Alliances, EDDP, GDDP, GreenLabs DK	Cooperation with the GTS-system has developed very well, but cooperation of firms with Danish universities is less successful. Danish firms prefer to cooperate with foreign universities. University IPR legislation might be an obstacle for good cooperation.  The new policy measures address this, but it is too early to say if they can succeed.
<b>Commercialisation of public research results</b>	Proof of concept Strategy for education and training in entrepreneurship Strategy for strengthening of entrepreneurial universities Growth Foundation	Only a few universities do succeed (DTU and Aalborg University). There is a need for a better entrepreneurial culture and education at Danish universities. The new strategies do address this, but it remains unclear how they are implemented and if they may succeed.

## 4 National policy and the European perspective

The Danish policy mix for closing the gap between Denmark and the peak performers regarding R&D intensity has been developed over time in the right direction, but needs some further improvements. The reintroduction of tax-incentives is one step in the right direction. Another one is the implementation of the Renewal Fund. However, innovation policy has to ensure that not only high-tech firms are in the centre of policy attention and that low-tech firms are also included. The shortage of highly skilled labour has been

addressed by a right mix of policies and will over time probably improve. The cooperation between science and the business sector has been targeted in a range of policy actions, mainly focused on the GTS-system. The proposed “national partnership between universities, business sector and public authorities” should be implemented with concrete and coordinated policy actions. It is still too early to say if the new government will succeed here. Commercialisation of public research results requires a better entrepreneurial culture and education at Danish universities. The new strategies do address this, but it remains unclear how they are implemented and if they will succeed. The improved coordination of initiatives has proved to be important. Such coordination is important for avoiding a multitude of minor initiatives, which may compete with each other and endanger their intended impacts. This is especially important for research and innovation policy since there are several ministries which develop own policy actions in these fields. The closure of the Danish Research Coordination Committee in December 2010 has to be followed up by new coordinative actions.

The Danish policy mix is well aligned with the ERA pillars and objectives. This alignment has been set as an explicit goal by the Denmark’s government in several recent policy documents.

**Table 3: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)**

	ERA dimension	Main challenges at national level	Recent policy changes
1	Labour Market for Researchers	<p>Danish university researchers are less internationally mobile than in the European Union (MORE 2010).</p> <p>The share of graduated international PhDs who leave Denmark after getting their degree has increased from 2001 to 2010 (Universitets- og Bygningsstyrelsen 2011). Mobility is highest among natural scientists and lowest among researchers specialised in humanities (DASTI 2011b).</p> <p>All Danish universities have joined the ‘Charter for Researchers’ and the ‘Code of Conduct for the Recruitment of Researchers’. Denmark participates in international co-operation through the Europass Framework.</p> <p>EU gender equality directives have been implemented in Danish law via the Act on Gender Equality and the Act on Equal Treatment of Men and Women.</p>	<p>In November 2010, a political agreement was reached to increase the number of in-service training places in 2011 with 8,900 extra places within the vocational education and training system (Danish Government, 2011b).</p> <p>The promotion of entrepreneurial training at Danish universities is one of the priorities in the recently launched initiative for entrepreneurial universities and the Danish Foundation for Entrepreneurship – Young Enterprise.</p>
2	Cross-border cooperation	<p>Denmark is active in a number of other ERA related cooperative actions, such as European Technology Platforms (ETP), Joint Technology Initiatives, Article 169 initiatives, ERA-NETs, and ERA-NET Plus.</p>	<p>Danish funding schemes are open to researchers based abroad, regardless of their nationality, provided that their research is judged to be of benefit to Danish research.</p>

	<b>ERA dimension</b>	<b>Main challenges at national level</b>	<b>Recent policy changes</b>
3	World class research infrastructures	In March 2010 the Ministry of Science, Technology and Innovation published an Action Plan for research infrastructure (Ministeriet for Videnskab, Teknologi og Innovation, 2010).	A road map' for the development of research infrastructure was published in September 2011 (DASTI, 2011a).
4	Research institutions	In June 2009, a political agreement on a new distribution model for core funding to the universities was reached. The new distribution model is a modification of the former 50-40-10 model, which covered indicators for education, external funding and PhD graduates.	The new model includes bibliometric indicators and will be introduced stepwise over the period 2010-2012. The envisioned distribution for 2012 is: 45% based on education appropriations, 20% based on external funding of R&D activities, 25% based on bibliometric indicators, and 10% based on PhD graduates.
5	Public-private partnerships	In an evaluation report published in September 2010, an international evaluation panel presented the results of an evaluation of several funding schemes which aimed at fostering such co-operation (Svedberg et al., 2010). The evaluation panel concluded that these funding instruments are functioning well and that the evaluated projects appear to be based on a high level of knowledge transfer between the public and the private sector.  This evaluation also highlighted that the participation of SMEs appears to be too low and should be investigated further.	In 2010, the Council for Strategic Research and the Council for Technology and Innovation launched a new initiative, inviting proposals for Strategic Platforms for Innovation and Research (SPRI).
6	Knowledge circulation across Europe	The Danish Government has approved the Council of the European Union's conclusions about scientific information in the digital age.	An Open Access Committee was appointed under the steering committee for Denmark's Electronic Research Library (DEFF). In March 2011 the Open Access Committee published the recommendations for the implementation of Open Access in Denmark (Danish Agency for Libraries and Media, 2011). This report can be seen as an implementation plan for a 4-years period with indication of process, players and finances.  In June 2011 a study was published on the levels of access to and use of research and technical information by knowledge-based SMEs in Denmark.

	<b>ERA dimension</b>	<b>Main challenges at national level</b>	<b>Recent policy changes</b>
7	International Cooperation	<p>The former Ministry of Science, Technology and Innovation initiated several collaboration agreements and other policy measures to ensure an improved knowledge exchange between Danish and knowledge communities outside Europe.</p> <p>Denmark is actively cooperating with other Nordic countries in joint programmes and institutions. The organisation of Nordic collaboration in research and innovation rests on two main pillars, one for research, the Nordic Research Board, NordForsk, and one for innovation, the Nordic Innovation Centre (NICE). The Top-level Research Initiative (TRI) is the largest joint Nordic research and innovation initiative.</p>	<p>Denmark has developed specific strategies for the so-called BRIC-countries (Brazil, Russia, India and China) to improve trade and investment cooperation and to market Danish strengths and competencies, in fields such as climate and energy, welfare, architecture, research, education and food (Danish Government, 2011a; p. 4).</p>

## **Annex: Alignment of national policies with ERA pillars / objectives**

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### **1. Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers**

#### **1.1 Supply of human resources for research**

The share of human resources in science and technology (HRST), amongst the economically active population aged 25–64, was 51.9% in 2010 compared to an average of 40.5% for the EU-27 (Eurostat, 2011). However, when analysing the field of education the picture seems less positive. The HRST share amongst those aged 25-64, who are educated in science, mathematics and computing is only 5.2%, compared to a share of 9.9% across the EU-27. In the field of engineering, manufacturing and construction Denmark's HRST share is 17.3% compared to the share for the EU-27 of 17.9%. These lower shares for Denmark are consistent with concerns about a lack of engineers expressed by the private sector. The private economic sectors with the highest share of HRST are ICT, professional, scientific and technical activities, and knowledge-intensive services. In a comparable, low-tech sector like agriculture, forestry and fishing, the share of HRST is three times as high as in the EU-27. This means there is a great potential for knowledge based value creation. The number of persons participating in second stage of tertiary education has increased from 4,831 in 2007 to 7,063 in 2009 (Eurostat, 2011). Denmark has attracted increasing numbers of researchers from EU-27 and third countries. The number of international PhD students has more than trebled since 2001. About 75% of the international PhD students take a grant in natural sciences or engineering. 18.5% of doctoral candidates come from outside Denmark, and here mostly from EU-27 and Asia, Middle East and Oceania (Mogu rou and Pietrogioacomo, 2007). The share of international PhDs who leave Denmark after getting their degree has increased from 7% in 2001 to 16% in 2010 (Universitets- og Bygningsstyrelsen, 2011). Danish researchers at universities are less internationally mobile than in the European Union (MORE, 2010). An increasing number of experts in science and technology leave Denmark for other countries: from 31,000 in 2006 to 37,000 in 2009 (Eurostat, 2011).

The Independent Research Councils give funding to postdoc stipends. In March 2010 a career programme for excellent young researchers started, the Sapere Aude programme. The programme aims to provide encouragement for individual and talented researchers to conduct their own research programme independently, and develop international networks. Sapere Aude is a talent development programme for the elite and mainly serves three purposes: strengthening young research talents, encouraging female researchers and being a launching point for the research elite to apply for funding at international research councils and foundations. The programme addresses the three career stages from the post-doctoral level to the associate professor level and professor level. Data on international mobility of researchers shows that younger researchers (under 40 years) have been abroad more often than researchers who are older than 40 years. Mobility is highest among natural scientists and lowest among researchers specialised in humanities (DASTI 2011b, p. 57).

#### **1.2 Ensure that researchers across the EU benefit from open recruitment, adequate training, attractive career prospects and working conditions and barriers to cross-border mobility are removed**

Providing attractive employment and working conditions are priority areas in Denmark, since the employment system for public researchers generally displays a high levels of flexibility (Steering group on human resources and mobility 2009, p. 12). When considering the cost of living, the level of remuneration for researchers in Denmark is high, but still below remuneration levels in the U.S. (European Commission, 2007, p. 20). There are huge differences between the remuneration levels for the different levels of education in the public and the private business sector, both for employees with long-cycle higher education and for employees with PhDs. However, the specific field of an individual's education is important in shaping these differences: in the humanities and arts the remuneration level is about the same in both sectors for employees with a PhD, while a PhD in technical sciences, social sciences, natural science and health care have a 20% higher remuneration in the private sector, compared to the public sector (Statistics Denmark, 2009).

In January 2009 all Danish universities joined the 'Charter for Researchers' and the 'Code of Conduct for the Recruitment of Researchers'.

Open and competition-based recruitment of researchers has been implemented at Danish higher education institutions and other public research organisations. Research job vacancies are published on the EURES Portal, the EURAXESS portal or at the job portals of the different organisations. The Ministerial order on the Appointment of Academic Staff at universities stipulates that 'positions at professor and associate professor levels have to be posted internationally', while this is not mandatory for assistant professor, post-doc or PhD levels positions (SGHRM, 2009, p. 8).

Denmark participates in international co-operation through the Europass Framework, and is active in implementing of the Bologna Process on higher education, and the Lisbon Recognition Convention. Recognising academic and professional qualifications from other countries is a prerequisite for foreign researchers to be able to apply for researcher positions in Denmark. The Danish Agency for International Education provides assessments of non-Danish degrees, diplomas and certificates as well as information about international recognition of Danish qualifications. In the case of regulated professions, applicants must have their professional qualifications authorised by the responsible Danish authority. There are about 100 regulated professions. Temporary service providers from EU/EEA countries, in most cases, only need to submit a declaration regarding their professional qualification. For some professions, gaining access on the basis of foreign qualifications is more difficult. If the profession involves a governmental function, Danish citizenship may also be a requirement, as in the cases of judges, police and priests. The DCIR participates in the EUROHORCS initiative, authorizing researchers moving to other countries to take the remainder of any awarded grant with them, while the DCSR has not signed the letter of intent 'Money follows researchers' (SGHRM, 2009, p. 9).

### **1.3 Improve young people's scientific education and increase interest in research careers**

The high quality of the vocational education system and the further education of employees are key pillars of the Danish flexicurity system. A key element of the Welfare Agreement from 2006 was the strengthening of adult and vocational education and training. In the 2008 NRP several initiatives in the field of lifelong learning were highlighted, such as making labour market-related programmes more attractive, flexible, and oriented towards a specific purpose, providing better competence development programmes for adults in the special continuing training system for adults, and higher public grants for an increased number of adult apprentices who can acquire a vocational education and training qualification. Extensive changes were implemented in upper secondary education during 2009/2010. In November 2010, a political agreement was reached to increase the number of in-service training places in 2011 with 8,900 extra places within the vocational education and training system (Danish Government, 2011b, p. 27).

However, Denmark still lags behind the leading countries in the field of entrepreneurial education and training. Therefore the Danish Government introduced a Strategy for Education and Training in Entrepreneurship, which was developed by the Ministry for Science, Technology and Innovation, the Ministry of Culture, the Ministry of Education and the Ministry of Economic and Business Affairs (Danish Ministry of Science, Danish Ministry of Culture et al., 2010). The strategy covers entrepreneurial education at all levels, including the university level. In addition the government has established the Danish Foundation for Entrepreneurship – Young Enterprise which will become a national knowledge centre for education and training in entrepreneurship. The promotion of *entrepreneurial training* at Danish universities is one of the priorities in the recently launched initiative for entrepreneurial universities.

### **1.4 Promote equal treatment for women and men in research**

The remuneration gap between men and women in Denmark is very small compared to other countries (below 5% after 15 years of working life). The difference in the annual average salary between men and women is 6%. However, there are differences between scientific domains in terms of remuneration gaps (European Commission 2007, table 65, based on Eurostat data). The EU gender equality directives have been implemented in Danish law via the Act on Gender Equality and the Act on Equal Treatment of Men and Women.



However, there is evidence of a considerable loss of female research talent. Although more women than men graduate from Danish universities today, only 28% of all senior lecturers, and 14% of all professors, are women (Ministry of Science 2009, p. 5).

## ***2. Facilitate cross-border cooperation, enhance merit-based competition and increase European coordination and integration of research funding***

Denmark is active in a number of other ERA related cooperative actions, such as European Technology Platforms (ETP), Joint Technology Initiatives, Article 169 initiatives, ERA-NETs, and ERA-NET Plus. These activities have been mapped in a report published by DAST (DASTI 2010c). The report concludes that Denmark is best represented in Article 169 Initiatives and Joint Technology Initiatives, while participation in ERA-NETS is rather low. For more detailed information see the EW Country Report for 2010 (Klitkou, 2011a).

Generally, according to Danish law, Danish funding schemes are open to researchers based abroad, regardless of their nationality, provided that their research is judged to be of benefit to Danish research. Accordingly, both DCIR and DCSR welcome applications that comprise elements of international research cooperation, to support the best Danish researchers and groups of researchers in their efforts to coordinate and develop their cross-border research collaboration. DCIR and DCSR therefore make no requirements regarding the applicant's citizenship, to the registered office of the research institutions or to a specific geographical location for the implementation of the research activities in question, but in all events, the application will be assessed on the basis of whether the project applied for benefits Danish research. Foreign research groups can also apply for funding within the Strategic Network Project scheme or the Strategic Research Alliance. All the strategic research programmes with recent calls promote this openness. They include strategic research alliances as an instrument. The rationale for this openness is to strengthen Danish research groups through cooperation with excellent researchers from third countries.

## ***3. Develop world-class research infrastructures (including e-infrastructures) and ensure access to them***

In November 2008, the political agreement between the government and the opposition on the distribution of the globalisation pool for R&D included an increase in investment in research infrastructure between 2010 and 2012. In 2009 the National Programme for Research Infrastructure allocated €26.8m (DKK200m). The programme provided funding for establishing major national research infrastructures and Danish membership or participation in major international research infrastructures (DASTI, 2009a).

In March 2010 the Ministry of Science, Technology and Innovation published an Action Plan for research infrastructure (Ministeriet for Videnskab 2010). The action plan acknowledged that there is still a great need for improvement in research infrastructure. The Action Plan highlighted that national framework conditions for research have to be improved across individual research organisations. A 'road map' for the development of research infrastructure was to be developed, based on a mapping of the short-term and long-term infrastructure needs in the following six areas:

- material and nano technology;
- biotechnology, health and life sciences;
- physics and astronomy;
- energy, climate and environment;
- humanities and social sciences; and
- e-Science.

In September 2011 this roadmap was published (DASTI 2011a). The following table contains a list of ESRI projects which are of Danish interest in the short term. The table is broken down by those research fields named in the 2008 ESFRI roadmap.

**Table 4: ESRI projects which are of Danish interest in the short term (DASTI 2011a, p. 17)**

Social sciences and humanities
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CESSDA - Council of European Social Science Data Archives	Considerations going forward concerning Danish participation in and funding of CESSDA will be included in the planned efforts to reorganise and strengthen Danish register research.
CLARIN - Common Language Resources	Danish membership of CLARIN will be funded by the anticipated grant for the Digital Humanities Lab and Technology Infrastructure (DigHumLab) project.
DARIAH - Digital Research Infrastructure	Danish membership of DARIAH will be funded by the anticipated grant for the Digital Humanities Lab for the Arts and Humanities (DigHumLab) project.
ESS - European Social Survey Upgrade	Considerations going forward concerning Danish participation in and funding of ESS-Survey will be included in the planned efforts to reorganise and strengthen Danish register research.
SHARE - Upgrade of the Survey of Health, Ageing and Retirement in Europe	Denmark will be participating in SHARE with a view to execution of phase 1 of the project. The cost of participation will be covered by the University of Southern Denmark. Considerations going forward concerning Danish participation in and funding of SHARE will be included in the planned efforts to reorganise and strengthen Danish register research.
<b>Environmental sciences</b>	
EPOS - European Plate Observing System	Danish membership of EPOS-ERIC will be funded by the anticipated grant for the DanSeis (National Centre for Seismic Instrumentation) project.
ICOS - Integrated Carbon Observation System	Danish membership of ICOS-ERIC for the short term is dependent on developments in the international project, national interest and options for funding via the Research infrastructure for collection of data on greenhouse gases project.
LifeWatch - e-Science and Technology Infrastructure for Biodiversity and Research infrastructure for biodiversity and Observatories	Danish membership of LifeWatch-ERIC for the short term is dependent on developments in the international project, national interest and availability of funding via the environmental data.
<b>Energy</b>	
WindScanner.eu	The expectation is that Danish research environments and the consortium behind Windscanner.dk will spearhead the preparation and development of the European WindScanner project, which was inscribed on the ESFRI roadmap in 2010.
<b>Biological and medical sciences</b>	
BBMRI - Biobanking and Biomolecular Resources Research Infrastructure	Considerations going forward concerning Danish participation in and funding of BBMRI-ERIC will be included in the planned efforts to reorganise and strengthen Danish register research.
EATRIS - European Advanced Translational Research Infrastructure in Medicine ELIXIR - European Life Sciences Infrastructure for Biological Information**	Danish participation in the planned transition phase and subsequent membership of EATRIS-ERIC will be funded by the anticipated grant for the Danish EATRIS node. In connection with the allocation of the National Programme for Research Infrastructures in 2009 a reserve grant of DKK 25m was earmarked with a view to extending and guaranteeing Danish participation in ELIXIR. The reserve grant is expected to be allocated in 2011, again, depending on the project's development nationally and internationally.
INSTRUCT - An Integrated Structural Biology Infrastructure for Europe	Danish membership of INSTRUCT will be funded by the anticipated grant for the Danish GHz Solid State NMR Instrumentation Centre.
<b>Materials and analytical facilities</b>	
ESRF-upgrade	Danish participation in ESRF (European Synchrotron Radiation Facility)-upgrade will be funded through the ordinary membership fee. The Danish commitment to ESRF will otherwise be addressed in a new Danish strategy for access to X-ray laser, synchrotron and neutron radiation facilities, which is due by summer 2011.
ESS - European Spallation Source	Denmark is a co-host of ESS. ESS Data Management & Software Centre is planned to be sited in Copenhagen.
European XFEL	Denmark has been a member of the European X-Ray Free-Electron Laser Facility (European XFEL) since 2009.



ILL20/20 Upgrade	In 2009, Denmark took out a two-year trial membership of the Institut Laue-Langevin (ILL). Continued Danish commitment to ILL will be addressed in a new Danish strategy for access to X-ray laser, synchrotron and neutron radiation facilities, which is due by summer 2011.
<b>Physical sciences and engineering</b>	
E-ELT - European Extremely Large Telescope	Danish participation in E-ELT is funded via the ordinary membership fee to the European Southern Observatory (ESO).
E-Infrastructures	
PRACE - Partnership for Advancing Computing in Europe	Considerations going forward concerning Danish participation in and funding of PRACE will be included in the planned efforts to reorganise and strengthen Danish e-Science.

#### ***4. Strengthen research institutions, including notably universities***

The reform of the university system in Denmark has led to a high level of autonomy regarding management of research budgets and hiring of research personnel. The universities sign development contracts with the Minister for Science, Technology and Innovation, lasting for 3 years. These contracts are based on performance indicators and describe the level of ambition for the universities. The universities then get funding based on these performance indicators, with funding received as a lump sum, allowing autonomy to decide on its distribution. The government is not involved and does not interfere with the appointment of new researchers, but has defined the overall framework for how to proceed. However, this management process is due to the reforms of the university sector, mentioned earlier, and not based on staff democracy but on professional management. Decisions about researchers' salaries are delegated to the universities, but salary negotiations are determined by an agreement between the government and trade unions. The decision on research agendas or research specialisation is reserved by the university, and interference from the ministry is not welcomed by the academic community. However, the increased share of competitive funding for mission-oriented research, based on strategic priorities, contributes to pressure on universities to align their research specialisation with nationally agreed priorities.

The mission statements of all Danish universities cover quality of academic research and higher education, interaction and exchange of knowledge with the private sector and society in general, and strengthening international cooperation. This implies that the third mission is an important task for Danish universities. Most universities use third mission indicators on the number of patents, number of spin-off firms funded by faculty members and annual revenues (income) from sales of licences from patents and copyright. Most of the universities also have their own technology transfer office. The most successful university in these areas is the DTU.

We can distinguish between core funding and competitive funding of universities, both of which will be strengthened in the future. The share of competitive funding has been over several years 40% of the total public research funding (Danmarks Forskningspolitiske Råd, 2011, p. 16). The distribution of both types of university funding is largely based on performance indicators. In June 2009, a political agreement on a new distribution model for core funding to the universities was reached. The new distribution model is a modification of the former 50-40-10 model, which covered indicators for education, external funding and PhD graduates. The new model includes bibliometric indicators as well, and will be introduced stepwise over the period 2010-2012. The envisioned distribution for 2012 is: 45% based on education appropriations, 20% based on external funding of R&D activities, 25% based on bibliometric indicators, and 10% based on PhD graduates. This means a stronger focus on performance measures for the Danish universities. This performance based funding model has been disputed by academics.

#### ***5. Facilitate partnerships and productive interactions between research institutions and the private sector***

Intellectual property rights (IPR) have been much debated in recent years. In 1999, the Act on Inventions at Public Research Institutions was passed by parliament. This changed the rules for patenting at universities. Prior to this Act, the rights to inventions made by university researchers belonged to the researchers, while the government research institutes could claim the IPR. Since January 2000 all public research organisations can claim the rights to inventions made by their researchers, the researchers are obliged to disclose inventions and shall receive a reasonable royalty payment from their organisation. The implementation of the Act was supported by considerable funding efforts by the Ministry of Science, Technology and Innovation.

In 2004, an evaluation concluded that the Act has been well received by the researchers and the funding was appreciated, but the outcome (number of patents and licenses) was

only modest.

The legal framework conditions in the Act on Inventions at Public Research Institutions were supplemented by the Act on Technology Transfer at Public Research Institutions in 2004. The objective of the Act was to support:

- transfer of knowledge between public research institutions and industry;
- the establishment of research-based enterprises; and
- cooperation between public research institutions, foundations and associations.

Since 2004, the commercialisation of public research results has been assessed annually. In 2004, DASTI established an inventor service counselling office. An external evaluation of this office has shown that it has acted effectively and will be continued, in a strengthened form, until 2013 (Inhouse Consulting, 2008).

Most of the universities also have their own technology transfer office, but the number of staff varies from more than ten full-time employees, to less than one full-time post. The most successful university in these areas is the DTU. The creation of academic spin-off companies is assessed as being a good mechanism for circulating new, educated R&D personnel from the universities into industry. The statistics reveal a modest increase in this type of activities since 2004. The National Network for Technology Transfer organises the TTOs from the universities, research institutes, hospitals and regional TTOs and it supports the sharing of competences, knowledge and methods involved in technology transfer.

There are several funding instruments which are targeted at increasing R&D co-operation between the business sector and public research organisations. In an evaluation report published in September 2010, an international evaluation panel presented the results of an evaluation of several funding schemes which aimed at fostering such co-operation (Svedberg, Andersen et al., 2010). The evaluation panel concluded that these funding instruments are functioning well and that the evaluated projects appear to be based on a high level of knowledge transfer between the public and the private sector. This panel also highlighted that the participation of SMEs in the selected projects appears to be too low and should be investigated further.

In 2010, the Council for Strategic Research and the Council for Technology and Innovation launched a new initiative, inviting proposals for Strategic Platforms for Innovation and Research (SPRI). This new policy measure targets inter-sectoral R&D co-operation and improved linkages between research and innovation. The platforms will be funded for 5-7 years.

A code of conduct for research cooperation between universities and companies was developed by The Confederation of Danish Industries and The Danish Rectors' Conference (Burmeister and Ørnsholt, 2004). Inter-sectoral mobility of researchers is high in Denmark in comparison to other EU-27 countries (MORE, 2010). Approximately 80% of the industrial PhD programme contributes to improved mobility between universities and companies while only around 20% of traditional PhDs gets positions in the private sector. Public-private knowledge transfer is ensured by the involvement of representatives from the private sector in the governance of higher education institutions. At several universities the majority of board members are external members and some of them come from the private sector.

Open access to knowledge is an important issue, especially for SMEs. In June 2011 a study was published on the levels of access to and use of research and technical information by knowledge-based SMEs in Denmark. The study revealed "barriers to access, access difficulties or gaps, and the costs and benefits involved in accessing research findings" (Houghton, Swan et al., 2011). The study was based on an online-survey and interviews and gave policy recommendations: "(i) addressing information literacy and improving the capacity of SMEs to navigate the information landscape; (ii) addressing accessibility and affordability of access for SMEs; and (ii) responding to the expressed concerns and wishes" of SMEs.

## ***6. Enhance knowledge circulation across Europe and beyond***

The Danish EU Research Office in Brussels assists Danish researchers and research organisations and promotes Danish participation in FP7; the EuroCenter under DASTI is specialised in information and consulting services regarding the FP7; and other measures from DASTI include the START-scheme and Pre-project grants for SMEs. In most programmes under the DSR and the DCTI foreign participation and cooperation is encouraged, through higher rankings in the evaluation process and through the inclusion of foreign research institutes in project consortia.

Collaboration with Nordic and Baltic countries is fostered through collaboration under the Nordic Council of Ministers. The Ministry of Science, Technology and Innovation also has a focus on research collaboration with strong economies outside Europe: the ministry signed bilateral agreements on research collaboration with China, India, Israel and Japan. Danish Innovation Centres have been established in Silicon Valley, USA, in Shanghai, China and in Munich, Germany.

The Danish Government has approved the Council of the European Union's conclusions about scientific information in the digital age. An Open Access Committee was appointed under the steering committee for Denmark's Electronic Research Library (DEFF). In March 2011 the Open Access Committee published the recommendations for the implementation of Open Access in Denmark (Danish Agency for Libraries and Media 2011). This report can be seen as an implementation plan for a 4-years period with indication of process, players and finances.

## ***7. Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world***

Several new initiatives for the coordination of international activities were set up in 2009, such as the FACIT committee (Funding Agency Coordination of International Tasks), and a pool of €6.7m for research collaboration, set up in 2009 by the Ministry of Science, Technology and Innovation. The former Ministry of Science, Technology and Innovation initiated several collaboration agreements and other policy measures to ensure an improved knowledge exchange between Danish and knowledge communities outside Europe. These collaboration agreements include bilateral agreements (Memorandums of Understandings) about research cooperation with countries outside the EU in areas, agreements about the building of joint university centres (in China), partnership agreements on research cooperation together with research and innovation networks and authorities in the U.S., and establishing innovation centres in leading research, innovation, and industrial communities outside the ERA.

Denmark has developed specific strategies for the so-called BRIC-countries (Brazil, Russia, India and China) to improve trade and investment cooperation and to market Danish strengths and competencies, in fields such as climate and energy, welfare, architecture, research, education and food (Danish Government, 2011a; p. 4).

Denmark is actively cooperating with other Nordic countries in joint programmes and institutions. The organisation of Nordic collaboration in research and innovation rests on two main pillars, one for research, the Nordic Research Board, NordForsk, and one for innovation, the Nordic Innovation Centre (NICE). The Top-level Research Initiative is the largest joint Nordic research and innovation initiative to date. The Nordic cooperation is actively addressing global challenges, especially climate, environment and energy issues.

NICE funds Nordic projects that boost innovation and competitiveness in the Nordic business sector and lead to commercial and sustainable development. Specific recent initiatives issued in 2011 are oriented towards following topics:

- Innovation in the Nordic marine sector;
- Integration of large scale wind power;
- Nordic user-driven competence centre for realisation of carbon capture and storage;
- Sustainable Freight Transportation.

The *Top-level Research Initiative* has launched several initiatives which address important global challenges, especially regarding climate and access to sustainable energy. Most recent initiatives are:

- Energy Efficiency with Nanotechnology;
- Integration of Large-scale Wind Power;
- Nordic user driven competence centre for realisation of carbon capture and storage;
- Nordic Partnership Initiative on Up-scaled Mitigation Action which will help Peru and Vietnam to cut their greenhouse gas emissions in highly polluting sectors like waste and cement.

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## List of Abbreviations

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BERD	Business Expenditures for Research and Development
BRIC	Brazil, Russia, India and China
CERN	European Organisation for Nuclear Research
COST	European Cooperation in Science and Technology
DASTI	Danish Agency for Science, Technology and Innovation
DCIR	Danish Councils for Independent Research (Det Frie Forskningsråd)
DCSR	Danish Council for Strategic Research (Det Strategiske Forskningsråd)
DCTI	Danish Council for Technology and Innovation (Rådet for Teknologi og Innovation)
DEFF	Denmark's Electronic Research Library
DK	Denmark
DTU	Technical University of Denmark
EBST	Danish Enterprise and Construction Authority (Erhvervs- og Byggestyrelsen)
EDDP	Energy Technology, Development and Demonstration Programme (Energiteknologisk Udviklings- og Demonstrationsprogram)
EPO	European Patent Organisation
ERA	European Research Area
ERA-NET	European Research Area Network
ERP Fund	European Recovery Programme Fund
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU-27	European Union including 27 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
FP	Framework Programme
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDDP	Green Development and Demonstration Programme
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GTS	Godkendte Teknologiske Serviceinstitutter (Advanced Technology Group)
GUF	General University Funds
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
HRST	Human resources for science and technology
IP	Intellectual Property
IPC	International Patent Classification
IPR	Intellectual Property Rights
NICE	Nordic Innovation Centre
NRP	National Reform Programme

OECD	Organisation for Economic Co-operation and Development
PRO	Public Research Organisations
R&D	Research and development
RD&I	Research, Development and Innovation
RD&D	Research, Development and Demonstration
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
S&T	Science and technology
SF	Structural Funds
SME	Small and Medium Sized Enterprise
SPIR	Strategic Platforms for Innovation and Research (Strategiske forsknings- og innovationsplatforme)
TRI	Top-level Research Initiative
TTO	Technology transfer office
UNIK	University Research Investment Capital (UNiversitetsforskningens InvesteringsKapital)
VC	Venture Capital



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#### Abstract

The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. EW Country Reports 2011 identify the structural challenges faced by national innovation systems. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. The annex of the reports gives an overview of the latest national policy efforts towards the enhancement of European Research Area and further assess their efficiency to achieve the targets.

These reports were originally produced in November - December 2011, focusing on policy developments over the previous twelve months. The reports were produced by the ERAWATCH Network under contract to JRC-IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl.

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

