PEER-REVIEW OF THE DANISH RESEARCH AND INNOVATION SYSTEM:
Strengthening innovation performance

Expert Group Report prepared for the
European Research Area Committee

Commissioned by the European Commission
Financed by the European Commission
Copenhagen or Brussels, September 2012

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Paul Cunningham, Senior Research Fellow and Director, Manchester Institute of Innovation Research (MIoIR), University of Manchester (Rapporteur): Paul Cunningham joined PREST (the forerunner of MIoIR) in 1985. Since then his work has covered a wide range of activities and his research interests have diversified greatly. Particular (albeit broad) areas of personal research interest now include: studies of the development and application of STI evaluation methodologies; investigations of HEI-industry collaboration mechanisms; quantitative measures of R&D performance and the development of science and technology indicators; national and regional level studies of innovation and the identification of innovation best practice; studies of transnational scientific collaboration; and international science and technology policy development. Much of this work has been undertaken either as a direct input to, or as a means to inform, policy making. In this context, he has undertaken numerous studies for a wide range of bodies including UK Government Departments, UK Research Councils, the British Council, together with international bodies such as the European Commission, the OECD, national governments (Canada, Greece, Ireland, Japan, Malta, Poland, Sweden) and other local, regional, national and international agencies. He was rapporteur for both the CREST Policy Mix peer review of the United Kingdom and of Cyprus. He has an honours degree in biological sciences from the University of East Anglia and a PhD in marine ecology from UCNW Bangor.

Kimmo Halme, Ramboll Management Consulting. Prior to his current position Kimmo Halme was Managing Director and Founding Partner of Advansis Ltd. From 1990 to 1992, he served as Business Incubator Manager and Acting Managing Director at Otaniemi Science Park Ltd. In 1992, he was appointed as a Senior Researcher at the Technical Research Centre of Finland, for carrying out studies on high-tech businesses and innovation support schemes. From 1995 to 1999, he worked as a full-time Expert to the European Commission Innovation Programme in Luxembourg, through a UK consulting company INBIS Ltd. His main fields were design & management of regional innovation strategies, as well as being part of the team for the EU Green paper on Innovation. Mr. Halme served as the Chief Planning Officer for the Science and Technology Policy Council of Finland since 1999. He has unique practical experience having participated in numerous working groups for innovation policy preparation at EU, national and regional levels. He served as the Director of Advansis Ltd. since 2003. He is a well-known speaker in various seminars and conferences on topics ranging from cluster policies to regional innovation strategies. Mr. Halme has an MSc in industrial management (1990) and a Lic.Tech in business strategy and international business (1995), both from the Helsinki University of Technology.

EC observer:

Johan Stierna, DG Research and Innovation

The ERAC SAT pilots

In October 2010, Commission's Europe 2020 flagship initiative Innovation Union[1] reaffirmed the role of peer reviews in support of reforming national research and innovation systems. It also invited Member States to carry out self assessments[2] based on the methodology described in its Annex. The objective of the Member States' self-assessments is to identify key challenges and critical reforms as part of their National Reform Programmes.

During 2010-2012, three of the new type of ERAC (European Research Area Committee) peer-reviews have been piloted, namely by Belgium, Estonia and now the latest one by Denmark. These pilots used and built upon the analytical structure introduced in the Innovation Union Communication Self-Assessment Tool (SAT), that is by responding to the SAT questions.

Overall, the new approach of the ERAC peer-reviews and the introduction of SAT have been considered very positive, bringing a more systematic and structured methodology to the process. At the same time, there are still areas of the peer-review process that could be further developed to better facilitate systematic and efficient comparison of national research and innovation policies, systems and practices amongst the Member States. The experiences of Belgium, Estonia and Denmark are each unique and provide many good practices for the future reviews to take on board.

These first experiences on the use of the new SAT tool have been separately reported to the ERAC in June 2012, and on the basis of that, further improvements of the tool and review methodology will be planned. The SAT experiences will also be reflected at the Europe INNOVA Conference in October 2012. The report will be made available at the ERAC site.

Please see: http://ec.europa.eu/research/era/partnership/coordination/erac_omc_cycle_en.htm# for further developments.

[1] http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf COM(2010) 546 final; p. 28

[2] Annex 1 of the Innovation Union Communication presents the Self Assessment Tool - SAT

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1 Executive Summary: opportunities for strengthening innovation performance

This Summary presents the recommendations arising from a Peer Review of the Danish research and innovation system carried out in the broader context of the European Research Area Committee (ERAC) peer review process. It is based on a visit made by the members of the Peer Review team to Denmark in June 2012, supplemented by information on the overall research and innovation system of Denmark summarised in a Background Report.

1.1 First impressions

We have found Denmark offers an excellent example of a well-performing R&I system. Its notable strengths lie in:

- A strong international standing in terms of comparative international performance in most RD&I indicators.
- A strong education base with excellent higher education and research systems.
- A strong public and private sector commitment to continue to maintain the necessary levels of investment into education, research and innovation.
- A timely response to the prevailing economic conditions and identified challenges in the development of a new national innovation strategy by the Danish government which demonstrates a number of appropriate courses of policy action.
- A unique Danish approach and culture for innovation and innovation policy, which strongly reflects the country's open and dynamic welfare society.

However, a number of concerns exist which may call for further policy attention:

- A large and heavy Danish public sector, which tends to dominate the R&I system.
- Concerns around insufficient growth of productivity levels and a slowing down of economic growth.
- A need for well-performing Danish companies to 'raise their game' from the European level to the global arena – in particular for Danish SMEs to exploit their niche market opportunities.
- A need to increase the visibility, both in performance and policy attention, of sectors of the Danish economy outside multinational companies in the pharmaceutical, biotechnology and energy sectors
- The existence of policy instruments in a limited number of policy areas which need further development in order for the RDI system to achieve its full potential.

1.2 Recommendations for future action

The following section presents the recommendations set out above within the context of the main issues set out by the Danish authorities in advance of the Peer Review, which were based on the outcomes of the Self Assessment Test (SAT-note Denmark), namely:

- How to develop demand-driven innovation policy further and facilitate service innovation;
- How to create a simplified funding system for research and innovation that can better accommodate the needs of customers;
- How to increase innovation capacity throughout the educational system;

- How to increase the innovation capacity and growth of SMEs.

1.2.1 How to develop demand-driven innovation further and facilitate service innovation

Reference Section: 4.2.4 Balance between supply-side and demand-side policies and 4.2.5 Innovative public procurement

While the Danish system tends to operate a strong set of supply side instruments and policies, there are also good indications that significant progress has been made into the development of demand-side instruments, including the use of innovative public procurement. The newly introduced Danish instruments to inform public procurers and the pilot project within the Business Innovation Fund are good examples of this progress. Further development of these policies would seem to offer good potential, particularly if accompanied by complementary policies in other domains (competition, consumer, labour, environmental regulation, etc.) in which Denmark has a good track record.

- **Recommendation:** Denmark should continue to develop its demand-side policy instruments and activities in a more systematic way alongside and complementary with the traditional supply-side instruments and aim systematically towards integrating demand and supply policies around societal challenges, including so-called grand challenges of a global nature. .
- **Recommendation:** Potential areas for the development of public procurement policies should be explored and assessed according to their potential to deliver innovation which is also accompanied by market growth opportunities. Good examples of the procurement of innovative products should be systematically disseminated and new instruments, such as pre-commercial public procurement for the development of innovative products to meet the needs of public institutions, could be tested.

1.2.2 How to create a simplified funding system for research and innovation that can better accommodate the needs of customers

Reference Section: 4.2.1 Policy agenda priorities

Despite its size, Denmark is at the forefront of innovation policy development in many areas and is now developing a National Innovation Strategy, based on a holistic approach with an emphasis on addressing societal challenges. However, it is also necessary to connect these goals with existing competitive strengths and to ensure that the research base remains sufficiently broad in order to address future research needs and capacities. Moreover, it is clear that the priorities of the Research 2020 Initiative and the National Growth Teams should be in line, and that the development of the National Innovation Strategy will benefit from the involvement of all major stakeholders from the Danish research and innovation system.

- **Recommendation:** Concentrate policy priorities to three or four main activity fields which align with Danish economic strengths.
- **Recommendation:** Investigate the integration of foresighting activities involving the key stakeholders to a greater extent within the strategic policy process.

Reference Section: 4.3.1 Structure of the governance and funding system

The structure of the Danish RD and innovation funding and advisory system appears overly complex, with a range of overlapping responsibilities. Some questions arise concerning whether the system effectively addresses the full range of challenges faced or if their activities are effectively coordinated. Turning to the funding bodies for innovation, there seems to be an imbalance towards the basic end of the spectrum, again with an overlap of responsibilities: reducing the number of funding institutions would gain efficiency, increase transparency and reduce red-tape, while

permitting larger and more cross-cutting projects to be financed. Similarly, clarification of the role of the Growth Teams in implementing innovation policy would be desirable.

- **Recommendation:** Expand the advisory remit of the Danish Council for Research Policy to encompass innovation and education related concerns so that it becomes a Research, Innovation and Education Policy Council, which is able to address the entire knowledge triangle
- **Recommendation**: a streamlining of the Danish Innovation System, while maintaining a clear path from basic research to market, would help stimulate innovation. One suggestion would be to have one funding council for basic/strategic research and another for applied/innovation oriented research as in several other countries, such as Finland, the Netherlands, Norway, Sweden, etc.

Reference Section: 4.3.7 Coordination and monitoring of funding schemes
Denmark exhibits a strong evaluation culture with some good practice examples of the use of evaluation methodologies, particularly with economic impact evaluations of specific support programmes. However, there is a need to better understand the way in which the Danish policy mix operates in order to optimise its performance. Appropriate models may be found in several other countries.

- **Recommendation:** Denmark could further benefit from its expertise in programme evaluation by extending the practice of evaluation to the system level, for example by undertaking systemic evaluations of policy fields such as support for innovative SMEs which would encompass all relevant programmes. This would serve to provide a clearer picture of the complexities of the Danish innovation system.

Reference Section: 4.3.8 Streamlining and marketing of funding schemes
The innovation funding system itself (the policy mix) appears overly fragmented, particularly for an economy the size of Denmark, with many of the instruments appearing comparatively subcritical in their volume, a feature that may be related to the size of the Danish public governance system. Moreover, there is some evidence that the number and opacity of the available policy mix presents something of an “innovation jungle”. Recent experience indicates that many other countries have undertaken steps to rationalise their range of available policy measures, whilst improving the way in which available support is signposted to clients. Finally, the route by which Danish public R&D funding is provided to the private sector provides an interesting comparison with regards to procedures used in a number of other countries, where companies exercise greater control over the direction of R&D projects, whilst also enhancing the transfer of public research knowledge into the private sector.

- **Recommendation:** investigate ways in which the currently separate and numerous policy instruments and funding programmes may be merged and simplified. The application of more systemic evaluations (see section 4.3.8) would provide evidence for opportunities for such rationalisation.
- **Recommendation:** the business advice and counselling system should be improved, perhaps by better linking existing web based services and national call-centre with an individual demand oriented counselling service, working in line with the innovation agents. Simultaneously, more efficient use of the Internet in connection with individual counselling could be considered as a way to improve the awareness in SMEs about the relevant funding programmes.
- **Recommendation:** Reinvestigate - based on international best practices – whether the Danish system for providing public R&D funding is the best way to leverage companies’ R&D

investment. For example, the eligibility criteria or objectives of direct instruments might be too strong, whereas fiscal incentives offer companies greater flexibility to organise their research more optimally.

1.2.3 How to increase innovation capacity throughout the educational system

Reference Section: 4.2.3 Governance and monitoring of universities; 4.4.3 Supply of graduates; 4.4.4 Profile of graduates

The Danish university sector is very strong: education and research volumes are high, as is the quality of research. However, with regards to university autonomy, the university development contracts appear to be a less than optimal mechanism for the control of management, funding and performance. One key issue is that the Government does not seem to have a decisive role in directing universities in providing the range and types of skills required by the labour market, while the development and anticipation of educational needs, particularly in addressing the requirements of the business sector, are fragmented and not systematically organised. Linked to this is a lack of suitably qualified engineers and technicians entering the public and private research sectors, which might be partially addressed through the introduction of a differentiated student grants system. Denmark also exhibits an historical lack of employability among its highly educated graduates, which again suggests that further policy attention should be paid to the design and development of curricula. Another issue concerns the age of those graduating from the higher education system, a feature that may be related to the generous Danish grants system.

- **Recommendation:** Reassess the structure and scope of the development contracts with the Danish universities to investigate their potential to influence the skills/competences range and completion rates of graduates and the commercialisation of research results. One possibility might be the use of financial incentives to increase the universities' level of engagement with stakeholders.
- **Recommendation:** Undertake a review of the current incentives system and structure for the supply of scientists and engineers to seek ways in which it may be re-balanced in order to more effectively meet Denmark's future needs in research and innovation.
- **Recommendation:** Undertake a review of the available options, including good practice examples from other countries, by which stronger linkages can be developed between the universities and the business world in terms of ensuring a supply of appropriately trained and skilled personnel. Options might include: linkage mechanisms, especially at the local level, differential student grant systems, caps on student numbers within disciplines, expansion of PhD and graduate placement/cooperation schemes, attraction of skilled personnel from abroad, social loan schemes, etc.
- **Recommendation:** Consider suitable measures to promote entrepreneurship and start-up creation for young graduates as an alternative route for careers and employment.
- **Recommendation:** Develop the use of foresight exercises aimed at aiding decision making on future skills needs and the ways in which these might be addressed, by the government and by the universities and other educational establishments. The process should closely engage business and could operate at a sectoral level. Companies should be integrated into this process.

Reference Section: 4.3.4 University funding

Although the evidence gained on this topic was not sufficiently detailed to make any strong conclusions, it appears that around 40% of Danish university research funding is given on the basis of competitive mechanisms: on first impressions, this proportion appears quite low and one might assume that if the research needs of SMEs were to be extensively analysed, there would be a significant latent need and potential for research collaboration.

- **Recommendation:** In order to understand this issue, a more extensive analysis of university funding and SME collaboration would be required.

Reference Section: 4.3.6 Stimulating partnerships and business research and innovation; 4.5.1 Linkages between public research and private enterprises

Responsibility for liaison with industry (particularly with SMEs) lies mainly with the GTS Institutes, which are responsible for applied research and development, leaving the universities with a more peripheral role. This may in part explain the comparatively low level of industry funding of universities in Denmark, where, it should be noted there is a much weaker tradition of for direct industrial funding of university research than in the UK, for example. There may also be an overreliance on the GTS and Innovation Networks in their ability to engage SMEs into RDI activities. Further efforts may be needed and the new initiative for the strengthening of entrepreneurial universities and improving commercialisation may play a contributory role. However, the barriers to SME engagement remain unclear. In addition, there is an impression that the Danish PPP-instruments focus too strongly on cooperation between industry and the GTS (i.e. in applied research) thereby reducing the propensity for industrial collaboration with the universities and the more fundamental research base.

- **Recommendation**: A new culture of cooperation between science and industry should be established. Longer-term cooperative initiatives should bring together companies (big firms and SME) as well as universities to define jointly strategic research programmes paving the way to innovation. Ideally, these research programmes could be linked to the identified strategic priority topics (i.e. through Research 2020 and the growth initiative).

1.2.4 How to increase the innovation capacity and growth of SMEs

Reference Section: 4.5.5. Raising the innovation capacity and growth of SMEs; 4.5.2 Promoting knowledge and commercial exploitation

The development of clusters and critical mass in niche markets seems to offer potential in an economy such as that of Denmark. However, there was an impression that Danish business innovation support is somewhat underemphasised, especially for the engagement of SMEs, and that the relevant instruments are too small. There also seemed to be scope for greater encouragement of business-to-business cooperation, particularly between SMEs and larger businesses, and greater cooperation with international partners in order to develop a more globalised position, with more proactive policies to attract large knowledge intensive firms from abroad to cooperate with Danish SMEs. Lastly, the available public sector measures seem to place insufficient attention on the issues of valorisation and commercialisation of research results.

- **Recommendation:** The potential for the design of measures to encourage large and small companies, together with research institutes, to undertake cooperative projects or to engage in dialogue over shared innovation requirements should be investigated.

The provision of tax incentives alone may not offer the best solution with regards to increasing the innovation capacity and growth of SMEs and further complementary support may be required. Moreover, despite being comparatively simple to administer they would further increase the complexity of the overall funding landscape and there is mixed evidence on their levels of success. Lastly, it seems both from previous experience and from remarks during the discussions that Danish companies do not appear to show much interest in tax incentives .

- **Recommendation:** Revisit the design of the Danish R&D tax incentive scheme based on international experience to take full advantage of it for leveraging private R&D investments. Also, undertake an immediate review of the uptake of the tax incentives in order to assess demand and any barriers facing their uptake and to inform the design of complementary measures to remove such barriers.

Reference Section: 4.5.3 Supply of venture capital
While the Danish VC market seems to be performing well, the availability of VC funding is seen as a major growth challenge facing European companies and it is not clear whether the current provisions for equity financing in Denmark will be sufficient. There may also be potential for the development of a closer level of cooperation between existing instruments and structures.

- **Recommendation:** Reconsider the structure of the various schemes to support venture capital provision. Opportunities for the use of forms of crowd sourcing could also be investigated.

1.2.5 General issues

Reference Section: 4.2.2 Addressing major societal challenges
The current and anticipated RDI policy focus areas in Denmark appear relevant and reflect the broad understanding across the RDI community and other societal stakeholders. The 'reverse foresight' process used in the preparation of Research 2015 could be regarded as an example of good practice. However, the translation of this strategic level into policy implementation will require a careful matching of research and innovation capacities in order to derive the optimum benefits to the country.

- **Recommendation:** concentrate on those societal challenges which are the most important for the Danish economy and which, in particular, offer strong opportunities for Danish industry and its reliance on SMEs.

Reference Section: 4.3.3. Promoting international mobility
Denmark seems to have adopted a pragmatic and targeted strategy for the selection of international partners, but the need to develop linkages with the global research system is paramount for smaller countries in order to overcome the problems of insufficient critical mass, narrow research capabilities, resource limitations and international visibility. This issue is, thus, relevant in the context of the issues discussed above (strength of the research system, global market presence, development of clusters, etc.).

- **Recommendation:** The international orientation of the Danish innovation system could be further strengthened by the attraction of foreign innovative companies to the country. Where this is not already possible, the opportunities for, and costs of opening up remaining national funding instruments to international participants should be investigated, so that companies and universities from abroad could participate in research projects on equal terms with Danish parties in order to strengthen the Danish research and innovation system.

2 General Introduction

This report has been produced to support the European Research Area Committee (ERAC) peer review of the Danish research and innovation system. It represents the outcomes of a visit made by the members of the Peer Review team to Denmark between 11th and 13th June 2012. Prior to this visit, the Peer Review team were provided with a Background Report containing a structured set of information relating to the overall research and innovation system of Denmark in the context of existing information.

The Background Report presented a structured set of key issues which were intended to provide initial guidance to the Peer Review team in preparation for their visit. However, during the visit, the members of the Peer Review team were entirely free to develop their own line of questioning and to pursue issues they felt to be relevant. The Background Report drew heavily on information provided by the Danish Government, particularly the outcomes of the Danish Self Assessment Test (SAT-Note) introduced as part of the ERAC Peer Review process, and derived its format principally from this source, with additional information on the structure and performance of the Danish innovation system. The report was produced by the review facilitator, Dr Paul Cunningham in consultation with Mr Kimmo Halme.

Section 3 of this report presents the organisational arrangements, key people involved with the discussions and the overall programme. The latter was organised according to the key actors in the Danish research and innovation system. The main topics were as follows:

1. Governance and scope of policy
    a. The Danish Research and Innovation system – an introduction
    b. Strategic research priorities – The Research 2020 initiative
    c. International research collaboration and participation in EU framework programmes
    d. University governance and priorities – performance contracts
    e. The research policy advisory system
    f. Business and Growth Policy priories – National Growth Teams
2. Public funding system
    a. The public funding system for research & innovation - an overview
    b. The Danish Council for Independent Research
    c. The Danish National Research Foundation
    d. The Danish Council for Strategic Research
    e. The Council for Technology and Innovation
    f. The Advanced Technology Foundation
    g. Example of a sector initiative: The Green Development and Demonstration Programme
    h. The Business Innovation Fund
3. Business sector policy
    a. The business structure in Denmark – target groups of the research and innovation system
    b. Regional growth initiatives – an example
    c. Innovation Networks and cluster policies in Denmark
    d. Technological Service Institutes
    e. Innovation Incubators & science parks
    f. Venture capital market initiatives
    g. Future demand for SME and growth initiatives

4. Human resources & training
    a. The higher education system in Denmark – an overview
    b. Future demand for graduates, training and mobility
    c. Entrepreneurship training
    d. Mobility and recruitment programmes – Industrial PhDs and Knowledge Pilots

Section 3 also details the key issues addressed by the review team. These were derived from the information contained in the Background Report.

Section 4 contains the main feedback from the peer review team. This is organised as a set of recommendations and suggestions under a series of broad headings, which, where possible, are aligned with the structure of the SAT-Note and the key issues outlined therein:

- Overall impressions
- Governance
    - Policy agenda priorities
    - Addressing major societal challenges
    - Governance and monitoring of universities
    - Balance between supply-side and demand-side policies
    - Innovative public procurement
- Public funding
    - Structure of the governance and funding system
    - Promoting excellence in research
    - Promoting international mobility
    - University funding
    - Publication and protection of research results
    - Stimulating partnerships and business research and innovation
    - Coordination and monitoring of funding schemes
    - Streamlining and marketing of funding schemes
- Public policies aimed at the public sector
    - Autonomy of universities
    - Attractiveness of research careers
    - Supply of graduates
    - Profile of graduates
    - Entrepreneurship in science and education
- Public policies aimed at the business sector
    - Linkages between public research and private enterprises
    - Promoting knowledge and commercial exploitation
    - Supply of venture capital
    - Protection of intellectual property
    - Raising the innovation capacity and growth of SMEs

Acknowledgement: The facilitators and the peer review team would like to express their gratitude to all those who made presentations and participated in the discussions. Particular thanks are also due to Mr Thomas Alslev Christensen and Mr Kåre Jarl of the Danish Agency for Science, Technology and Innovation for the administrative and logistical arrangements and for their hospitality during the visit.

3 Peer Reviewers and Interview programme

On 12-13 the June 2012, the Peer Review Team visited Copenhagen and held a series of interviews with senior officials and representatives of the key stakeholders groups in the Danish research and innovation system. These stakeholder groups were identified through an iterative series of communications between the organising authorities in the Danish Ministry of Science, Innovation and Higher Education, the Ministry of Business and Growth and the lead consultants.

The Peer Review team comprised:

- Mr **Wolfgang Crasemann:** Head of Unit "Technology and Innovation Policy", Bundesministerium für Wirtschaft und Technologie, Germany.
- Mr **Petri Lehto**: Head of Division (Innovation Policy), Ministry of Employment and the Economy, Finland.
- Mr **Otto Starzer**: Head of "Excellence and Competence" Group, Austrian Research Promotion Agency (FFG), Austria.
- Mr **Arie van der Zwan**: Senior Policy Advisor on Research and Innovation Policies, Ministry of Economic Affairs, The Netherlands.

Also accompanying the team were:

- Mr **Johan Stierna**, DG Research and Innovation, European Commission and
- Mr **Mikko Salo**, DG Research and Innovation, European Commission (with a focus on methodology)

The lead consultant for the Danish Review, Dr **Paul Cunningham** of the Manchester Institute of Innovation Research, University of Manchester, UK, was also present and acted as facilitator for the meetings. He was assisted, particularly in recording the discussions, by Mr **Kimmo Halme**, of Ramboll Management Consulting Oy, Finland.

Organisational arrangements were made by Mr **Kåre Jarl**, of the Danish Agency for Science, Technology and Innovation, Ministry of Science, Innovation and Higher Education, who also attended the meetings as an observer. Invaluable assistance was also provided by Mr **Thomas Alslev Christensen**, Head of Department for Innovation Policy and Head of Secretariat of the Danish Council for Technology and Innovation, Danish Agency for Science, Technology and Innovation.

The overall proceedings were opened with a welcome by the Danish Minister for Science, Innovation and Higher Education, Mr. Morten Østergaard who gave an introduction to Denmark's plans for a new national innovation strategy.

The presentations were arranged according to main topics outlined above and were made by representatives of the main actors in the Danish research and innovation system. Each presenter gave an brief overview of the specific topic under discussion before responding to a number of questions addressed by the members of the peer review team. If time was available, a more general discussion was developed at the end of each session. In addition, due to time constraints it was not always possible to have individual presentations in which case a general round-table discussion was held. The programme of presentations is presented below.

- **Session I: Governance & scope of policy**
  - *Director General Hans Müller Pedersen, Danish Agency for Science, Technology and Innovation*
  - *Head of Department Kim Brinckman, Danish Agency for Science, Technology and Innovation*
  - *Head of Department Birgit Kjølb, Danish Agency for Universities and Internationalisation*
  - *Head of Secretariat Karin Kjær Madse, Danish Council for Research Policy*
  - *Deputy Permanent Secretary Jens Lundsgaard, Ministry of Business and Growth*

- **Session II: Public funding system**
  - *Head of Department Thomas Alslev Christensen, Danish Agency for Science, Technology and Innovation*
  - *Council Chairman Jens Christian Djuurhus, Danish Council for Independent Research*
  - *Board Chairman Klaus Bock, The Danish National Research Foundation*
  - *Director General Hans Müller Pedersen, Danish Agency for Science, Technology and Innovation – on The Danish Council for Strategic Research*
  - *Council Chairman Conni Simonsen, The Council for Technology and Innovation*
  - *Managing Director Carsten Orth Gaarn-Larsen, The Advanced Technology Foundation*
  - *Programme board member Bent Claudi Lassen, The Green Development and Demonstration Programme*
  - *Head of Department Christian Bruhn Rieper The Business Innovation Fund*

- Joint discussion with session II presenters on possible improvements of the funding system.

- **Session III: Business sector policy**
  - *Head of Department Sigmund Lubanski, Ministry of Business and Growth*
  - *Head of Department Dorthe Kusk – Region of Southern Denmark*
  - *CEO Merete Daniel Nielsen, Netmatch*
  - *CEO Søren Stjernquist, Danish Technological Institute Chairman of Advanced Technology Group*
  - *CEO Lars Stigel, Østjysk Innovation, Chairman of The Danish Science Park and Innovation Incubator Association*
  - *CFO, Senior Vice President Martin Vang Hansen, Vækstfonden*
- Roundtable discussion with session III presenters and additional stakeholder representatives comprising:
  - *Advisor Katrine DiBona, Confederation of Danish Industry*
  - *Policy consultant Dorte Kulle, The Danish federation of Small and Medium Sized Enterprises*
  - *Research Director Annette Toft, Danish Agriculture & Food Council*

- **Session IV: Human resources & training**
  - *Director General Inge Mærkedahl, Danish Agency for Higher Education and Educational Support*
  - *Director General Jens Peter Jacobsen, Danish Agency for Universities and Internationalisation*
  - *Chief advisor Sarah Gade Hansen, Confederation of Danish Industry*
  - *CEO Christian Vinthergaard, Foundation for Entrepreneurship - Young Enterprise Denmark*

- Roundtable discussion with session IV presenters and additional stakeholder representatives comprising:
  - *Rector Ib Poulsen, Roskilde University*
  - *Rector Erik Knudsen, University College Lillebaelt*
  - *Deputy Director Bjarne Lundager Jensen, Think Tank DEA*
  - *Managing Director Lia Lefland, Danish Academy of Technical Sciences*
  - *Head of Education- and ICT-Department Per Påskesen, Danish Metalworkers Union*
  - *Chief of Staff Anders Frandsen, The Danish Society of Engineers*

3.1 Remit of the peer review

As stipulated in the Terms of Reference for the Expert Group, the aim of the peer review was to:

> "provide external advice to Danish authorities in the process of creating a forward looking national innovation strategy. As a central ambition of the Government platform, the Danish Government has decided to develop a comprehensive and ambitious strategy aimed at integrating innovation policy with areas such as energy and environmental solutions, public-private partnerships, etc. The goal of the innovation strategy will be to better address and accommodate solutions to societal challenges. Defining new targets for a national innovation strategy shall result in the capacity to build a better, stronger and more cohesive innovation system in Denmark".
>
> "The preparations for the new innovation strategy are headed by the Danish Ministry of Science, Innovation and Higher Education, but will include a broad dialogue also with other national and regional authorities as well as major stakeholder institutions and organisations. Specific focus points of the ERAC peer review should be identified through the initial self assessment. This will be conducted jointly by The Ministry of Science, Innovation and Higher Education and The Ministry of Business and Growth, and the outcome will be consolidated at Government level".
>
> "The peer review in particular should provide advice on and inspiration from best practise policy initiatives in other EU member states and beyond."
>
> "According to the schedule drafted by The Danish Ministry of Science, Innovation and Higher Education the ERAC peer review should be finalised in the autumn of 2012 allowing for the international advice to feed into the national innovation strategy presented by the end of the year."

3.2 Main issues addressed

Whilst the discussions covered a range of topics under the broad headings of the above four presentation sessions, the overall line of questioning by the peers was shaped by the specific sets of challenges identified in the Background Report. These are provided below for information.

3.2.1 Challenges identified by the SAT-note Denmark

3.2.1.1 How to develop demand-driven innovation policy further and facilitate service innovation:

- How can demand side policies be further developed to stimulate innovation?
- How can demand-driven research effectively be transformed into practical innovation and large scale solutions to societal challenges?

- What can be adopted from international best practise in regard to innovative procurement - e.g. use of life cycle considerations, functional procurement and SME-involvement?
- What can be learned from international best practise in regard to intelligent use of technical standards and public regulation as drivers to stimulate innovation of private enterprises?
- How can service innovation policies be further supported and developed?

3.2.1.2 How to create a simplified funding system for research and innovation that can better accommodate the needs of customers:

- To what extent does the current supply of funding bodies for research and innovation reflect the needs of public and private applicants?
- To what extent does the current division of labour and supply of support schemes at government and regional level provide sufficient synergies?
- Is the current amount of time limited programmes consistent with the desire to have an effective and user-friendly system?

3.2.1.3 How to increase innovation capacity throughout the educational system:

- How can the profile and content of university curricula become more aligned with future job opportunities - e.g. in the private service sector?
- How can more students be attracted into science and engineering without compromising the professional educational standards of the relevant fields?
- How can teaching staff in human and social sciences become more motivated and skilled at dealing with demands and problems of private enterprises? E.g. what can be learned from international best practise?
- How can the impact of entrepreneurship training be improved e.g. via acknowledgement of training courses and student projects?

3.2.1.4 How to increase the innovation capacity and growth of SMEs

- How can more non-innovative SMEs be motivated to raise their internal innovation capacity and utilise new knowledge - e.g. via recruitment of staff or board-members with supplementary skills?
- How can private business associations at regional or branch level be engaged more actively in raising the innovation readiness of member SMEs?
- How can the entrepreneurial culture in public research be enhanced as a driver for new business creation and additional university-business linkages e.g. via cross-sector mobility or use of wage or promotional incentives?
- How can more innovative SMEs be incentivised to engage in international activities, export and realise their potential for international growth?

3.2.2 Challenges identified by other sources of analysis

The ERAWATCH Country Report Denmark, 2011 identifies four key structural challenges facing the Danish research and innovations system:

1. Denmark has a lower R&D intensity than the group of lead performing reference countries. Knowledge-intensity in the 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.

2. The shortage of highly skilled labour is critical for growth in high-tech sectors. Students need 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 a major societal challenge for Denmark. This may put a risk the goal of increasing the numbers

of R&D personnel employed in SMEs and may negatively impact the possibilities for employees to keep their knowledge base updated.

3. Cooperation between public science and the business sector needs to be improved as indicated by the limited purchase and uptake of R&D results from universities. Currently only the GTS-system functions well as an R&D provider for the business sector. A related challenge will be to retain the RD&I activities of larger enterprises in Denmark or to attract foreign companies to Denmark.

4. The commercialisation of public research results needs to be improved. The merger of the majority of the independent research institutes with the universities was intended to strengthen the universities' capabilities to commercialise research results but, apart from very recent data, the statistics tend to show that most universities still have limited experiences with and capacities for patenting, licensing, start-up companies and other commercialisation efforts. This situation, may however, be improving. Nevertheless, university IPR policies may not be conducive to inter-sectoral knowledge exchange. IPR issues have been identified as a barrier in cooperative R&D projects and this issue requires further investigation and attention at a higher policy level[3].

Lastly, the TrendChart Mini-Country Report 2011 states that the new National Reform Programme published in May 2011 (Danish Government, 2011b) gives a summary of the main challenges for the Danish society and announces a series of political reforms to address these challenges. The following challenges related to innovation policies are 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.

Whereas manufacturing and the public sector achieve higher productivity growth rates, low productivity is a particular issue in services, and may be explained by the following factors, which also require policy attention:

- Improved employment rates of less skilled people;
- Weak innovation performance by Danish enterprises;
- Slow growth in service industries and construction.

[3] This challenge has been slightly amended in the light of comments and recent data from DASTI.

4 Findings of the peer review team

It should first be noted that the peer review team members were highly impressed with the set of presentations provided to them. All presenters were very concise and made strenuous efforts to comply with the rigid time constraints that were imposed on them. Overall, the peer reviewers felt that they had been provided with a very clear picture of the Danish research and innovation and the key issues it faces. The presenters and other stakeholders present gave a good range of perspectives and provided some very comprehensive answers to the questions posed. However, it should also be noted that it was not always possible to go into each issue in as much detail as might have been possible or desirable and, as such, the peer reviewers were not able to provide highly specific recommendations.

The peer reviewers, Commission representatives and facilitators were also grateful to the staff of the Danish Agency for Science, Technology and Innovation for the organisational arrangements, which allowed for a very efficient and effective set of discussions, and for their hospitality.

4.1 Overall impressions

The Danish R&I system, including its overall policy-making infrastructure and range of policies has achieved an excellent international standing and its impressive performance is the envy of many other European countries. Some of its strengths are indicated below:

- According to most comparisons and indicators, Denmark is one of the innovation leaders both in the European and in world ranking systems. It is often regarded as the 'one to watch'.

- The education base is very strong (although STI fields can be considered to be comparatively less strong) and the quality of its higher education and research are excellent: its science production system is of a very high quality and efficient in terms of quality citations per unit of invested public money. The reforms that have been applied to the universities and public research institutions (in 2007) appear to have been very successful and the country has achieved second place on the EU innovation scoreboard.

- There is a strong commitment, from both the public and private side, to continue to maintain the levels of investment into education, research and innovation. This commitment seems likely to be retained regardless of the political complexion of the Government and despite the prevailing economic conditions in Europe.

- The development of the new national innovation strategy by the Danish government seems to represent a timely response to the major identified challenges. With the involvement of the five Danish regions and their innovation efforts, the current policy focus is on expanding the level of public-private cooperation, reinforcing cluster dynamics and finding new solutions to better align the supply of innovation to public demand (through public procurement of innovative products and services) and private demand (firm-to-firm technology markets). At the level of human resources, there is a determined policy to enhance creativity and entrepreneurship through the education system, including adult education.

- There seems to be a unique Danish approach and culture for innovation and innovation policy, which strongly reflects the country's open and dynamic welfare society. This is largely founded on a combination of an openness to change, strong regional innovation

determinism, acceptance of policy systems such as the multi-actor policy governance structure, funding by largely independent funds, the restricted level of direct funding to industry, coupled with the generous educational system and light touch governance. It is this 'Danish Innovation DNA' that the peers would wish to reinforce; accordingly, the peers were reluctant to disturb the present system or to make strong suggestions for solutions from other countries which might not be appropriate to the Danish context. However, we would caution against too much complacency in a world where global competition is getting increasingly fiercer.

Nevertheless, there are a number of concerns which it is felt warrant further attention:

- The Danish public sector is very large and heavy. The overall research and innovation system is very much dominated by the public sector. As noted in the Minister's opening address, this feature should be turned into an advantage by creating more leverage for the private sector.

- Despite strong Danish performance in many of the RDI-related indicators, including the overall growth of GDP, at the same time there is a growing concern about insufficient productivity levels and a slowing down of economic growth. To expand on this point, Denmark exhibits a much lower productivity level than other knowledge-intensive countries (only slightly above EU average) and the productivity growth has been falling since 2003 (with a negative productivity growth from 2007 onwards). Denmark's share of value added in high-tech and medium-high-tech sectors plus knowledge-intensive services in total value added is lower than the EU-27 average – a trend that has been stagnating since 2000 [4]. It seems that the problem is not in the public sector, since Denmark attained a 1% public R&D investment in 2009 and has a high quality higher education and science production system (as noted above). In contrast, examination of the output side of the innovation system points towards a less favourable performance (around the EU average or even decreasing). It is likely that despite excellent levels of investments into RDI, these are not being effectively translated into economic impacts, a lack of valorisation which suggests that elements of the RDI system are underperforming or that the investments are not being optimally targeted. Thus, a challenge for Denmark lies in the valorisation of knowledge and technologies by firms (together with public research institutes) and in boosting innovation in firms to enhance firm growth, with a corresponding upgrading of the economic structure.

- Danish companies are well represented in the EU R&D Scoreboard. However, the challenge is for them to now make the transition from European leaders to global leaders. During the last decade the policies targeted at SMEs and fast growing companies have been very successful, but they seem to have been realised by strong growth within the national market. The emphasis should now be focused on realising the previous high investments in R&D by improved performance in the global market. This could require different types of instruments, such as ensuring optimal conditions for the establishment of international firms and attracting FDI that fits the Danish innovation profile.

[4] The same trend is observed in the Netherlands, where it is partly caused by a high degree of (rather low tech) transit related activities to Germany, which are caused by geographical location. At the same time policy attention is focused on the relationship between firm-size and productivity level – i.e. which types of firms show high productivity growth and how can they be supported, including improvement of the continuity between different types of instruments.

- Apparently much of the Danish private sector RDI investment is being generated by a few multinational companies together with a number of Danish firms that are concentrated in the pharmaceutical and biotechnology, ICT and energy sectors: RDI investments and activities across other sectors, and particularly amongst the SME and services sectors, seem to be much weaker. The latter sectors also appear to receive less policy attention. Consequently, the system might also benefit from the presence of more 'innovation disrupters', possibly developed from a wider range of domestically based SMEs.

- Overall, it can be said that the framework conditions for RDI are largely excellent in Denmark and the majority of the policy activity is appropriate, sound and well delivered. However, there remain a few policy areas which need further development in order for the RDI system to achieve its full potential. For example, Denmark's deteriorating productivity growth can be viewed as a symptom of an innovation system that is, perhaps, not functioning as well as it could and some rebalancing between the innovation and research policies is required.

4.2 Governance

4.2.1 Policy agenda priorities

As a small country, Denmark can and has demonstrated flexibility and responsiveness with regards to RDI policy. It is at the forefront of innovation policy development in many areas, such as in service innovation, demand and user-driven innovation, use of regulation and standards for innovation, innovative public procurement, large scale/systemic innovation, etc. Many of the current trends in European innovation policy, such as orientating RDI systems towards addressing societal challenges, the open involvement and broad participation of social stakeholders in the policy dialogue or the setting of ambitious objectives for policy evaluation are all well integrated into the Danish policy culture.

It was noted that a Danish National Innovation Strategy is now under development, based on a holistic approach. Many other countries have developed similar holistic innovation strategies, which are worthy of analysis. For example the Netherlands, also a medium size country with a very open economy, has adopted a holistic, but at the same time sectoral policy approach[5]. Here, research and innovation are integrated with entrepreneurship, education, trade policies, IPR, lower administrative burdens, FDI and 'economic diplomacy' (the use of innovation councillors, trade missions, bilateral agendas, etc). The Dutch have selected ten "top sectors" and for each an innovation agenda has been drafted. The top sectors are led by 'figureheads' from the business sector. Responsibility for the innovation aspects of the sectors is vested with the Ministry of Economic Affairs, Agriculture and Innovation. In the Danish Growth Team initiative, seven areas have been selected (out of which five, creative industries, water, health, energy, agriculture coincide with the Dutch selection[6]). In addition, the Netherlands has a specific top sector relating to the headquarters of international companies: this might offer an interesting option for Denmark as well.

While the Dutch top sector approach could be a useful input to the Danish system, there are caveats that should be noted. At present, the Danish research system (as foreseen in Research 2020) aims at addressing societal challenges. However, it can be difficult to make a good connection between a research system targeted at societal challenges and an innovation system based on a sectoral approach focused on competitive strengths; in particular, there is a risk that the role of horizontal,

[5] Examples from other countries are included for illustrative purposes only: we recognise the problems associated with transferring policies between national contexts, however, it is considered that the Dutch system does share some similarities with that of Denmark, although there are other international examples that could also be considered.

[6] The other two being shipping and tourism.

converging technologies like ICT, nanotechnology and biotechnology could be underexposed. Because of this, the Dutch approach pays significant attention to the role of horizontal technologies.

To provide a further example for consideration, Germany has developed the High-Tech Strategie, which focuses on societal challenges, such as energy supply, climate protection, health, mobility, security and communication. Cross cutting issues, such as IPR, standardization, public procurement, venture capital, SME financing and development of a qualified workforce are also major issues for consideration: these issues are addressed in the new innovation concept of the Ministry of Economics and Technology.

Another risk of this type of focus is that fundamental, curiosity driven research can be dominated by research with a more applied orientation. This can lead to longer term problems since a broad basic research base is required to address future research needs and capacities. However, since Danish public investment in research (1%) is comparatively high, a slight shift in the balance towards a greater share of external funding by the private sector might be justified. On the other hand, it is still important to continue to strengthen the quality of basic Danish research (see Section 4.3.2).

A point for consideration would be to concentrate the funding of curiosity-driven research within a more restricted number of strategic areas which would have greater potential for uptake by Danish industry. In this context, the strategic platform for innovation and research (SPIR) seems to offer significant potential to improve the involvement of all relevant stakeholders in agenda setting for strategic research.

It is clear that the priorities of the Research 2020 Initiative and the key areas of the National Growth Teams should be in line. However, given the rather small size of the country and the small, SME-dominated scope of the economy, the opportunities for a greater concentration to three or four main activity fields including regional aspects (smart specialisation), which align very closely with Danish economic strengths, should be considered (possible candidates being health, environmental/energy and creative industries). This would optimise the effective use of tax-payers money. The planned new integrated innovation strategy could lay the ground for this integrated and prioritised approach encompassing research, innovation and education aspects. It is also worth noting that the foreseen involvement of all the key Danish ministries in the planning process for the new strategy forms a good model for similar innovation strategies in other countries.

- **Recommendation:** Concentrate policy priorities to three or four main activity fields which align with Danish economic strengths.

In addition, the process employed for the development of Research 2015 had a strong resemblance to a foresight exercise, although it appeared to focus strongly on research priorities: a similar process with greater emphasis on innovation and internationalisation concerns could prove a useful input to future discussions on national innovation policy development. The employment of regular foresighting and horizon scanning activities is a useful policy tool which is used to good effect in the UK and has proved influential on research, innovation and internationalisation policy agendas.

- **Recommendation:** Investigate the integration of foresighting activities involving the key stakeholders to a greater extent within the strategic policy process (see Section 4.2.2).

4.2.2 Addressing major societal challenges

The current and anticipated RDI policy focus areas in Denmark (i.e. those based on Research 2015) are well thought through and has been updated (in the context of Research 2020). They appear relevant and reflect the broad understanding across the RDI community and other societal

stakeholders. In particular, as noted above, the 'reverse foresight' process used in the preparation of Research 2015 could be regarded as an example of good practice.

There is a very strong coherence between the EU2020/Horizon 2020 objectives and the Danish RDI policy objectives and topics. This may not be a coincidence, but rather may reflect the fact that Denmark is very open, internationally adaptive and actively positioning itself in the ERA. It may also be the case that Denmark is actively utilising the opportunities afforded by the EU research and innovation agenda although it seems that participation in the research activities of the ERC could be improved.

It should be noted that one caveat associated with the design of policies addressing the so-called Grand Challenges is that they are, by nature, pervasive (incorporating societal, economic, research and innovation concerns) and cannot be solved by mega-scale solutions, but by the scaling up of micro-scale mitigation efforts. The identification of such micro-scale (local) solutions offers opportunities to for the development of research policy whilst the scaling up process greatly depends upon the innovation potential. Thus, Danish policy in this area requires a careful matching of research and innovation capacities in order to derive the optimum benefits to the country.

- **Recommendation:** concentrate on those social challenges which are the most important for the Danish economy and which, in particular, offer strong opportunities for Danish industry and its reliance on SMEs.

4.2.3 Governance and monitoring of universities

With regards to university autonomy, the university development contracts appear to be effectively 'gentlemen's' agreements' and operate in the absence of any apparent sanctions for non-compliance. This makes it difficult to understand their role as a mechanism for the control of university management, funding and performance. As noted during the interviews and presentations, Denmark faces particular concerns over the competences of skilled graduates, the length of time taken to introduce these into the business sector and also on the need to increase the valorisation of the outputs of research (see Sections 4.4.3, 4.4.4 and 4.5.1).

- **Recommendation:** Reassess the structure and scope of the development contracts with the Danish universities to investigate their potential to influence the skills/competences range and completion rates of graduates and the commercialisation of research results. One possibility might be the use of financial incentives to increase the universities' level of engagement with stakeholders.

4.2.4 Balance between supply-side and demand-side policies

As noted already, the Danish research and innovation system is characterised by a strong emphasis on supply-side policies (although there is also openness to demand-side policies – see below). Demand-driven innovation policy can offer new insights into and opportunities for policy-making by focusing attention on the framework factors that are important for the creation of markets and for the take-up and diffusion of innovations as well as co-creation by end users. These issues tend to become more and more serious as one begins to understand and work on the growth opportunities that societal challenges offer. Public procurement, standardization, regulation and systemic behaviour are the core policy instruments in this approach. Moreover, the mere recognition that societal challenges provide a new opportunity for innovation and growth forms an important stimulus to policy development (see Section 4.2.2).

Danish policy development seems to acknowledge societal challenges as a new opportunity while corporate social responsibility also has a strong degree of support. Moreover, the research system shows a capacity to allow for the development of skills and competencies around these. However,

an essential step towards the preparation for a global presence in these areas is the development of a home market that is innovation-friendly (and embraces the notion of corporate social responsibility) with the help of the new demand-driven innovation policy instruments. It is especially important that demand and supply policies in these areas are systematically joined. Therefore, there are opportunities for the Danish government to place a stronger emphasis on public demand, for example, through encouraging public procurers to innovate through the purchase of technologies and knowledge services from Danish SMEs or through other forms of close engagement (see Section 4.2.5).

There does already seem to be evidence that in some sectors and areas Denmark has had some success in the use of demand-side instruments. For example, the ultra-strict Danish environmental regulations are known to boost competitive companies, while Denmark is among the first European countries to introduce a national standardisation strategy that includes an innovation perspective, while innovative public procurement already forms a topic for close policy scrutiny.

Finally, innovation policy could be more closely linked to broader policy areas, in particular competition policy, thereby stimulating competition and avoiding the protection of a small, closed national market, and consumer policy, through enhancing advanced consumer test markets for innovative products. Likewise, a flexible labour market can contribute to more innovative working methods and social innovation.

- **Recommendation:** Denmark should continue to develop its demand-side policy instruments and activities in a more systematic way alongside and complementary with the traditional supply-side instruments and aim systematically towards integrating demand and supply policies around societal challenges, including the so-called 'grand challenges' of a global nature .

4.2.5 Innovative public procurement

The Danish intention is to further develop innovation in public procurement to support innovation from the demand side. Overall, it appears that the potential is high, in particular in the health sector (there have been some good examples of small scale successes in the UK's National Health Service) and the relative size of the Danish public sector should provide good opportunities. In the Netherlands, the aim is to make far more active use of government procurement budgets to use innovations to overcome social issues, in part through the Small Business Innovation Programme (SBIR), adapted from the well known US scheme. The UK has also adapted the US scheme in its own Small Business Research Initiative (SBRI). In both the UK and Dutch schemes the target is that 2.5% of the total government procurement budget should be used for innovative procurement (from SMEs, in the UK case). The German federal government will introduce similar measures from 2013 onwards: a new competence centre for procurement of innovations will be established and pilot projects to test new instruments, such as pre-commercial procurement will be financed.

However, despite the widespread policy attention attracted by this topic and although many examples of successful product innovations can be found, there is still a lack of empirical evidence that large scale public procurement schemes can be harnessed to effectively promote innovation and lead to the development of substantial market opportunities. Thus, the development of policies needs to proceed with some caution.

There are two distinctive types of public procurement of innovation - innovative procurement procedures and the purchase of innovative goods, which are used in different situations. In the second type, an active lead customer plays a crucial role, focusing on "what" is procured and not just on "how" it is procured, and they can also create reference projects for innovative suppliers. In this

regard it is important to use the most suitable type of procurement, using a variety of procurement instruments and depending on the wishes and needs of the lead customer. It is also useful to encourage public authorities to interact, with each other and with the market, and to build business cases that can link the different stages of public procurement of innovation. If possible (as noted above) demand and supply schemes should also be linked if possible.

Projects dealing with the public procurement of innovation can be used as best practices to stimulate other public authorities to learn lessons and apply their own policies. Showcasing of successful examples, as happens in the UK SBRI, is also a useful approach in this regard.

The newly introduced Danish instruments to inform public procurers and the pilot project within the Business Innovation Fund are good steps towards the goal of further increasing innovative public procurement by the Danish public authorities. In addition, further approaches such as pre-commercial procurement could be tested.

- **Recommendation:** Potential areas for the development of public procurement policies should be explored and assessed according to their potential to deliver innovation which is also accompanied by market growth opportunities. Good examples of the procurement of innovative products should be systematically disseminated and new instruments, such as pre-commercial public procurement for the development of innovative products to meet the needs of public institutions[7], could be tested.

4.3 Public funding

4.3.1 Structure of the governance and funding system

While the Danish research institutes and universities have been the subject of a strong and apparently successful merger process, the various funding and advisory councils retain a structure that reflects a degree of historical legacy. To the outside viewer, this structure seems to be complicated (see Background Report, Fig. 1, page 3): several councils and foundations have overlapping responsibilities for the funding and support of R&D and innovation activities, while some combine these funding responsibilities with that of an advisory role to Government.

Consequently, the current set up of advisory councils is complex and their individual roles are unclear. More importantly it is not clear whether the councils collectively address all the necessary challenges encountered by the Danish system or whether their activities are effectively coordinated. In particular, the Danish Council for Research Policy, the highest advisory body, seems to have a too narrow mandate over the full scope of RDI concerns (particularly at the innovation end of the spectrum). Thus, it is suggested that the Council for Research Policy should function as a high profile and independent advisory body, not only for research, but should also combine the responsibilities for innovation and education. This would enable synergies and interdependencies between these three (knowledge triangle) topics to be better addressed. The Council should also have a budget for in-depth studies upon which it could base thorough, evidence-based recommendations. The responsibilities of all other councils and foundations should be limited to funding decisions within their own specific remits to avoid conflicts of interest.

[7] An important distinction to consider is that public institutions have specific requirements for products and services, which may be innovative, while public procurers only execute the procurements in order to fulfil the need: if the latter become fixated on innovative characteristics as a primary criterion, the specific requirements of the public institutions may be neglected.

- **Recommendation:** Expand the advisory remit of the Danish Council for Research Policy to encompass innovation and education related concerns so that it becomes a Research, Innovation and Education Policy Council, which is able to address the entire knowledge triangle.

Turning to the funding bodies for innovation, there seems to be an imbalance towards the basic end of the spectrum, with four bodies having responsibilities for dealing with basic or strategic research, while only one or two are concerned with bridging the steps towards implementation. This could be adjusted accordingly, for example, by extending the activities of at least one body (the Council for Strategic Research, say) from basic research more towards research and development. This might be achieved through the use of cooperative research instruments as a means to create more practical innovation (see Background Report, Fig. 3, page 7). Alternatively, the responsibilities for basic research funding could be merged under a single body.

Such a move would align the overall funding structure more closely with the needs of a small country such as Denmark: reducing the number of funding institutions would gain efficiency, increase transparency and reduce red-tape. The Danish National Research Foundation, the Council for Independent Research and the Council for Strategic Research in particular seem to have overlapping responsibilities. By combining these three bodies, the whole research chain from basic research to applied research would effectively be addressed by a single funding body. This would enable larger and more cross-cutting projects to be financed.

Similarly, the National Growth Teams that have recently come into operation under the ministerial committee on business and growth appear to be an appropriate policy mechanism and address an identified need. However, it is not clear how these are linked to the implementation of policy and, hence, their role as an additional actor in the national innovation strategy is unclear.

- **Recommendation**: a streamlining of the Danish Innovation System, while maintaining a clear path from basic research to market, would help stimulate innovation. One suggestion would be to have one funding council for basic/strategic research and another for applied/innovation oriented research as in several other countries, such as Finland, the Netherlands, Norway, Sweden, etc.

4.3.2 Promoting excellence in research

The Danish RDI system has gone through a number of significant revisions during recent years, including the significant move to merge universities and to integrate the research institutions. Perhaps as a partial consequence of these revisions, the university sector in Denmark is very strong: education and research volumes are high, as is the quality of research.

The reported low level of success of Danish applications to the ERC is a potential cause for policy attention, but is not felt to be a major issue: similar low levels of success seem to be relatively commonly reported for smaller EU Member States and result from a range of issues, such as absence of critical mass, lack of sufficient track record and other factors not directly related to the quality of applications. It is recognised that the formulation of applications for Framework Programme and ERC funding requires a certain familiarity and experience with the system. Nevertheless, some countries (for example Norway) regard the ambition to increase the number of Framework Programme and ERC funding awards as an important driver for the gradual improvement of national research quality (and its international recognition). The introduction of national incentives to promote success in such applications is a possible policy mechanism, although it can be argued that success, and the recognition that accompanies it, form suitable incentives in their own

right, without the need for government intervention. We feel that the situation should improve as a reflection of the excellent standing of Danish research and its increasing international recognition.

Overall, it was felt that Denmark is performing particularly well in this field.

4.3.3 Promoting international mobility

One of the key issues faced by small countries is the need to link extensively to the global research system in order to overcome the problems of insufficient critical mass, narrow research capabilities, the need for prioritisation due to resource limitations and low international visibility. One option is through the opening up of national initiatives to international parties in order to tap into global expertise and capacities in science, technology and innovation and to obtain the benefits of participating on the international stage. The presentations suggested that, as far as international research collaboration is concerned, Denmark has adopted a pragmatic and targeted strategy for the selection of international partners – something that several countries have grappled with over recent years.

- **Recommendation:** The international orientation of the Danish innovation system could be further strengthened by the attraction of foreign innovative companies to the country. Where this is not already possible, the opportunities for, and costs of opening up remaining national funding instruments to international participants should be investigated, so that companies and universities from abroad could participate in research projects on equal terms with Danish parties in order to strengthen the Danish research and innovation system.

4.3.4 University funding

Around 40% of university research funding is given on the basis of competitive mechanisms: there are potential benefits to raising this percentage which include increasing the focus of research towards strategic national policy targets, developing better alignment with industrial needs and focusing resources on topics where research capacity needs to be fostered. However, we feel that this issue is more systemic and complex than it appears: the 40% noted above includes both the money universities receive from competitive sources and that which they use in collaboration with companies. On this basis, the 40% appears quite low[8] and one might assume that if the research needs of SMEs were to be extensively analysed, there would be a significant latent need and potential for research collaboration.

- **Recommendation:** In order to understand this issue, a more extensive analysis of university funding and SME collaboration would be required.

4.3.5 Publication and protection of research results

This issue was not discussed extensively during the presentations. However, the issue of open publication is currently the topic of extensive debate in academic policy circles in many countries. We are uncertain of the significance of the issue in Denmark, but the implications of such a policy should be investigated, not the least because of the cost savings opportunities it offers to university libraries and individual researchers but also due to the greater benefits of open publication: broader awareness of research and data from elsewhere, wider collaboration base, faster access to data and, indirectly, higher quality and more relevant research, etc. The issue of Open Access to scientific data in the context of public-private partnerships also forms a topic of discussion and in such cases it can be in the interest of the parties involved to make special arrangements. This could be the case in Denmark as well.

[8] The comparable figure for the Netherlands, for example, is 36% which is considered too low.

4.3.6 Stimulating partnerships and business research and innovation

The GTS and the 22 Innovation Networks seem to be the main mechanisms by which public efforts are made to reach and link SMEs into RDI activities. While these appear to work well, they may not be sufficient on their own. In particular, further efforts may be needed with regards to incentivising universities and polytechnics/applied universities to engage more systematically with companies.

It was noted that in 2010 a new initiative for the strengthening of entrepreneurial universities and improving commercialisation was launched, supported by the Danish Growth Council, the Danish Enterprise and Construction Authority and DASTI. This seems to address a recognised problem and the universities reportedly are keen to develop these activities since they align with their 'third mission' responsibilities. However, it is not clear what the barriers are. This area requires more policy scrutiny and perhaps an investigation of the potential of giving the regions more responsibilities for organising these activities. This topic also receives further attention in Section 4.5.1.

4.3.7 Coordination and monitoring of funding schemes

This issue was not covered specifically in the presentations although it is evident that Denmark exhibits a strong evaluation culture with the use of evaluation methodologies, some of which that may be described as good practice from which other countries may learn. Notable developments include the use of economic impact evaluations which use comparative approaches derived from company performance data gathered prior to the introduction of the evaluated measures[9], and the use of different types of evaluation (examining, for example, programme delivery and management, networking activities and output and impact performance) at appropriate stages of the programme lifecycle rather than in a single evaluation which may suffer from timing-related problems. However, there is a need to better understand the way in which the Danish policy mix operates in order to optimise its performance, through developing synergies and complementarities whilst avoiding duplication and complexity.

Several other countries, such as Germany and Austria have conducted evaluations of sets of related programmes, which address the same or similar target groups in a so called "systems evaluation". Whilst methodologically more demanding and somewhat harder to interpret such evaluations provide a better picture of the interplay of the relevant innovation actors and the effects of complementary measures.

- **Recommendation:** Denmark could further benefit from its existing expertise in evaluation by extending the practice of evaluation from the programme level to the system level, for example by undertaking systemic evaluations of policy fields such as support for innovative SMEs which would encompass all relevant programmes. This would serve to provide a clearer picture of the complexities of the Danish innovation system.

4.3.8 Streamlining and marketing of funding schemes

In a point related to the structure of the research and innovation funding system (see Section 4.3.1), it is clear that the range of funding instruments is presented in a continuum or chain, in which each set of instruments complements others (see background Report, Section 2.1.2, p. 7). On paper this makes sense. However the funding system itself (the policy mix) is fragmented into several instruments/programmes across a number of small organizations. This fragmentation seems excessive, particularly for an economy the size of Denmark: compared to Finland (where the RDI volume, population size and number of companies are roughly the same), or the Netherlands (an economy almost three times as large as that of Denmark) many of the instruments seem subcritical

[9] Provided by the Danish industrial regulatory system which obliges companies to routinely provide such information.

in their volume (see Section 4.5.5). This feature may be related to the size of the Danish public governance system (see Section 4.3.1).

Whereas those inside the Danish system, especially researchers, appear to know their way around the complicated system, a rather different opinion was shown by representatives of the private sector, particularly SMEs (see Section 4.5.5). Evidence from the representatives of Danish SME federations highlighted several issues concerning the number and opacity of the funding programmes – the "innovation jungle" and there was also criticism that the needs of industry are not fully satisfied. However, the views from the representatives from large and small enterprises were quite mixed. One conclusion is that industry associations could have more influence if they were better positioned to speak with one voice in order to articulate their demands to government more coherently. There might also be a risk of "lock-out" for those who do not know how to navigate the instruments jungle, thus efforts should be made to ensure that they are involved.

A general tendency in other countries has been towards fewer, larger instruments, in order to promote clarity and efficiency – Germany, the UK and the Netherlands have recently applied such approaches. Such a simplification is found to be more enterprise-friendly (one-stop shops are a good example of this). The impression is that the Danish government and the five Danish regions are attempting to invent new measures to cater for the many specific needs of companies, a process that has resulted in multiple instruments that are closely parallel in the objectives and mechanisms. It is suggested that the programming system should be analysed to determine how it might become more effective: small, sub-critical measures with low effectiveness could be abolished or combined with other programmes in order to promote critical mass. For example, in Germany, the large and integrated "Zentrales Innovationsprogramm Mittelstand" combined four programmes into one integrated programme with two funding lines. A possible solution would be to utilise a single programme to fund innovation projects in SMEs.

- **Recommendation:** Investigate ways in which the currently separate and numerous policy instruments and funding programmes may be merged and simplified. The application of more systemic evaluations (see section 4.3.8) would provide evidence for opportunities for such rationalisation.

A potential candidate for merger would be to closely coordinate the cluster schemes (which are comparatively small in funding terms) with the European Commission's Structural Funds for innovation. The objective would be to make Denmark's competitive advantages (in wind energy, or sub-sectors of the food industry, for example) more visible at a global level through the development of world class clusters and enhance the potential for the attraction of foreign companies or foreign investment.

The policy mix also seems to be rather over-supplied in the environment/energy area, with three or four closely related schemes (the Green Development and Demonstration Programme, Greenlabs DK, the Energy Technology, Development and Demonstration Programme and the Strategic research programme for environmentally sustainable energy and energy production). To increase visibility and to reduce the associated administration burden, these schemes could be consolidated into a single environment related programme.

Guidance for Danish companies to the so-called 'innovation jungle' is provided through a one-stop dedicated website and accompanying national call-centre (www.vaekstguiden.dk) whilst individualised and targeted counselling services are offered at the regional level. At present the national system is largely reactive and relies on a degree of self-awareness and an understanding of companies' own needs for assistance in order to interrogate the system, although the regional

system appears to be more proactive in identifying suitable clients for innovation and business assistance.

- **Recommendation:** the business advice and counselling system should be improved, perhaps by better linking existing web based services with an individual demand oriented counselling service, working in line with the innovation agents. Simultaneously, more efficient use of the Internet in connection with individual counselling could be considered as a way to improve the awareness in SMEs about the relevant funding programmes.

A particularly interesting characteristic of the Danish innovation system is the typical way in which public R&D funding is provided to the private sector: rather than providing grants to the companies, they are instead given to the research organisations. Companies are then asked to join the research programmes as partners but at their own, full expense. While Switzerland applies a similar model, the public research organisations provide very high quality research services (e.g. through the ETH-model): however this may not be a particularly appropriate approach for fostering incremental innovation within SMEs.

Compared to other systems, this does not represent the only way in which R&D funding may be channelled to the private sector performers (particularly SMEs). In Finland and in Germany, for instance, companies directly receive a substantial part of the funding. This gives the participating companies more direct control of the research and development project with the perspective to increase the opportunities for the transfer of research results into marketable products. The reason given for this decision in Denmark is that it was the result of "a political decision" (this appears to stem from a traditional Danish scepticism towards subsidising private industry with public funds. The arguments for this include the risk of market distortion and the risk of replacing private investments with public ones). Consequently, this may have a very strong impact on the willingness of Danish companies to conduct R&D which can have the consequence that the amount of R&D they perform is below that which is desirable or that they are forced to undertake research which falls within the criteria of the instruments rather than that which fulfils their own strategic and business needs.

- **Recommendation:** Reinvestigate - based on international best practices – whether the Danish system for providing public R&D funding is the best way to leverage companies' R&D investment. For example, the eligibility criteria or objectives of direct instruments might be too strong, whereas fiscal incentives can offer companies greater flexibility to organise their research more optimally.

4.4 Public policies aimed at the public sector

4.4.1 Autonomy of universities

This issue is addressed in Section 4.2.3.

4.4.2 Attractiveness of research careers

This issue is closely linked to that of the supply of graduates and their competence profiles. These issues are dealt with in Sections 4.4.3 and 4.4.4.

4.4.3 Supply of graduates

One of the most important ingredients for innovation is the skills and competencies of individual citizens and companies. Universities play a crucial role not only by educating individuals to the highest level but by also enhancing the suitability of such graduates as employees, able to demonstrate a broad range of skills above those that are purely academically focused. The evidence suggests that Danish universities are very autonomous and that the government does not seem to have a decisive role in supervising them in the range and types of skills and competences that a

university education should supply to the labour market. If this supply does not meet the needs of companies, then the Danish educational system risks an unacceptable degree of inefficiency, with serious implications for those companies that are reliant on such skills and competences for their competitiveness and growth. Currently, the development and anticipation of educational needs, particularly in addressing the requirements of the business sector, appear to be fragmented and not systematically organised.

One potential organisational model is available in Finland, but other examples are also available: here, the Finnish Ministry of Employment and the Economy (MEE) has set up a consortium of four ministries (MEE, Ministry of Education and Culture (MEC), Ministry of Social Affairs and Health, Ministry of Finance) to coordinate the national forecast of employment and educational needs; the consortium requests the Government Institute for Economic Research to produce specific forecasts for individual sectors (and regions). This forms the basis for calculation, which is complemented by other (thematic and more detailed) forecasts. MEE manages the short and medium term forecasts of needs, while MEC is responsible for the long-term forecasts – both ministries collect detailed forecasts from their various agencies, regional offices and stakeholders (such as the confederation of industries). Every four years, the Government approves a plan for education and research, which sets out the official target figures. Finally, MEC negotiates these targets in its annual management meetings with universities, which then form part of the universities' management targets (and which influence funding levels). Denmark also exhibits an historical lack of employability among its highly educated graduates.

Both these features suggest that further policy attention should be paid to the design of curricula and how these might be evolved. One possibility is through the use of foresight analyses to better align the market orientation of the education system: foresight is always a challenging exercise but at least it offers a way to attempt to predict future skills needs in comparison to working on an *ad hoc* basis. However, in addressing the demands of industry there is also a need to balance the universality of higher education against its orientation to a pipeline for narrow industrial employment requirements.

Another issue concerns the age of those graduating from the Danish higher education system, caused by extending the time from enrolment to graduation and entry to the labour market. It is worth examining the underlying causes of this before suggesting courses of action. However, it is possible that the generous Danish student grants system may be a factor in reducing the need for graduates to seek immediate employment, a factor that is likely to be further exacerbated at a time of economic stringency and falling employment opportunities. Again, this requires reviewing.

In addition, the employment needs of Danish industry might be alleviated through greater efforts to attract qualified foreign students to Denmark. This could be initiated, for example by developing a closer connection with the European Institute for Innovation and Technology (EIT): Denmark could actively create Knowledge and Innovation Communities (KICs), for example in welfare, wind energy or sustainable agriculture, with key institutions in other European countries, focusing on innovation and entrepreneurship. Many other options are also available.

The existing Industrial PhDs programme already seems to be designed to address the concern of ensuring a supply of highly trained researchers to industry (and also that of improving science-industry cooperation). It appears to be successful according to a 2011 evaluation[10] but clearly, since

[10] http://www.fi.dk/tilskud/forsknings-og-innovationsprogrammer/hoejtuddannede-i-virksomheder/erhvervsphd/publikationer/analysis-of-danish-innovation-policy-the-industrial-phd-programme-and-the-danish-innovation-consortium-scheme-samlet-web-1-final.pdf

the problem of supply remains, it is evidently not able to address the problem in its current scope and scale. However, industry's demands also include the need for less highly qualified graduates (such as technicians or medium-skill workers). A possibility would be to also involve Master's students in similar types of cooperative placement schemes. This would provide experience of the business world at an earlier career stage and allow new researchers to be trained according to the needs of industry.

- **Recommendation:** Undertake a review of the available options, including good practice examples from other countries, by which stronger linkages can be developed between the universities and the business world in terms of ensuring a supply of appropriately trained and skilled personnel. Options might include: linkage mechanisms, especially at the local level, differential student grant systems, caps on student numbers within disciplines, expansion of PhD and graduate placement/cooperation schemes, attraction of skilled personnel from abroad, social loan schemes, etc.

- **Recommendation:** Develop the use of foresight exercises aimed at aiding decision making on future skills needs and the ways in which these might be addressed, by the government and by the universities and other educational establishments. The process should closely engage business and could operate at a sectoral level. Companies should be integrated into this process.

4.4.4 Profile of graduates

Closely linked to the above issue of supply (Section 4.4.3), one of the main areas of concern is the lack of suitably qualified engineers and technicians entering the public and private research sectors. Therefore, a priority is to attract greater numbers of students into natural sciences and engineering and achieve a better balance with the numbers of students qualified in the social sciences and humanities (SSH). Denmark is not alone in this challenge, but good practice examples can be found. For example, in Germany various schemes exist, such as school laboratories in research institutes; the provision of attractive school projects within enterprises; school competitions and demand-related curricula in universities, organised in close cooperation with industry. In general, the message is that a stronger connection between businesses and educational institutions is desirable and those that operate at the 'local' level are often preferable, such as presence of industry representatives on school, college and university governing boards, pupil and student visits, staff exchanges, etc., while 'job-fairs' and student internships can be offered at a national level.

Another solution to channel students into the natural sciences and engineering would be a differential, demand-related student grant system which would offer higher support for students in these study areas (with conditions to ensure subsequent employment choices). A further option is to use scholarships sponsored by businesses (perhaps with associated public sector co-funding).

Another option, although this might be perceived as a challenge to university autonomy, would be to cap the numbers of places available on SSH courses, while expanding those for natural sciences and engineering. By increasing demand for SSH places, competition would be expected to enhance graduate quality whilst the existing excellence of the Danish education system should be able to sustain the quality of graduates in other disciplines. Such a process could be negotiated through the development contracts between the universities and the Ministry for Science, Innovation and Higher Education.

- **Recommendation:** Undertake a review of the current incentives system and structure for the supply of scientists and engineers to seek ways in which it may be re-balanced in order to more effectively meet Denmark's future needs in research and innovation.

4.4.5 Entrepreneurship in science and education

This topic was not extensively addressed during the peer review process, but did not seem to present any major issues for concern. It should be noted that whereas major efforts have been introduced to promote entrepreneurship training within the educational system, no dedicated initiatives are available to facilitate young graduates in creating start-ups. In countries like Germany and the USA this is an issue of particular attention.

- **Recommendation:** Consider suitable measures to promote entrepreneurship and start-up creation for young graduates as an alternative route of career and employment.

4.5 Public policies aimed at the business sector

4.5.1 Linkages between public research and private enterprises

Compared to the situation in a number of other EU Member States (e.g. Finland), Danish universities are highly autonomous. Again, this tends to reflect the cultural and political environment in Denmark. However, it appears that much of the responsibility for liaison with industry (particularly with SMEs) has been designated to the GTS Institutes, which are responsible for applied research, leaving the universities somewhat detached. This feature may be a contributory factor in the comparatively low level of university-industry linkages and the low level of industry funding of universities in Denmark[11]. It was noted that the revised institutional set up for applied research and development (i.e. the GTS system) has recently been evaluated and, based on the general findings, it seems to be well-performing. However, there may be scope for re-examining the relationship between the universities, the GTS sector and industry to determine how the universities can assume a higher profile in terms of their interactions with industry. For example, is there a crowding out effect being exerted by the GTS sector and are there industrial demands that the GTS are not able to address? There is also an impression that the Danish PPP-instruments focus too strongly on cooperation between industry and the GTS (i.e. in applied research) which may reduce the propensity for industrial collaboration with the universities and the more fundamental research base.

In addition to the GTS, a number of other existing funding instruments (for example, within those operated by the Danish Council for Strategic Research) could be adjusted in order to facilitate the transfer of R&D results into practical innovations, thus initiating new products, processes or services. For example, the strategic research centres (which have a 5-7 years' duration) could involve companies from the very beginning to define jointly their strategic research agenda (e.g. within the application stage). This would help to increase the commercial output of the centres, especially, if some of the financing has to be provided by the companies themselves (including through cash investments)[12].

More provision should be made for longer term (5-7 years), mutually sustainable cooperative research programmes between universities and companies. Such a longer-term perspective would help to foster cooperation between science and industry, increasing the socio-economic outputs of

[11] Some 2.3 % of university research is funded by private companies, placing Danish universities in 27th position among 34 OECD, EU and BRIC countries in terms of the proportion of university research that is funded by private sector (Forskningsbarometer 2009 – Dansk forskning i internationalt perspektiv. København: Ministeriet for Videnskab, Teknologi og Udvikling, pp. 25, 28, cited in in the Danish University Report, 2009: Evaluation Report. Danish University and Property Agency, Copenhagen).

[12] One example of industrial co-financing is given in the Austrian COMET programme ("competence centres for excellent technologies"). Industry has to provide approximately 50% of the budget (half of it is cash, the rest in-kind. See: http://www.ffg.at/sites/default/files/allgemeine_downloads/strukturprogramme/comet_0.pdf).

research. These larger research programmes could comprise a number of (multi-firm) flexible projects. These would be subject to mid-term evaluations to ensure quality and added value.

It was felt that more attention should be paid to facilitating RDI collaboration, particularly in Public-Private Partnerships (PPP). Funding instruments can act as an effective incentive to this end and good examples can be found among the Finnish funding instruments.

- **Recommendation**: A new culture of cooperation between science and industry should be established. Longer-term cooperative initiatives should bring together companies (big firms and SME) as well as universities to define jointly strategic research programmes paving the way to innovation. Ideally, these research programmes could be linked to the identified strategic priority topics (i.e. through Research 2020 and the growth initiative).

The number of technology transfer actors seems to be sufficient, although the way in which they are established and coordinated by central government appears unusual in comparison to other countries' approaches where, typically, the universities decide on the establishment of incubators and oversee their management, funding and operation while government monitors their performance (usually in the form of outputs, such as spin-offs, contracts, licenses, etc.). This approach, which is influenced by local conditions and market demands and opportunities, seems to contrast with the more controlled and limited Danish approach. Moreover, given the changes in Danish university law which tasked Danish universities with a 'third mission' it would seem appropriate for the universities themselves to assess the way in which collaboration with industry and the commercialisation/utilisation of research results and knowledge could best be implemented.

4.5.2 Promoting knowledge transfer and commercial exploitation

As already noted (see Section 4.2.4), the Danish policy mix very much emphasises the provision of specific supply side measures. Financial incentives are targeted at the public sector, including public-private partnerships and there seems to be a strong reticence to employ measures for the direct support of research and innovation activities by the private sector. However, the public sector measures seem to place insufficient attention on the issues of valorisation and commercialisation of research results. The rationale for this seems to be that finely tuned public research conditions and facilities offer the optimal support to innovating companies, notably SMEs. (See also Section 4.5.1).

This contrasts sharply with the current Dutch policy mix, where the main part of the budget is targeted at generic financial support to companies, mainly by tax incentives and an innovation fund with a revolving character. Similarly, in the UK, some 75% of the overall budget for innovation support to companies is provided indirectly via tax incentives (for large and small companies). In the Dutch system there is a specific sectoral policy based on the 'top sector' approach based on common research and innovation agendas, led by the business sector, together with academia and public research institutions. In this system, the valorisation of research is a critical element. Likewise, the UK focuses on this aspect in its Knowledge Transfer Networks programme.

These significant differences in policy approach could be explained by differences in the demography of the business sector. Over 50% of private R&D in the Netherlands is concentrated within eight companies – mainly active in electronics, semiconductors and chemicals, while in Denmark the concentration is much lower, and the largest companies are active in pharmaceuticals, biotechnology and energy. This concentration could explain the much stronger influence of the Dutch private sector on the composition of the policy mix, notably fiscal measures supporting private R&D cost. Likewise, in the UK, the size of the private sector means that direct support of R&D is more effectively targeted at SMEs, whilst other measures aim at leveraging private sector R&D investments and the promotion of public-private sector collaboration.

4.5.3 Supply of venture capital

According to the presentations, it seems that the Danish VC market is performing well. Indeed, new instruments such as the DVK 'fund of funds' have been recently established. However, given the pressures facing private equity funding across Europe (even in the UK, which is known for the presence of a strong venture capital market), the availability of VC funding is seen as a major growth challenge facing companies and the fact that Denmark does not exhibit particularly strong investment volumes, it is not clear whether the current provisions for equity financing in Denmark will be sufficient.

There may also be potential for the development of a closer level of cooperation between the innovation incubators and the Vaekstfonden, perhaps even a merger between the two funds. The ambition and efforts to utilise the returns of the VC activities for investment in new companies is seen as a welcome development, along with the new solutions to attract pension funds for early stage investments. Eventually, the mixture between early stage and later stage funding in combination with smart financing tools could result in a revolving system, lessening or removing the dependence on tax-payers money.

- **Recommendation:** Reconsider the structure of the various schemes to support venture capital provision. Opportunities for the use of forms of crowd sourcing could also be investigated.

4.5.4 Protection of intellectual property

This issue did not feature in the peer review dialogues.

4.5.5 Raising the innovation capacity and growth of SMEs

An important caveat with regard to designing innovation support policies for SMEs is that whilst many countries seem to exhibit a strong political support for SME policies (or rather their perceived growth potential) much evidence indicates that only a small percentage are responsible for employment growth. Nevertheless, in an economy such as that of Denmark, the development of clusters and critical mass in niche markets do seem to present opportunities.

Overall, the impression gained was that Danish business innovation support is somewhat underemphasised. In particular, the Business Innovation Fund (operated by the Danish Enterprise and Construction Authority), the key instrument for supporting close to market innovation in SMEs seems to be too small in terms of its volume: the volume of the fund is DKK489 over two years (covering 106 projects), in other words, €33m and 53 projects per year. In comparison, Tekes (which operates in a similar size country, with a similar number of SMEs, but with a broader set of instruments and where other SME funding organisations exist) has an annual volume of around €600m across 2,000 projects – approximately 20 times that of the Business Innovation Fund.

In addition, there should be more incentives (but within the existing range of support measures) to encourage business-to-business cooperation and for cooperation with international partners, as in the Eureka and EUROStars programmes. In particular, successful clusters (and not only those having received public funding) need to be reinforced in order to achieve a level of global critical mass, possibility by linking them with similar clusters in other European countries. The Dutch Innovation Performance contract, which supports collaborative research between a group of SMEs and which replaced the Innovation Vouchers scheme, offers one example. Another example is the German Central Innovation Programme, which offers support for business-to-business co-operations; in this scheme, international projects receive bonuses. In Denmark, the innovation consortium scheme promotes collaborative research between groups of SMEs, universities and GTS-institutes.

There seems to be a specific demand to incorporate SMEs into the growth initiatives. Thus, the current range of measures (e.g. growth initiatives, clusters/networks, GTS, etc.) should seek ways in which SMEs may be better integrated.

As observed in several countries, however, the difficulty is how to stimulate awareness and interest among SMEs and how to encourage them to take up the opportunities presented. One possibility would be to encourage SMEs to work together with larger firms in cooperative consortia with a longer-term perspective. In this way both sets of actors may benefit: larger firms could use the flexibility of SMEs, for example, as suppliers, while SMEs could use the larger firms' capabilities and experience of defining and managing innovation projects[13]. Ideally, these research programmes would be co-financed by industry: if part of this co-financing was in cash (in addition to in-kind contributions), this would heighten the commitment of the firms and ensure that only projects with clear industry relevance are supported.

- **Recommendation:** The potential for the design of measures to encourage large and small companies, together with research institutes, to undertake cooperative projects or to engage in dialogue over shared innovation requirements should be investigated.

At the same time, a more proactive policy is needed to attract large knowledge intensive firms from abroad to cooperate with Danish SMEs. It is understood that the Innovation Consortia offer a mechanism by which SMEs and larger companies (from within and outside Denmark) may engage on cooperative projects, but these may be too cumbersome since they also require the presence of research institutes and other public sector actors – a lighter touch industry to industry scheme may be more appropriate. These efforts might be best achieved by boosting advanced niche consumer markets and by opening up existing clusters to international cooperation. The key actors in this regard would be the Danish Agency for Science, Technology and Innovation and export councils.

It was not clear whether tax incentives would offer the best solution with regards to increasing the innovation capacity and growth of Danish SMEs. Such companies often require good counselling reflecting their needs, together with support measures that are oriented towards technological innovation, with open characteristics that incentivise and stimulate interaction with other businesses and research institutes and which are responsive to their needs, flexible and not overly bureaucratic. Furthermore, it seems that the introduction of a new tax incentive scheme will further increase the complexity of the overall funding landscape. On the other hand, tax incentives are administratively simpler to deliver than direct mechanisms and the recipient has greater flexibility in implementing the benefits.

Evidence suggests that, if properly designed, R&D tax incentives can complement direct R&D grants. For example, the Dutch Fiscal WBSO scheme is very supportive for SMEs, offering a 42% reduction on the labour cost part of their R&D expenditures. The scheme is graded, being less generous for larger companies and with a cap for very large firms. Evaluations show that the multiplier of the WBSO scheme is quite high, around 1.7. Moreover, it is liked by SMEs since it is not contingent on making a profit and it is received almost directly. Similarly, the Norwegian Skattefun, a fiscal incentive scheme introduced by the Research Council of Norway, has been found to be successful, particularly for high-tech SMEs.

[13] An Austrian example for cooperative research is the COMET program: www.ffg.at/comet (German version) http://www.ffg.at/sites/default/files/allgemeine_downloads/strukturprogramme/comet_0.pdf (English version).

However, recent analyses in various countries have shown some disadvantages of the tax incentive measure, such as misuse of public money and lower effects on the increase of private R&D than those predicted. The measure seems to have positive effects on the innovation capacity in small and medium sized companies, in particular in the provision of a stable extra funding base for R&D. Not so clear are the effects of tax incentives on increasing the R&D investments of large companies and the multiplier effects on the economy as a whole.

Another issue to be considered in the design of fiscal measures concerns the definition of R&D. In some countries, policy discussions are ongoing into broadening the definition based on the Frascati manual to include more elements of non-R&D innovation, particularly those that play an important role in services, where SMEs are especially active.

However, the interviews seem to indicate that the Danish tax incentives have not been designed in such a way that they would further incentivise Danish companies to innovate. Despite the introduction of the incentives, the impression gained was that the clients (Danish businesses) are currently showing little interest towards them. This appears counter-intuitive since tax incentives offer a direct means to reduce R&D expenditures by companies. This hesitance seems to imply that there is a design problem in this instrument. The government's argument is that the tax deduction of R&D expenses offers the risk of speculation and misuse, while it also seems to only favour well-established industries, since start-up companies which do not make a profit for the first years of their operation cannot benefit from it. Another explanation encountered in the discussions was that the tax incentives are proving to be inefficient due to the scarcity of the R&D personnel that the companies need to hire in order to make use of the incentives. Although this problem has been identified above in the context of companies' future needs for growth and competitiveness (see Sections 4.4.3 and 4.4.4), the Danish research and innovation system should be capable of producing these personnel and, if not, especially in the shorter term, Danish companies should be fully able to make use of the broader European and international skilled labour markets.

- **Recommendation:** Revisit the design of the Danish R&D tax incentive schemes based on international experience to take full advantage of it for leveraging private R&D investments. Also, undertake an immediate review of the uptake of the tax incentives in order to assess demand and any barriers facing their uptake and to inform the design of complementary measures to remove such barriers.

Annex 1. Adapted Innovation Union Self-Assessment Tool

(For further developments, see also: http://ec.europa.eu/research/innovation-union/sat)

Self assessment tool:
Features of well performing national and regional research and innovation Systems[14]

1. Promoting research and innovation is considered as a key policy instrument to enhance competitiveness and job creation, address major societal challenges and improve quality of life and is communicated as such to the public

- Public action in all relevant policy areas including education and skills, the functioning of product and service markets, financial markets, labour markets, entrepreneurship and the business environment, industrial policy, cohesion/spatial planning, infrastructure/ICT as well as taxation and at all levels, is designed and implemented in a strategic, coherent and integrated framework geared towards fostering innovation and strengthening the knowledge base and fundamental research.
- Where policies and funding are focused on specific priorities, these are increasingly oriented towards addressing major societal challenges, such as resource efficiency, climate change, and health and ageing, and towards deriving competitive advantage from finding new solutions to tackle them.

2. Design and implementation of research and innovation policies is steered at the highest political level and based on a multi-annual strategy. Policies and instruments are targeted at exploiting current or emerging national/regional strengths within an EU context ("smart specialisation")

- An effective and stable centre-of-government structure, typically steered by the top political level, defines broad policy orientations on a multi-annual basis and ensures sustained and properly coordinated implementation. This structure is backed up by networks involving all relevant stakeholders, such as industry, regional and local authorities, parliaments and citizens, thereby stimulating an innovation culture and building mutual trust between science and society.
- A multi-annual strategy defines a limited number of priorities, preceded by an international analysis of strengths and weaknesses at national and regional level and of emerging opportunities ('smart specialisation') and market developments, and provides a predictable policy and budgetary framework. The strategy duly reflects EU priorities, avoiding unnecessary duplication and fragmentation of efforts, and actively seeks to exploit opportunities for joint programming, cross-border co-operation and exploiting the leverage effects of EU instruments. Bilateral co-operation with non-EU countries is based on a clear strategy and, where possible, is co-ordinated with the other EU Member States.
- An effective monitoring and review system is in place, which makes full use of output indicators, international benchmarking and ex-post evaluation tools.

3. Innovation policy is pursued in a broad sense going beyond technological research and its applications

- A broad concept of innovation - including innovation in services, improvements of processes and organisational change, business models, marketing, branding and design - is actively

[14] European Commission – DG Research and Innovation, Europe 2020 Flagship Initiative Innovation Union, SEC(2010) 1161

promoted, inter alia through more interdisciplinary work involving groups of users or consumers as important constituencies of open innovation.

- Supply and demand-side policies are developed in a consistent manner, building on and increasing the absorptive capacity of the Single Market.

4. There is adequate and predictable public investment in research and innovation focused in particular on stimulating private investment

- It is recognised that public funding assumes an important role in providing a high quality knowledge infrastructure and as an incentive for maintaining excellence in education and research including access to world-class research infrastructures, building regional S&T capacity and supporting innovation activity especially during periods of economic recessions. As a consequence, public investments in education, research and innovation are prioritised and budgeted in the framework of multi-annual plans to ensure predictability and long term impact, and drawing on the Structural Funds where appropriate.
- Public funding aims at leveraging greater private sector investments. Innovative financing solutions (e.g. public-private partnerships) and the use of tax incentives are explored and adopted. Reforms are implemented to reflect changing conditions and ensure optimal returns on investments.

5. Excellence is a key criterion for research and education policy

- Research funding is increasingly allocated on a competitive basis and the balance between institutional and project-based funding of research has a clear rationale. Institutes are evaluated on the basis of internationally recognized criteria and projects are selected on the basis of the quality of proposals and expected results, subject to external peer review. Funding to researchers is portable across borders and institutes. Results of publicly funded research are protected and published in a way that encourages their exploitation.
- Higher education and research institutes enjoy the necessary autonomy to organise their activities in the areas of education, research, and innovation, apply open recruitment methods and to draw on alternative sources of funding such as philanthropy.
- The legal, financial and social frameworks for research careers, including doctoral studies, offer sufficiently attractive conditions to both men and women in comparison to international standards, especially those in the US. This includes favourable conditions for reconciling private and professional life and for professional development and training. There are incentives in place to attract leading international talent.

6. Education and training systems provide the right mix of skills

- Policies and incentives are in place to ensure a sufficient supply of (post)graduates in science, technology, engineering and mathematics and an appropriate mix of skills among the population (including through strong vocational and education and training systems) in the medium-to-longer term.
- Education and training curricula focus on equipping people with the capacity to learn and to develop transversal competences such as critical thinking, problem solving, creativity, teamwork, and intercultural and communication skills. Special attention is paid to address innovation skills gaps. Entrepreneurship education and training is widely available or included in curricula. Partnerships between formal education and other sectors are actively promoted to that end.

7. Partnerships between higher education institutes, research centres and businesses, at regional, national and international level, are actively promoted

- Where possible, research efforts are accompanied by instruments to support the commercialisation of innovative ideas. Policies and instruments such as innovation/knowledge clusters, knowledge transfer platforms, and voucher systems, are in place to encourage co-operation and knowledge sharing and at creating a more favourable business environment for SMEs.
- Researchers and innovators are able to move easily between public and private institutes. There are clear rules on the ownership of intellectual property rights and sharing and support systems are in place to facilitate knowledge transfer and the creation of university spin-offs and to attract (venture) capital and business angels.
- There are no obstacles to setting up and operating transnational partnerships and collaborations.

8. Framework conditions promote business investment in R&D, entrepreneurship and innovation

- Policies to promote innovation, entrepreneurship and enhance the quality of the business environment are closely interconnected.
- Favourable conditions are in place to foster a growing and robust venture capital market, especially for early stage investments.
- Consistent with the Small Business Act for Europe[15], the rules for starting up and running a business are simple and designed from an SME perspective. The legal framework is transparent and up-to-date. Rules are properly enforced. Markets are dynamic and competitive. Willingness to take risks is promoted. Insolvency regulations support the financial reorganisation of enterprises. There is no discrimination against entrepreneurs who may have failed the first time around.
- An efficient, affordable and effective system for the protection of intellectual property is in place, which fosters innovation and preserves investment incentives. The market for innovative products and services is kept constantly up to date by means of an efficient standard-setting system.

9. Public support to research and innovation in businesses is simple, easy to access, and high quality

- There is a limited number of well targeted, clearly differentiated, and easy to access support schemes consistent with support available at EU level and that address well identified market failures in the provision of private funding for innovation.
- Funding support is tailored to the needs of companies, particularly SMEs. The emphasis is placed on outputs rather than on inputs and controls. Bureaucracy is kept to a minimum, selection criteria are straightforward and time to contract and to payment are as short as possible. Funding schemes are regularly evaluated and benchmarked against comparable schemes in other countries.
- National funding is allocated through international evaluation procedures and encourages trans-national cooperation. Rules, procedures and time-tables are aligned in order to facilitate participation in EU programmes and co-operation with other Member States.
- Specific support is often available to young innovative companies to help them commercialise ideas rapidly and promote internationalisation.

[15] "Think small first". A "Small Business Act" for Europe. COM (2008)374

10. The public sector itself is a driver of innovation

- The public sector provides incentives to stimulate innovation within its organisations and in the delivery of public services.
- Active use is made of public procurement of innovative solutions in order to improve public services, including through dedicated budgets. Tenders are based on output-based performance specifications and contracts are awarded on the basis of qualitative criteria which favour innovative solutions such as life-cycle analysis, rather than lowest price only. Opportunities for joint procurement are exploited.
- Where possible, government-owned data is made freely available as a resource for innovation.

NOTES:

PEER-REVIEW OF THE DANISH RESEARCH AND INNOVATION SYSTEM – OUTCOMES REPORT