

# Self-Assessment of the Danish knowledge-based innovation system

Challenges to be addressed by the international  
peer review panel

February 2019

Published by Danish Agency for Institutions and  
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Publication can be downloaded at [ufm.dk/publikationer](http://ufm.dk/publikationer)

ISBN (electronic publication): 978-87-92962-79-9

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# 1. Introduction

Today, Denmark is one of the strongest research countries in the world. This is the result of large investments in private and public funded research as well as a continuous effort into creating optimal conditions for knowledge production. However, knowledge production cannot be carried out in isolation. Denmark aims to become a world leader turning research into innovation. When research and new knowledge are transformed into new technologies, products and solutions by companies and entrepreneurs, it creates value for society as a whole.

In December 2017, the Danish Government published its national strategy for research and innovation, *Denmark – Ready to Seize Future Opportunities*, outlining its goals and objectives for future research and innovation policy. The Government's research and innovation policy must support that Denmark's significant research investments result in the greatest possible return, and that knowledge dissemination to society is considerably strengthened.

The strategy specifies that the Danish Ministry of Higher Education and Science (MHES) will set up a peer review panel of international experts. The purpose is to provide recommendations for how Denmark's effort in knowledge-based innovation can rank among the global elite, and support stakeholders working effectively and in close cooperation towards common overall objectives. The aim is to build the most effective bridges between research-based knowledge building and the application of this knowledge in business and society.

The objectives of the peer review are

1. to assess how Denmark can adjust public policy efforts on knowledge-based innovation based on international best practices and
2. to provide concrete recommendations on further developing the Danish public policy efforts on knowledge-based innovation.

Knowledge-based innovation is defined as “*new or changes to existing products, processes or organisation that arise out of knowledge derived from research and development activities*”. The peer review will examine the Danish knowledge-based innovation support system as a whole, including the value chain from research to innovation in established and new companies. It will start with a self-assessment by MHES of the present situation of the Danish knowledge-based innovation system, which is presented in this report and in the accompanying “Background report”.

The peer review will draw upon the conclusions of the simultaneous evaluation of Innovation Fund Denmark and the review of the universities' technology transfer activities – both of which are initiatives from the Danish Government's research and innovation strategy.

The Horizon 2020 Policy Support Facility (PSF) has approved to assist with the peer review involving high-level experts from the EU Member states. MHES welcome the support of PSF to review the national knowledge-based innovation system and look forward to submitting to international evaluation.

## 2. Approach to the self-assessment

The Danish self-assessment report includes three appendices: 1) a literature review and assessment of the knowledge-based innovation system, 2) a paper on Danish innovation policy in a historical context, and 3) an indicator report. The three appendices are defined as the Danish “Background report” to the panel. The purpose of the Danish self-assessment report is to provide the external reviewers with insights to particular challenges to the Danish knowledge-based innovation system.

In accordance with the Horizon 2020 Policy Support Facility (PSF) framework, the self-assessment report and the “Background report” provides the panel with the background elements required prior to initiating their work. In particular, the Danish preparatory work shall provide the experts with a comprehensive analysis of Denmark’s knowledge-based innovation system, its organisation, governance, main actors and features, as well as its performance, focused on the elements, which are the most relevant with regard to the objectives of international Peer Review. The analysis of Denmark’s innovation performance and potential should be contextualised, i.e. understood within the context of the country’s economic structure and specialisation patterns.

The self-assessment report and the “Background report” has been authored by the MHES and has subsequently been qualified with stakeholders and operators in the knowledge-based innovation system and the Danish advisory group to the international peer review. The Innovation Union Scoreboard, OECD and data from Statistics Denmark have served as important sources of reference.

Denmark is amongst the European leaders regarding relative investments in research and innovation, and scores high in international benchmarks, as described in the analytical indicator report. When compared to international best practices, the Danish innovation system generally include the recommended functions. The review and the self-assessment of the Danish innovation system must be seen in this perspective of being advanced by international comparison.

The self-assessment report can not and should not be seen as a complete picture covering all aspects and challenges in the knowledge-based innovation system. Rather, it is intended as a guideline to identify challenges, where international insights and learning from best practices abroad could bring added value. Furthermore, the innovation system is continuously evolving as a result of changes in both industry, technologies, actors and policy. The review must thus address the system while it is still dynamic and developing.

Sweden, Finland, the Netherlands and Israel have been selected as peer countries for the review. The peer countries are all small advanced economies with relatively mature - yet evolving - innovation ecosystems. While there are strong similarities between the countries, they are also sufficiently diverse, which allows for meaningful comparative perspectives on public policy efforts and related instruments.

# Part 1



### 3. Review focus

The formal Danish knowledge-based innovation support system has been established during the last two decades. Since 2003 four major government innovation strategies have been launched, and several government initiatives implemented. From 2006 to 2013, the public research budget has increased from less than 0.8 pct. of GDP to approximately 1.1 pct. of GDP. Since 2016 the public research budget is targeted to 1.0 pct. of GDP. Additionally, Danish universities have been strengthened through mergers with other institutions, and given boards of directors with a majority of external members. Since 2010 Denmark has had an overall high ranking in European Innovation Scoreboard (EIS). The latest scoreboard showed Denmark in third place.

Despite this, it is the understanding of MHES that Denmark have not fully realised the expected potential of increased investments, more autonomous institutions with stronger leadership and a formal innovation support system. The Danish innovation policy efforts appears not to have translated sufficiently into increased value in new and established companies. This perspective is based on a number of indicators presented in the analytical indicator report. For instance, the number of R&D active companies in Denmark decreased by 25 percent from 2009 to 2016. Additionally, young Danish businesses' scale-up ability often flattens off after the first three years of growth. The Danish export levels for medium and high technology-products remains below the EU average. The share of sales of new-to-market and new-to firm innovations as a percentage of total turnover is likewise below the EU average. Furthermore, Denmark has one of the lowest shares of SMEs with in-house innovation among comparable countries.

The aim of a future adjustment of the Danish public policy efforts on knowledge-based innovation is to create a world-class knowledge-based innovation system with effective bridges between research-based knowledge production and the application of this knowledge in business and society. The goal is to create more value in new and established companies based on research and new knowledge.

#### *Review focus areas and scope*

There can be many reasons for why Denmark ranks relatively low in the innovation output indicators mentioned above and presented in the "Background Report". It may be a consequence of the Danish industrial structure or aspects of the Danish society that has little to do with the Danish research and educational institutions. However, when considering Denmark's high investments in research, the statistics indicate that there is an unrealized potential in Denmark to turn a strong knowledge base into innovation. This is the primary issue, which the peer review is asked to address.

MHES has furthermore identified possible challenges in the current innovation efforts within four key focus areas of MHES' field of responsibility. Within these areas, the international peer review panel could offer valuable advice for further improvement of the Danish knowledge-based innovation system for the benefit of the users of the system.

The four focus areas represent focal points of the Danish public innovation support system and constitute central financial and knowledge bridges in the current knowledge-based innovation system. The four focus areas are:

1. Innovation capacity and research priorities
2. Roles and collaboration
3. Knowledge-based entrepreneurship
4. Knowledge and technology adoption by businesses

The focus areas are not exhaustive. The panel is welcome to include the wider innovation policy mix. This includes how MHES' policies and institutions work together with policies, actors, etc. from other areas. If that is where the main challenges lie, MHES would very much appreciate the advice and recommendations on these issues from the panel.

Finally, MHES considers it an important outcome of the international peer review that the panel highlights cases of successful public policy efforts from other countries in addressing the four focus areas.

The focus areas are addressed in detail in section 4. The majority of the identified challenges within the four focus areas revolve around the following four dimensions:

- A diverse and complex target group  
The target group of the knowledge-based innovation system is diverse and complex. MHES' hypothesis is that companies and users of the system have very different needs and different levels of innovation capacity. Meanwhile, new industries emerge, while others mature. MHES considers it important to create a knowledge-based innovation system that can respond to the diverse needs of new and existing companies and society - now and in the future.
- Common goals and effective collaboration  
MHES considers the strategic and on-going interaction and coordination between actors and instruments in the system to play a critical role in the Danish innovation policy's efforts. It is the hypothesis of MHES that there is a potential to increase the capacity of and the results from the knowledge-based innovation system by creating common goals and effective collaboration between actors and instruments in the system.
- Internationalisation  
In the light of the continuously globalisation of technology and economic development, MHES' hypothesis is that it is increasingly important to integrate and align the Danish knowledge-based innovation system with innovation activities and policies at an international level, including the EU level. Denmark's current efforts are addressed in section 6.
- Innovation culture  
Researchers at the Danish universities and other higher educational institutions (HEIs) are influenced by their workplace culture. The culture at most institutions revolves around education and research excellence, while innovation, entrepreneurship and interaction with companies is subject to less attention. MHES' hypothesis is that lack of innovation culture at the institutions limits their exploitation of innovation opportunities. Many researchers do not actively seek opportunities for innovation and entrepreneurship. Correspondingly, some industries and

companies find it difficult to interact with researchers. Consequently, the innovation system may be biased toward supporting research fields, where there is already an established tradition for innovation and collaboration with companies. Additionally, the innovation culture of the knowledge institutions and companies is presumably also influenced by more structural factors in society and the legislative framework.

The four focus areas will be addressed individually in the next section. Even though each focus area is assessed separately, the underlying assumption is that the value and potential of the focus areas in the system must be interdependent. The four challenge dimensions are transversal in their characteristics and will be addressed when relevant when going through the focus areas in section 4.

## 4. Focus areas and key challenges

### 4.1 Innovation capacity and research priorities

The public research funding system has a national, regional and international level of funding. At national level, most of the public funding is distributed as basic funding and funding in open competition. The majority is distributed as basic research funding to the universities.

The universities are free to allocate basic research funding for research activities within their general fields of activity and prioritized strongholds. Thus, basic funding is not targeted specific scientific areas by the government. The basic research funding may be allocated by the institutions to specific areas in order to match donations from public and private foundations or in order to support research-based education. The basic funding to the universities was DKK 8.9 bn in 2018.

The public research funding in open competition is distributed by foundations, councils and funding programmes. They support the value chain from basic research, applied research to innovation, development and growth. The funds include the Danish National Research Foundation, Innovation Fund Denmark, the Independent Research Fund Denmark, and the three development and demonstration programmes for Energy, Ecoinnovation and Food (DDPs). Funds for strategic research within the Innovation Fund Denmark are allocated to specific thematic areas focusing on great societal challenges. This is primarily done according to the RESEARCH2025 catalogue of prioritized areas (see section 5). Recently, a small part of the budget of the Independent Research Fund Denmark has been allocated to RESEARCH2025 categories.

The distribution of funds to the different public foundations and specific thematic areas are a part of the yearly political negotiations about the so-called “research reserve” of the state research budget. In 2019 the “research reserve” is DKK 1.394 m. The funding of public research councils and foundations was approximately DKK 3.7 bn in 2018.

At regional and municipal level, the public authorities also fund research and development. In 2018 an estimated DKK 3.4 bn was invested in R&D. The research activities are primarily carried out by the regional hospitals within the medical and health sciences. In addition to the regional funding the regional hospitals receive a large amount of funds for research activities from private foundations.

In 2018, the international sources funded DKK 1.9 bn into the public research budget with the EU as the major source.

In addition to public research investments, private foundations play an increasingly important role in the Danish knowledge-based innovation system. Private foundations invest a major part of their funding in public research environments and the funding is increasingly important compared to public funding. In 2016 Danish higher education- and

research institutions carried out R&D activities for more than DKK 2.7 bn financed by private foundations. This is a 150 pct. increase compared to 2008. Approximately 50 pct. of funding from private foundations are invested in health sciences.

In sum, the distribution of Denmark's research funding to different scientific fields is partly a consequence of the priorities at the level of each institution and partly a result of public priorities at national, regional level and international level as well as priorities at private foundations.

MHES considers it relevant to have a closer look at the connection between the capacity of the knowledge-based innovation system and public research investment priorities. The hypothesis is that there is a close link between the accumulated public research investment priorities and the overall innovation capacity, which can help explain the current level of knowledge-based innovation.

### **Key challenges related to innovation capacity and research priorities:**

- Balancing priorities for innovation: There is currently no central coordination or strategic choices of public research priorities that aim to increase innovation in general or strengthen the coherence with the Danish knowledge-based innovation system. There may be an uneven balance between the accumulated public research priorities and the needs of companies. There may likewise be an uneven balance between research and innovation priorities that promote existing industrial strengths vs new emerging industries. Public policy instrument (for instance RESEARCH2025) could potentially be used more strategically to influence research priorities to increase innovation capacity.
- Systemic bias towards traditional users: Many researchers do not actively seek opportunities for innovation and entrepreneurship. Correspondingly, some industries and companies find it difficult to interact with researchers. And consequently, actors in the knowledge-based innovation system may be biased toward supporting research fields, where there is already an established tradition for innovation and collaboration with companies.
- High investments in medical and health sciences: A large share of the public R&D and private foundations investments are spent on research carried out within the medical and health sciences, where Denmark also has the highest level of R&D expenditure in percent of GDP among the OECD countries. New innovations within these fields have a long development period from basic research to market introduction and may have limited spillover effects to other sectors.
- Science and Technology: Denmark is not leading in the OECD in terms of public R&D expenditures within the Natural Sciences or Engineering and Technology. Research within these fields may be particularly relevant for a broad spectrum of companies, especially SMEs within manufacturing, construction as well as the ICT sector. These areas are however dominant within the public instruments for innovation support.

## 4.2 Roles and collaboration

A key objective of Danish innovation policy in recent years has been to increase the collaboration between companies and research and higher education institutions in order to foster knowledge-based innovation. Correspondingly, and as mentioned in the literature review, there has been a steady increase in collaboration activities between companies, researchers and students.

Most universities and some other higher education institutions have formulated goals on how to increase cooperation with private companies as part of their strategic framework contracts with MHES. The institutions have also, to varying degrees, established support functions and carry out networking and matchmaking activities to promote collaborative research and innovation projects.

At the national level, the Innovation Fund Denmark (IFD) finances collaborative projects, as part of their Grand Solutions programme and as a part of their Industrial Researcher programme. The three development and demonstration programmes (DDPs) finances collaborative projects within specific and highly regulated application areas. At the international level, the EU Framework Programme for Research and Innovation, Horizon finances international collaborative projects, for instance through their Industrial Leadership and Societal Challenges programmes.

Another main national instrument to promote collaboration are the national innovation networks. The innovation networks (currently 17) provide nationwide sector-focused collaboration platforms. By taking part in the networks, companies can through seminars, networking and matchmaking activities get access to relevant knowledge and collaboration opportunities with researchers. The innovation networks also initiate international project collaborations for instance as part of Horizon 2020, COSME, INTERREG. etc. The innovation networks also cooperate with the Danish Innovation Centres (ICDK) on foreign markets. The innovation networks have different types of operators, including universities, RTOs and cluster organisations, and are therefore also diverse in the type of activities they provide. In 2016, the total budget for then 22 Innovation Networks was DKK 235 million. MHES funding made up DKK 87 million (or 37%) of this.

The five Danish regions have been active in setting up and financing several regional cluster organisations. These regional clusters typically provide a wide range of services to enhance innovation and interaction among their members, including support for business development and the promotion of exports and inward investments. Many cluster organisations operate innovation networks. As a part of the reform of the business support system in Denmark, the current number of publicly supported cluster organisations and innovation networks will in the future be reduced and their selection and financing process will be changed, as mentioned in section 5.

It is also a core activity of the Danish RTOs to initiate and establish collaborative research and innovation projects with companies, both as individual research institutions and as facilitators of projects between companies and universities. Approximately 18 pct. of the total annual turnover of the RTOs derives from research and development with public co-funding, and in 2017 the RTOs were involved in more than 700 collaborative R&D projects. However, the number of collaborations between RTOs and universi-

ties in government supported projects show a general decline since 2009. To some degree this can be ascribed to changes in the funding programmes where the role of RTOs is no longer as prominent in recent programmes of the IFD.

**Key challenges related to roles and collaboration:**

- Collaboration between companies and research institutions: The level of cooperation between innovative companies and research institutions in Denmark is similar to other small research-intensive countries, such as the Netherlands and Sweden. However, Denmark has a lower share of innovative companies cooperating with research institutions than the majority of other comparative countries that are highlighted in the indicator report. Approximately 16 percent of the *innovative* companies in Denmark cooperate with a research institution compared to 24 percent in Finland.
- Collaboration between companies and other HEIs: The Danish university colleges, business academies, HEIs in the arts and culture and maritime academies may have an unrealised potential as contributors to collaborative innovation projects. The institutions offer and develop higher educations with a strong relation to practice and have close contact to many Danish SMEs. Many of these institutions' students participate in internships at SMEs.
- Unclear division of labour: While it is a benefit that both RTOs, universities, and other higher education institutions collaborate with companies, it can also lead to a perceived unclear division of labour. Companies may find it unclear which institutions to cooperate with and how the different types of institutions can contribute to their innovation processes. There may be a potential to establish a clearer division of labour, while at the same time provide incentives for the different actors to cooperate.
- Integration of innovation networks activities: There may be a potential to strengthen the collaboration and integration of activities that take place in the context of innovation networks and cluster initiatives with related activities that take place at the individual institutions, including networking activities and matchmaking. Additionally, many innovation networks are currently not involved in e.g. Grand Solutions projects. There may be a potential to strengthen knowledge dissemination of major strategic research and innovation projects through the innovation networks. As indicated in the literature review, there may additionally be a potential to include more junior scientists and students in the activities of innovation networks.
- Facilitation: Efforts to prepare, mature as well as follow-up on collaborative projects are often just as important for value creation as the project itself – especially for SMEs. Evidence from successful cases suggest that an increased focus on facilitation services in all phases of collaborative innovation projects might make university-businesses collaboration more attractive and relevant to both companies and researchers.
- International collaboration: International collaboration between research institutions and companies can be some of the most valuable collaborative activities. There may be a potential to support more international collaborative research

and innovation activities including participation in Horizon 2020 and the coming Horizon Europe (see section 7).

### 4.3 Knowledge-based entrepreneurship

Knowledge-based entrepreneurship has been an important part of Danish innovation policy during the 2000s and 2010s. New regulation and government strategies from 2000 to 2006 established a policy focus on technology transfer and an ambition to increase in the number of spinout companies from the universities. In 2006, the Globalisation Strategy of the Danish government introduced the development of entrepreneurial skills of students as a new policy goal. In parallel, formal goals for both spinout companies and student entrepreneurship were formulated in development contracts and strategies of the universities. Furthermore, since 2010 the Danish Foundation for Entrepreneurship has been supporting entrepreneurship education at all levels of the education system.

The literature review points to a significant increase in the number of curricular and extra-curricular entrepreneurial courses on offer at higher education institutions, as well as a greater supply of support functions for entrepreneurship. Initiatives include incubators for student-start-ups at almost all universities, advisory services, lab access, mentoring programmes as well as matchmaking events with investors and facilitation of local competitions for student entrepreneurs (case competitions) to encourage entrepreneurship. From 2003 to 2013, the number of student and graduate entrepreneurs increased by more than 50 pct.

Positive experiences from successful entrepreneurship initiatives at individual Danish universities underline the benefits of close collaboration between universities and the entrepreneurial system. Strong connections and networks with serial entrepreneurs, investors, etc. makes it easier to transfer and develop inventions, ideas and research-based technologies with people possessing the skills necessary to evaluate, refine and bring ideas to market.

From 1998 to 2018, the Danish innovation incubator-programme financed the development of new knowledge-based companies through equity-investments and loans, including spinouts from universities. Following the reform of the Danish business support system of 2018, the innovation incubators will be phased out from 2019, and instead new grant-based programmes will be introduced at Innovation Fund Denmark and new loan-based programmes will be introduced at the Danish Growth Fund.

#### Key challenges related to knowledge-based entrepreneurship

- Few spinout companies become scale-ups: From 2013 to 2018, around 80 new companies – corresponding to approx. 16 per year – have been established based on agreements with Danish universities about the transfer of technologies and intellectual property rights. Although the focus on entrepreneurship at the universities has been increasing, the number of IP-based spinout companies has not been increasing significantly. Reports from individual universities indicate that the number of non-IP-based spin-out companies has increased. Still, only a few spinout companies have enjoyed high growth rates and become scale-ups.



- Creating an innovation culture: Some research and higher educational institutions may lack a sufficiently strong innovation culture that stimulates entrepreneurship amongst researchers and students and fosters collaboration with partnering entrepreneurs and businesses.
- Supporting the entire innovation journey: Most Danish TTOs, central innovation offices, and financial support programmes only support entrepreneurs in their early development stages. There may be a potential to strengthen continual support functions and financial support for knowledge-based entrepreneurs throughout the entire innovation journey from idea and until market introduction.
- Interdisciplinary entrepreneurship: Current support services tend to focus on researchers and students from technical and mercantile sciences. However, there may be a potential to strengthen support to researchers and students from other scientific fields, including support for students who wish to develop intrapreneurial projects. Likewise, there may be a potential to strengthen support for interdisciplinary entrepreneurial activities, where researchers and students from different fields work together.

#### 4.4 Knowledge and technology adoption by businesses

Several actors in the knowledge-based innovation system assist companies in the adoption of new knowledge and technology.

Today, the primary government financed structure for the provision of traditional knowledge-based technology services is the seven Danish Research and Technology Organizations (RTOs) – known as the “GTS” Institutes.

Support for the RTOs has been a part of Danish technology and innovation policy for many decades. Their tasks include building R&D competences, develop and maintain a technological infrastructure, as well as to communicate knowledge about new technologies and infrastructure to businesses. The RTOs are very diverse in size, in their funding structure and in the kind of services, they provide. While the RTOs function under the same guidelines, they undertake a number of different tasks and operate with no common brand.

Currently the RTOs are expected to service Danish companies in general, and especially SMEs. More than 16,000 private Danish companies buy services from the RTOs each year. The RTOs are obligated to provide services to all interested customers, and the share of customers are proportionally distributed throughout the different regions of the country.

While the RTOs have existed for decades as providers of research-based services and access to testing infrastructure, other actors including universities, innovation networks and private suppliers of specific services have increasingly positioned themselves in similar roles.

In addition to collaborative research and innovation projects, universities also seek to contribute to technology adoption of firms through commercialization of new inventions. Since 2000, the universities have had both a right and an obligation to actively

seek the commercial exploitation of new inventions and technologies by transferring IP to private companies. This has led to a steady increase in commercialization activities of the universities.

**Key challenges related to knowledge and technology adoption by businesses:**

- Meeting the needs of companies: New knowledge and technology will also in the future be central to the productivity of companies. It is important that universities and RTOs effectively support knowledge and technology adoption by businesses, including companies from established and new industries.
- Target group and effects of RTOs: The literature review suggest that Danish RTOs may have a potential to reach more companies, if access to facilities were improved, and if the technological skills of the staff were supplemented with stronger business skills. However, the literature review also indicates, that companies that are already advanced technology users within their industry experience greater value creation from using RTOs than companies that consider themselves as technological “followers”. Technological followers are more likely to use the RTOs for more traditional tests, calibration services, etc. rather than R&D projects, while larger companies and technology leaders are more likely to work together with the RTOs in research and development projects.
- Cooperation between RTOs and universities: Stakeholders have pointed to the need for stronger cooperation between RTOs and other research institutions. There may be potential for further cooperation with the universities in order to create better research and development projects, supply more advanced technology services, and facilitate more knowledge dissemination to companies.
- Sharing of facilities: The cost and complexity of technological facilities is increasing. This leads to the challenge of how to maintain a relevant and up to date infrastructure. The literature review points to the possibility that RTOs increase their collaboration with national and foreign research institutions in order to be able to supply access to even more technological infrastructure.

# Part 2

## 5. Policy agenda

The international review of the Danish system for knowledge-based innovation takes place during a time of considerable political attention towards optimising parts or related aspects of the system for knowledge-based innovation in Denmark. There are several current relevant government initiatives:

### *The Disruption Council*

The Disruption Council was launched in May 2017. The purpose of the council is to create a forum to analyse, discuss and offer suggestions for how to create a prosperous Denmark that seizes technological opportunities in a way that benefits all Danes, as well as maintaining and expand a dynamic and well-regulated labour market. The Disruption Council is comprised by 8 ministers and 31 permanent members including the social partners, business representatives, CEOs of major Danish companies, experts and entrepreneurs. The council is chaired by the Danish prime minister. By bringing together perspectives, resources and ideas of key stakeholders in Denmark, the Disruption Council discusses and finds ambitious, inclusive, long-term responses with strong impact on the future of Denmark. The Disruption council held its last meeting in September 2018, and the council's work will be concluded with a report that compiles the Government's derived initiatives. The report will be published in February 2019.

### *Research and Innovation strategy 'Denmark - Ready to seize future opportunities'*

In December 2017, the Danish government published its research and innovation strategy, outlining goals and objectives for future research and innovation policy. The strategy presents two overall objectives for research and innovation policy: *Danish research must be of the highest international quality, and the research must provide the best possible benefit for society.*

The Government presents 28 specific initiatives with the ambition of ensuring that research investments result in the greatest possible return, and that knowledge dissemination to society is considerably strengthened.

### *A simpler business support system*

In May 2018, the Danish government reached an agreement with Danish People's Party on a reform of the general Danish business support system. The goal is a simpler business support system with fewer actors and with goals that are, to a greater extent, aligned with the needs of businesses. The reform also causes changes in the efforts for knowledge-based innovation, as, the Danish regions are replaced by a new national board for business support.

The number of publicly financed cluster organisations and innovation networks will be reduced from around 60 to 10-12 organisations within Danish strongholds, and a number of start-up clusters within new markets or technologies. The new national board for business support nominates positions of strength to the Ministry of Higher Education and Science, who will finance the 10-12 most relevant areas based on open calls and competition.

Moreover, the Market Development Fund will be decommissioned from 2019 and state funds for the innovation incubators will be phased out from 2019. The innovation incubators have played an important role in facilitating knowledge-based entrepreneurship, however, as the entrepreneurial environment has undergone large changes since their establishment in the 1998. The innovation incubators will be replaced by new programmes in the Danish Innovation Fund and the Danish Growth Fund from 2019.

#### *RESEARCH2025*

RESEARCH2025 presents a total of 19 prominent research themes within four main areas, namely new technological opportunities, green growth, better health, and people and communities. RESEARCH2025 provides a consolidated overview of the most important research areas of the future as seen from the perspectives of businesses, organisations, ministries, Danish knowledge institutions as well as a wide variety of other stakeholders with links to scientific research. The catalogue is prepared in a dialogue and co-creation process involving a wide range of stakeholders – and in arm's length to the political level. RESEARCH2025 is acknowledged across the political parties and across all major private and public stakeholders in Denmark as a substantial and widely recognised base for prioritising and allocating funds to Danish research. RESEARCH2025 serves as a widely acknowledged source of inspiration and knowledge, as well as a common frame of reference for prioritizing research investments in various contexts such as political negotiations of the distribution of the research reserve, strategic considerations at Danish knowledge institutions, in relation to Danish participation in international research partnerships and in concrete project proposal calls.

#### *Agreement on Funding of Higher Education in Denmark*

An underlying goal of the new funding system is to increase the quality of education programmes and strengthen the leadership focus on good teaching and a better transition to the workforce upon completion of studies in order to broaden the current tendency to focus on quantity in the higher education system. The new funding system is based on three key elements: Basic funding, Activity funding and Result funding. The new funding system is effective from 1 January 2019. The restructuring move to the new funding system is cost neutral. Additionally, the Government has allocated DKK 50 million in 2019 and DKK 65 million annually from 2020 for the new funding system.

#### *More flexible higher education*

The political agreement of December 2018 "More Flexible Higher Education" between the Danish Government and all the parties in the Danish Parliament aims to offer university students more flexibility and more options to individually organize their education.

The agreement aims at establishing a more diverse education system – so that not all students follow the same path throughout their studies. It also contributes to a more flexible system that match a broader range of student preferences and aligns the education system with modern times.

The result of the agreement is also an easier access for students to combine life as a student with work life, the possibility to study part time or the option to obtain a master's degree in one year instead of two.

*Better framework for governance and management*

In April 2017, the Danish government reached an agreement with the Danish People's Party and the Danish Social Democrats on better framework for governance and management of the universities. The agreement sustains the fundamental principle of professional autonomy, unconditional freedom of research and autonomy of the universities from the political system. Better framework for governance and management of the universities clarify the role and responsibility of the board; advance the procedure for appointment of external board members and strengthening the dialogue between the boards and the Minister of Higher Education and Science. Simultaneously, the development contract of the universities was replaced by a strategic framework contract. The new type of contract brought into focus the central strategic goals of the university based on the individual challenges of the institution.

*Review of technology transfer from universities*

Together with the universities of Denmark, MHES is conducting a review of the universities' technology transfer activities. The review covers both the regulation and practices of technology transfer. The goal is to make it easier for smaller businesses and entrepreneurs to access and exploit new knowledge and technology from the universities. The review is expected to be finalized early 2019.

*Evaluation of Innovation Fund Denmark*

The Minister for Higher Education and Science has appointed an independent international peer review panel to carry out an evaluation Innovation Fund Denmark. The purpose of the evaluation is to get an in-depth and critical view of the structure, functioning and results of Innovation Fund Denmark. The panel is expected to deliver a final evaluation report to MHES at the end of March 2019.

*Council for better recognition and rewards of academics:*

The council aims to create a better practice for evaluating, recognising and rewarding academics in terms of quality in both research, education and knowledge dissemination. The panel is expected to deliver their recommendations to MHES in April 2019.

## 6. Governance

### 6.1 Governance and monitoring

The Minister of Higher Education and Science has delegated MHES' monitoring of HEIs, research funds, and the innovation infrastructure (Danish RTOs and innovation networks) to the Danish Agency for Institutions and Educational Grants. The monitoring system is evolving around a concept built on a framework of dialogue-based management.

The obligation of the MHES to monitor the activities implemented under the framework of the national budget comprises both implementation and follow-up activities. These are to ensure that funding for public Danish R&D&I helps to meet the intentions and overall objectives, and that activities are carried out under the framework of relevant legislation.

The MHES' governance and supervision of higher education institutions, research funds and innovation infrastructure is based on a set of guiding principles:

- A dialogue-based approach will support efficient and well-functioning beneficiaries under the ministry's area of responsibility
- The role as authority and sparring partner is to be carried out in a way which contributes to the achievement of ambitious objectives
- An ambition of the ministry to be proactive in its professional relations to all relevant institutions
- Resources invested in the dialogue-based management concept are employed in the best possible way.

The aim of the MHES governance of the public knowledge-based innovation support system is to support a mutual understanding and promote fast clarification of key issues and achievement of results. The objective of the dialogue-based approach is to support a strategic development and efficient administration, and to do so via relevant and beneficiary-specific dialogue between the knowledge institutions or innovation actor and the agency. The concept is an important element in optimising the relation between beneficiary and ministry. The effort is systematic, evidence-based and analytical.

The practical realisation of the concept involves the following aspects:

- Annual reports and annual accounts checked and discussed internally
- Follow-up meetings with the individual institutions and relevant, horizontal collaboration fora
- Ad hoc / thematic monitoring tasks

As part of the political agreement of the Innovation Fund Denmark (2013) the administrative responsibility to govern the funding of Danish RTOs and the innovation networks similar to the funding of the HEIs was maintained in the MHES.

### 6.1.1 Universities and other HEI's goals for collaborative research and innovation

There are eight universities and 23 profession- and practice-based HEI with a research and development budget in Denmark. Universities and other higher education institutions are state-funded, autonomous institutions governed by boards with external majority and are regulated by individual laws. Two higher education institutions in the Art and Culture area are state-owned institutions.

The eight universities are responsible for much of all public research and account for more than 95% of the total research budget. The main task of the other higher education institutions is education. They have a regional educational obligation and therefore campuses are strategically located in the region of the institution.

Each higher education institutions have signed a four-year strategic framework contract with MHES. The current framework contracts run from 2018 to 2021. The purpose of the strategic framework contracts is to outline important strategic goals in core areas of the institutions, thereby supporting the institutions' development contribution to society. The strategic goals are established based on the specific strategies, strengths and challenges of each higher education institution.

All the universities framework contracts contain performance indicators for increased collaboration with businesses and society in general. (e.g. spinouts, license agreements, research collaborations with external actors, student projects or internships in private companies, etc.), but the specific indicators vary across the institutions.

As the strategies focus on the ambitions and direction of the universities and other higher education institutions, the indicators of goal achievement are not specified in target figures for the term of the contract. A baseline for each indicator is specified in the contract, however, and the universities are obliged to submit an annual status report to MHES in which developments in the outlined indicators are documented.

### 6.1.2 Research and Technology Organisations

The seven research and technology organisations (RTOs), known as GTS institutes, are non-profit institutions run as private companies, with the purpose of providing knowledge-based technology services to Danish companies on commercial terms. The RTOs are approved by the Minister for Higher Education and Science for a period of up to three year. In order to be approved, the RTOs must demonstrate a high level of technological capabilities and a sustainable organisation. By obtaining an approval, the RTOs are entitled to apply for a part of the funding assigned to RTO system as part of the yearly public research budgets. Based on a competitive calls, MHES signs several performance contracts with the individual RTO that finance specific research and development activities as well as knowledge dissemination activities.

The total turnover of the Danish RTOs is DKK 3.6 bn of which 10 pct. is from performance contracts, while approx. another 10 pct. derives from other competitive R&D funding, e.g. from the Innovation Fund Denmark, Horizon 2020 or other public research



funds. The rest of the turnover achieved through commercial sales of technological services to Danish and foreign companies. There is considerable diversity among the Danish RTOs in size and in the share of public funding.

### **6.1.3 Innovation networks**

Innovation networks promote knowledge dissemination, matchmaking and small-scale initial cooperation between knowledge institutions and companies. Funding is allocated through competition for multiannual grants. The current 17 networks are managed mostly by cluster organisations but also universities and an RTO.

The public funding must be co-financed at least 100 pct. by private companies especially SME, who are the main target group of the innovation networks.

## **6.2 Public actors of relevance to the innovation system**

The governance structure adhering to the Danish innovation system is presented in this section.

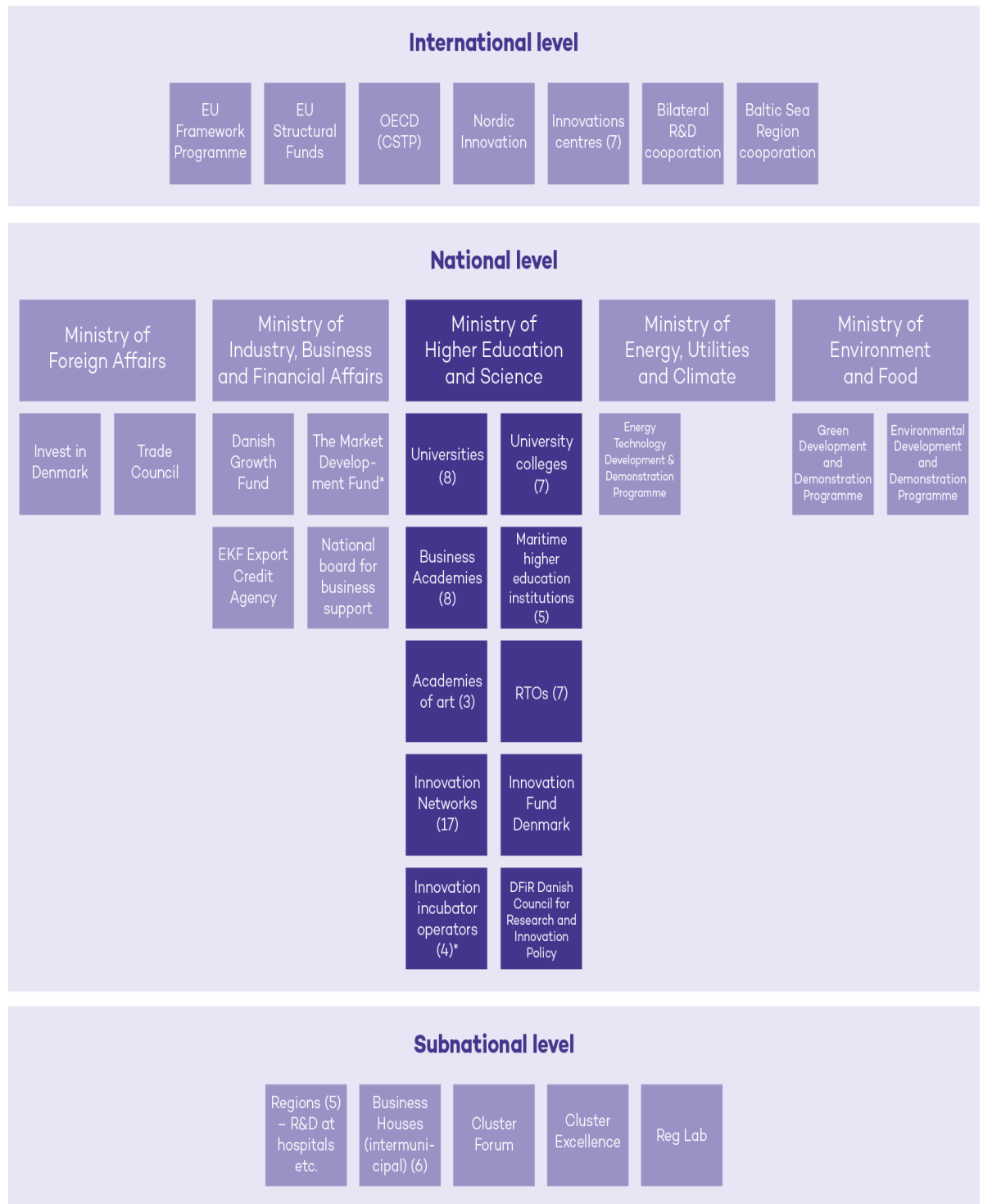
The figure on the next page presents an overview of public actors of relevance to the Danish innovation system. In the figure the governance structure is divided into three governance levels:

- the international,
- the national and
- the subnational level cf. below.

For each governance level several public actors perform different tasks according to their assigned areas of responsibility. The public actors included in the figure is selected due to their relevance to the Danish innovation system i.e. public actors that are assigned:

1. responsibility of developing and implementing policies of relevance to innovation (e.g. policy areas such as innovation, research, education, industry, business, foreign direct investment, international cooperation).
2. responsibility of oversight (monitoring) of the distribution of public funds.
3. responsibility of the distribution of public funds.

## Overview: Public actors of relevance to the Danish innovation system



*The international level*

On the international level several different public actors are relevant to the Danish innovation system. Included in this overview are actors or modes of cooperation that Denmark is a part of such as the European Union, the OECD, the Nordic Region, the Baltic Region as well as Denmark's bilateral cooperation with selected countries (e.g. bilateral R&D agreements and a programme to promote network activities for Danish researchers with colleagues in selected countries (International Network Programme)). A description of these actors and modes of cooperation on the international level is included in section 6.

*The national level*

On the national level the Danish government is the main actor. In the figure above, selected government ministries are included due to their responsibilities of policy areas that are of relevance to the Danish innovation system. Adhering to the ministries are a number of national public actors that implement different subareas of national policies by performing different tasks (e.g. research, innovation and educational activities, distribution of funds).

MHES is assigned the responsibility of the policy area knowledge-based innovation and has delegated tasks to a number of national actors cf. further description in this section.

Apart from the MHES, four ministries are included in the figure that are assigned responsibilities of policy areas of relevance to the Danish innovation system. These are the Ministry of Foreign Affairs (e.g. policy areas such as international trade, international cooperation more broadly) and the Ministry of Industry, Business and Financial Affairs (e.g. policy areas of business regulation, competitiveness). The Ministry of Energy, Utilities and Climate and the Ministry of Environment and Food are included in this figure because they implement R&D programmes within these areas.

The document "Danish innovation policy in a historical context" outlines the changes to the national governance structure i.e. the division of responsibilities between ministries from 1970s to present day.

*The subnational level*

On the regional level the five Danish regions are included. The regions are included due to their responsibility of university hospitals and thus substantial amount of R&D activities that are carried out here. Previously, Danish regions had responsibility of regional business support, however, as part of a reform of the general Danish business support system in 2018, the regions do no longer undertake activities in the field of business support cf. an outline of this reform in section 4. Instead, a new national board for business support as well as six centres of business support are established around the country ("tværkommunale erhvervshuse"). Included in this regional level are actors that coordinate and share experiences on local innovation related activities (Klyngeforum, Cluster Excellence, Reg Lab).

### 6.3 Coordination among public actors in the innovation system

#### *Coordination among ministries*

MHES is responsible for policy development and oversight of the knowledge-based innovation system, research and higher education.

MHES has an ongoing coordination of relevant policies with other ministries and in the case of major policy initiatives and strategies, the ministries coordinate multilaterally to form government policy. This is also the case in the yearly negotiation of the public research budget, including political negotiations of the so-called “research reserve”.

The Danish government occasionally forms sectoral strategies, where several ministries contribute with initiatives. The level of MHES involvement in the development of strategies depends on how much they focus on knowledge-based innovation, research and higher education. As a part of the strategies, MHES contributes with initiatives aimed at the different sectors in order to address specific challenges. Initiatives are sometimes based on recommendations by temporary “Growth Teams”, which consist primarily of representatives from industry appointed by the government. During the last four years, sectoral government growth strategies have for instance focused on life science, creative businesses, drones and space technology.

As a part of government strategies, some policy initiatives are established in cooperation among several ministries. Such initiatives include Digital Hub Denmark, the Foundation for Entrepreneurship and the Technology Pact, where several ministries work together in order to achieve specific goals or address challenges that transcend normal ministerial responsibilities.

#### *Coordination among foundations and funds*

The Danish public research and innovation foundations and funds are expected to coordinate their respective funding programmes and activities. For instance, Innovation Fund Denmark (IFD) is by law required to coordinate their programmes with other public and private foundations and funds.

Open competition is the guiding principle for the funding of activities by the Danish public foundations and funds. Funding is allocated from various programmes to projects based on the quality of the applications. Applications are evaluated based on formal criteria such as excellence and expected impact. Applicants from different sectors compete to achieve project financing. The programmes may focus on different parts of the value chain from basic research to commercialisation. Consequently, the basic funding mechanism does not have a strong focus on specific sectors and their individual challenges.

Approximately half of IFD’s funds are allocated to broad research areas based on the RESEARCH2025-catalogue. A small part of the budget of the Independent Research Fund is also allocated to RESEARCH2025 themes. To some degree, this provides a sectoral focus for the allocations of funds, but the funding programmes are in general not geared toward specific sectors. The three DDPs have – by design – a stronger focus on specific sectors with their fields of activity.

*Coordination among publicly financed actors*

Publicly financed actors in the knowledge-based innovation system work in a multi-layered governance structure, where the actors may interact with policies from different ministries and may receive funding from several public and private sources.

The individual actors in the system typically coordinate their activities bilaterally. For instance, individual universities coordinate their activities with RTOs, regional hospitals and other HEIs. Cooperation among different kinds of actors is typically encouraged in specific funding programmes, which consequently provides incentives for cooperation. The individual actors that operate under MHES supervision also coordinate their activities with the ministry through dialogue-based management concept mentioned in section 6.1.

However, due to the competitive nature of the financing system, there is no formal division of labour between institutions or actors of the same type. The specific activities of the actors are typically not defined by MHES through overarching plans, but through bottom-up processes, where the actors define the activities through application to funding programmes.

## 7. International activities

In the strategy “Denmark – ready to seize future opportunities”, one of the goals is to enhance the international collaboration. Denmark supports and participates in a wide range of international activities, e.g. the European Research Area (and its implementation programme Horizon 2020), OECD and innovation centers on specific strategic locations. The following will provide a brief account of particularly relevant international activities, as well as how they affect the Danish knowledge-based innovation system.

### 7.1.1 EU and Horizon 2020

One of the most important and significant platforms for international cooperation is EU's Framework Programme for Research and Innovation. The Danish participation in EU programmes has been steadily rising over the years. From 1,646 Danish participants in the 6th Framework Programme (FP6) to 2,754 in the 7th Framework Programme (FP7), the trend is expected to continue in Horizon 2020.

In 2015, MHES conducted an analysis of the impact from participating in the Sixth and Seventh Framework Programmes, which concluded that Danish researchers benefit especially in the form of bibliometric impact. The scientific impact of FP6- and, in particular, FP7-linked publications was ranked “outstanding”. Companies experienced substantial effects (though not statistically significant when compared to similar non-participating companies). Universities and RTOs likewise experience considerable effects, in particular regarding new European networks and funding of activities that would not otherwise have been funded.

The Danish ambition is to have strong participation in the framework programme due to the impact of research and innovation, which often reaches a higher level than achieved exclusively nationally. An indicator of the level of participation is the level of funding received. Therefore, Denmark has the ambitious goal of receiving at least 2.5% of the available funds in Horizon 2020. As of October 2018, Denmark has received EUR 952.2 million from Horizon 2020, which corresponds to 2.53% of all the available funds. As of October 2018, Denmark ranks second in receiving funds from Horizon 2020 per capita.

The largest group of participants are researchers at universities, accounting for 48% of the total Danish participation. The second largest group is private enterprises, which account for 32%, where SMEs are doing particularly well. If Denmark continues on the current track, Danish SMEs will have received three times as much funding as in FP7. The last group of participants represent around 20%. The group consists of GTS-institutes (RTO), Public institutions (agencies, Danish Regions, local government/municipalities), governmental research institution and NGOs.

MHES relaunched an action plan aimed at maintaining a high level of participation in Horizon 2020. Two main targets are 1) to improve the quality of Danish applications to Horizon 2020 and 2) to increase in the number of Danish participants in Horizon 2020.

### **7.1.2 Danish approach to the European Innovation Council (EIC)**

In its proposal for Horizon Europe the Commission proposes to establish the European Innovation Council (EIC). The purpose of the council is to create a more coherent approach to innovation support for enterprises, universities and other relevant actors throughout the whole innovation process – from research to development to market solutions. It is proposed to join and adjust the innovation supporting instruments through two main instruments – Pathfinder (small grants to early stage projects) and Accelerator (blended finance to bigger, close-to-market projects). The establishment of the EIC should be seen in the context of the “European innovation challenge”, namely that the EU should improve its capacity to translate excellent research into innovative solutions that create new markets and up-scaling in Europe.

Denmark supports the overall intention behind the EIC, and the Danish innovation system must thus be seen in the context of the challenges and initiatives at European level.

### **7.1.3 Innovation Centre Denmark (ICDK)**

Together with the Danish Ministry of Foreign Affairs, MHES has established eight innovation centres (ICDK) around the globe –located in advanced innovation ecosystems as well as in innovation systems and markets of the future. The eight locations are Silicon Valley, Boston, Shanghai, Seoul, New Delhi, Munich, Tel Aviv and São Paulo. The overall aim of the ICDK is to boost growth, employment and knowledge in Denmark through the internationalisation of Danish companies and research institutions. ICDK provides access for Danish businesses, start-ups as well as knowledge and research institutions to international innovation environments in order to promote new partnerships and business development and new business opportunities.

ICDK bring knowledge and perspectives from foreign innovation ecosystems to the Danish system (e.g. on topics as technology transfer, collaboration between universities and companies and the venture market) and contribute to positioning Denmark as a global innovation player in the local environment. Further, ICDK bring home knowledge to the Danish innovation system on global trends such as big data, digitalisation, the future of work and education, etc.

The innovation centres are important integrated players in the Danish innovation ecosystem and the centres collaborate with other publicly funded actors of the national innovation system, including RTOs, innovation networks, etc. in order to promote innovation in Denmark. Since 2015, MHES has allocated funding to stimulate collaboration between the innovation centres and the innovation networks. The purpose of the initiative is to encourage cooperation that involves Danish SMEs in international collaborations and alliances in advanced and emerging markets.