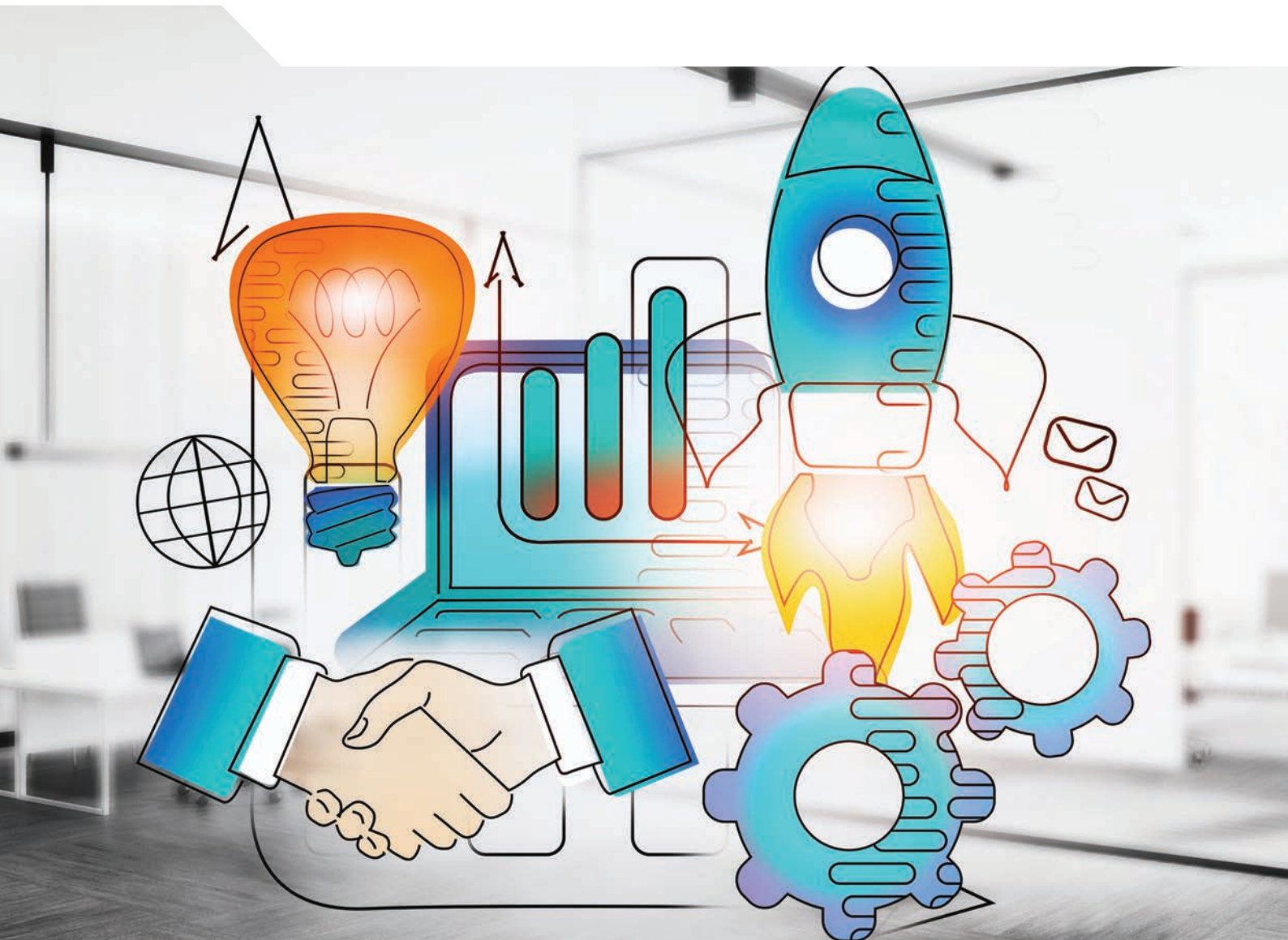


OECD Studies on SMEs and Entrepreneurship



Promoting Start-Ups and Scale-Ups in Denmark's Sector Strongholds and Emerging Industries



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Foreword

A priority for the Danish government is to strengthen entrepreneurship in the sector strongholds and emerging industries identified by the Danish Board of Business Development and the Ministry of Higher Education and Science. While research and technology development is generally world class in these areas, stronger mechanisms are needed to increase their commercialisation, including through start-ups and scale-ups.

This project aims to identify policy actions that can be promoted by the national government, national cluster organisations and others to support start-ups and scale-ups in the sector strongholds and emerging industries. This is built around an in-depth analysis of the following three sector strongholds:

1. Advanced production
2. Energy technology
3. Food and bio resources

These sectors have been selected so as to cover a range of different knowledge bases and modes of innovation, enabling lessons to be drawn for other sectors with similar characteristics. For the three case study sectors, opportunities and barriers to start-ups and scale-ups are identified and relevant examples of international best practice policies are examined. The analysis leads to a series of tailored recommendations for each sector. In addition, the report offers a number of generic policy recommendations, which are applicable to start-up and scale-up development in other sector strongholds and emerging industries.

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The project was led by Jonathan Potter, Head of the Entrepreneurship Policy and Analysis Unit, CFE, OECD under the overall supervision of Céline Kauffmann, Head of the Entrepreneurship, SME and Tourism Division, CFE, OECD. The report was drafted by a team involving Helen Lawton Smith (Birkbeck, University of London, United Kingdom), Bjorn Asheim (University of Stavanger, Norway), Pablo Shah (OECD/CFE) and Jonathan Potter (OECD/CFE).

Partners from the Danish Business Authority played a key role in co-ordination and steering of the project, including Torsten Andersen, Simon Hauptmann, Martin Haagensen, Rebekka Edemann, Sofie Jaeger, and Amalie Mathiesen.

The OECD team is grateful for the interviews held with Danish stakeholders. In advanced production, interviews were held with representatives of MADE – Manufacturing Academy of Denmark (Nigel Edmondson), REinvest Robotics (Esben Ostergaard), Technological Institute (Anne-Lise Lejre, Troels Pedersen), Centre for Technology Entrepreneurship at Technical University of Denmark (Jes Broeng), DTU Science Park (Steen Donner), Tech Station Invest (Birgitte Nygaard), Technicon (Casper Hansen), and Danfoss Drives (Morten Sorensen). In energy technology, interviews were held with representatives of Energy Cluster Denmark (Glenda Napier), Vestas Wind Systems (Bo Svoldgaard), DI Energy (Troels Ranis), Wind Denmark (Jan Hylleberg), Center Denmark (Soren Skov Bording), and Next Step Challenge (Soren Ron). In food and bio resources, interviews were held with representatives of Food and Bio Cluster Denmark (Jacob Mogensen), Arla Foods (Lars Dalsgaard), Fauna Photonics (Frederick Taarnhoj), Royal Greenland (Niels Boknaes), DI Foods (Hanne Bengaard) and Danish Agriculture and Food Council (Nicolai Hansen). Cross-sector interviews were also held with Copenhagen Business School (Toke Reichenstein), ByFounders (Tommy Andersen), Tech BBQ (Avnit Singh), Accelerace (Peter Torstensen), the University of Aalborg (Jesper Christensen, Kristian Nielsen, Michael Dahl), the University of Southern Denmark (Steffen Korsgaard, Mads Ingstrup), Impact Lab at Technical University of Denmark (Thomas Howard), the Danish Growth Fund (Ditte Rude Moncur), the Danish Innovation Fund (Sidsel Hougaard), and the Danish Business Authority (Torsten Andersen).

Interviews were also held with managers and stakeholders associated with the international policy case studies. Interviewees included Jasmine Bridges and Tina Kaasburg, Small Business Innovation Research Programme, USA; Paul Jordan, Energy Catapult, UK; Kevin O'Connor, Sean Douglas, Derek O'Brien, BIObic Science Foundation Ireland, Ireland and Donagh Berry, Vista Milk Ireland; Jeroen Wouters, Foodvalley NL, Netherlands; Ville Valovirta, VTT Technical Centre of Research, Finland; Jason Myers, NGEN, Canada, Rakhi Lad, Matthew Mahoney, Matthew Gordon, Lyn Doering, Saima Habib, Ben Willoughby, Ontario Government, Canada; Stina Lantz, Ignite, Sweden.

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Executive summary

The Danish Board of Business Development (DBBD) has identified 11 sector strongholds within Denmark, which have been selected on the basis of their sizeable economic footprint, international competitiveness, leading companies and excellent knowledge base. The DBBD and the Ministry of Higher Education and Science have each identified a further two emerging industries, which have been singled out due to their high growth potential. This report examines the entrepreneurial ecosystems of three of the strongholds – advanced production, energy technology and food and bio resources. It focuses on the role played by start-ups and scale-ups in these sector strongholds, the barriers they face and the policy measures that can increase their contribution to stronghold development. Many of the policy recommendations offered for the three case study sector strongholds are also relevant for start-up and scale-up support in other sector strongholds and emerging industries in Denmark.

The report commences with a mapping of the relevant programmes and policies that are currently in place in Denmark. This sheds light on the diverse range of policy actors and initiatives that each play a role in supporting start-ups and scale-ups in Denmark. These include the 14 national cluster organisations, the six regional business hubs, the broad network of business incubators and accelerators, and a variety of funding organisations, including the Danish Growth Fund and Innovation Fund Denmark. A quantitative analysis of the economic contribution of start-ups and scale-ups in the 15 sector strongholds and emerging industries is also provided, using new data compiled by the Danish Business Authority and Statistics Denmark. For this purpose, start-ups are defined as businesses aged 0-5 years old, and scale-ups are defined as businesses that experience annualised growth in employment or turnover of at least 10% over a three-year period, having had at least 10 employees at the start of this period.

The analysis shows that the scale of start-up and scale-up activity differs across the different sector strongholds and emerging industries, with implications for the degree to which start-ups and scale-ups can drive the sectors and need to be a focus of policy attention. In 2019, the share of start-ups in the business population ranged from 26% in environmental technology to 44% in tourism. The share of start-ups in the business population is relatively even across sectors, with the value falling within five percentage points of the all economy average of 32% in eight of the 15 sector strongholds and emerging industries. Scale-ups are significantly rarer than start-ups, and their prevalence varies more strongly across the sectors. The share of scale-ups in the business population ranges from as low as 1.0% in the animation, games and film industry to 5.6% in advanced production. Despite their relative scarcity, scale-ups accounted for 34% of employment in the life science and welfare technology sector and 54% of revenue in the energy technology sector in 2019. The population of start-ups declined in nine out of the 15 sector strongholds and emerging industries between 2010 and 2019, while the number of scale-ups increased in all of the sectors. There are further differences in whether the different sector strongholds are producing new firms growing to a large size. While there are new companies that have grown substantially in the food and bio resources (Faunaphotonics) and advanced production sectors (Technicon), this appears to be less common in the energy technology sector. Furthermore, no unicorns have spun-out of universities in any of the three sectors.

Following these analyses, the report provides a detailed assessment of conditions and policies for start-ups and scale-ups in each of the three case study sector strongholds – advanced production, energy technology and food and bio resources – including specific policy recommendations for each sector. The chapters are informed by a series of interviews with Danish and international stakeholders involved in the sectoral start-up and scale-up ecosystems, together with an examination of relevant examples of international policy practices. The case study sectors cover a variety of knowledge bases and modes of innovation, meaning that lessons can be applied to other sector strongholds and emerging industries with similar characteristics.

Sector-specific policy recommendations

The report concludes that each case study sector should develop some dedicated measures for start-ups and scale-ups adapted to their own contexts, including the following:

Advanced production

1. **Develop funding models** that address the long timeframe needed for deep-tech and hardware start-ups and scale-ups to become sustainable businesses.
2. **Encourage closer collaboration between advanced production companies and universities.** This should cover inter alia: joint applied research, joint development of products, joint exploitation of intellectual property (IP), students involved with spin-out companies, and syllabus development and planning.
3. **Increase the representation of start-ups and scale-ups** in the membership, committees and strategy making processes of the Manufacturing Academy of Denmark (MADE) national cluster organisation in order to secure more start-up and scale-up focused projects and initiatives and their inclusion in broader cluster projects.
4. **Broker effective relationships between larger firms and smaller firms**, with the former playing the role of first customers, innovation partners, and technology development advisors for start-ups and scale-ups, including through more active participation in incubators and accelerators.
5. **Promote a closer and more systematic co-operation between MADE and regional entrepreneurial ecosystem actors**, since spatial proximity better supports start-ups and scale-ups.

Energy technology

1. **Work with the private sector to develop a stronger sector-specific finance ecosystem**, including both early-stage finance and longer-term patient finance (aimed at the deep tech segment of the sector), potentially including R&D tax incentives adapted to start-ups and scale-ups.
2. **Establish an energy accelerator programme** that specialises in supporting start-ups and scale-ups in the sector, including access to experienced technology managers and market development and regulation experts. The accelerator should work with large firms and investors and include support for access to international markets as well as support with regulations.
3. **Focus on bringing more start-ups and scale-ups into the sector**, and especially into the supply chain, including start-ups and scale-ups based on use of energy data.
4. **Review the public procurement process and especially the early pre-tender stages to address current barriers** to the participation of start-ups and scale-ups. This should include simplifying the tendering process, facilitating participation in bidding consortia, raising awareness of opportunities, and increasing granularity of contracting.

5. **Develop physical infrastructure, including piloting and testing facilities and relevant science parks** to bring Denmark in line with competitor countries.

Food and bio resources

1. **Provide public sector support for improved physical piloting and testing facilities** for the food and bio resources sector, including state of the art facilities for a variety of tasks, such as handling waste, and access to capital equipment for piloting prototypes. This could include a national test centre.
2. **Address the funding gap faced by scale-ups when they reach medium size.** This includes finding ways to incentivise private investors to provide longer-term patient capital.
3. **Develop processes for public procurement of innovation from start-ups and scale-ups in food and bio resources.** This includes modifying pre-tender processes and introducing flexibility to procure products involving new types of food, ingredients or processes. Technical and legal competences for public procurement for innovation should be developed across government. Other public programmes should support start-ups and scale-ups with their procurement capabilities. Targets could be set for SME participation in public procurement for innovation in this sector.
4. **Support start-ups and scale-ups with compliance with food and drug regulations.** The Food and Veterinarian Administration can provide advisory support and materials and consult with the sector to improve regulatory ease for introducing new products to the market.
5. **Broker and facilitate closer dialogue between large firms and start-ups and scale-ups** in order to help start-ups and scale-ups to solve their innovation problems and to validate their products.

Cross-sector policy recommendations

In addition, there are start-up and scale-up measures that should be introduced across a broader range of sector strongholds and emerging industries. These include the measures proposed below. They are presented in priority order, although it should be noted that the actions would be expected to play out over differing timescales.

1. **Improve access to patient capital**, particularly for deep-tech firms, which tend to require larger funding rounds over more extended time horizons.
2. **Build collaborations between large firms and start-ups and scale-ups**, for instance by promoting the role of large firms as first customers for new firms and by involving large firms in the development of incubators and accelerators.
3. **Develop public procurement for innovation**, including measures to ensure that start-ups and scale-ups are involved in the bidding process.
4. **Build university-industry collaboration**, including by addressing issues related to intellectual property ownership, broadening evaluation metrics for researchers to include entrepreneurship activities, and providing targeted finance for universities to work more closely with start-ups and scale-ups.
5. **Provide longer-term and freer funding on a competitive bidding basis to the national cluster organisations** for the sector strongholds and emerging industries to enable them to take strategic actions not covered by funding tied to individual projects, backed up by regular evaluations of impacts achieved against bidding targets to secure funding continuation. These strategic activities should include pro-active work to find promising start-ups and scale-ups, matching them to potential partners and connecting them to resources.

6. **Build linkages between national cluster organisations and regional entrepreneurial ecosystem actors** to ensure appropriate regional-level projects and tailoring, reflecting the regional element of much cluster activity.
7. **Promote diversity in the populations of start-up and scale-up entrepreneurs** in order to tap into wider talent, alleviate skill shortages and secure equal opportunities in entrepreneurship.

1. Study background, objectives and approach

Study background

In its *Business Promotion in Denmark 2020-2023* strategy, the Danish Board of Business Development (DBBD) identified 11 sector strongholds, characterised by their international competitiveness, best in class companies and knowledge environments, and large contribution to the Danish economy. The 11 sector strongholds are:

- Environmental technology
- Energy technology
- Food and bio resources
- Maritime industry and logistics
- Life science and welfare technology
- Construction and building
- Design, fashion and furniture
- Advanced production
- Digital technologies
- Finances and financial technology (Fintech)
- Tourism

The DBBD also identified two emerging industries – robot and drone technology and animation, games and film – which have a high potential for growth and commercial success. The Minister for the Ministry of Higher Education and Science identified two further emerging industries – defence, space and security and sound technology.

A priority for the Danish government is to strengthen entrepreneurship and improve the performance of start-ups and scale-ups in these sector strongholds and emerging industries. There are many public entities and initiatives in Denmark that play a role in this area. These include the six regional business hubs, the plethora of publicly-supported business incubators and accelerators, and the variety of funds that boost start-ups and scale-ups' access to finance. Among the key players are the 14 national cluster organisations. Each organisation focuses on a specific sector stronghold or emerging industry, supporting co-operation between companies, knowledge and educational institutions, and public organisations. The tourism sector does not have an appointed national cluster organisation, whose functions are filled by a range of existing tourism development agencies and destination management organisations.

This study aims to support policy makers in identifying actions that can be promoted across the public support system to support start-ups and scale-ups in the sector strongholds and emerging industries, with

a particular focus on building the sectoral entrepreneurial ecosystems of three case study sector strongholds in Denmark – energy technology, food and bio resources and advanced production.

Study objectives

The project seeks to develop recommended actions for the national government, national cluster organisations and other public bodies at national and regional levels to support start-ups and scale-ups in specific sector strongholds drawing on international policy experiences in these sectors. As such, the project has the following objectives:

- Identify entrepreneurial ecosystem drivers and weak links for start-ups and scale-ups in selected sectoral entrepreneurial ecosystems in Denmark;
- Identify gaps in the policy measures and policy mechanisms used to support start-ups and scale-ups in selected Danish strongholds and emerging industries as compared with practice in these same sectors in other OECD countries, and the potential transferable of these international policy experiences to Denmark;
- Recommend generic, cross-sector, policy actions to be taken for start-ups and scale-ups in the Danish sector strongholds and emerging industries;
- Recommend tailored, sector-specific, policy actions that can be taken by the national government, national cluster organisations, regional business hubs and others in Denmark in specific sectors.

Study approach

Conceptual framework

The project focuses on entrepreneurial ecosystems at the sector level. It builds on the OECD's ongoing work on entrepreneurial ecosystems, which identifies a number of key dimensions along which the strength of ecosystems need to be assessed with respect to their ability to generate impactful start-ups and scale-ups. It also draws from the conceptual framework of the OECD's local emerging industries work stream, which examines opportunities for new industry path development at regional level, including a classification of potential path development avenues according to knowledge base, industry diversity and innovation system sophistication.

Method

The initial phases of this project involved the mapping of policies relevant to start-ups and scale-ups in Denmark based on a review of policy documentation and the generation of new data on start-up and scale-up activity by sector stronghold and emerging industry by DBA and Statistics Denmark with guidance from the OECD. In addition, the study involved in-depth stakeholder consultations in three sector strongholds in Denmark – advanced production, energy technology and food and bio resources. These case study sectors cover a range of different knowledge bases and modes of innovation, ensuring that a variety of challenges are considered and enabling lessons to be drawn for other sectors with similar knowledge bases and modes of innovation. Further desk research and online interviews were undertaken on policies to promote start-ups and scale-ups in the chosen case study sectors in OECD comparator countries with a view to identifying transferable policy lessons for Denmark.

Report structure

The report begins with a description of the barriers typically faced by start-ups and scale-ups internationally and a mapping of key policies to address these barriers in Denmark's sector strongholds and emerging industries. Further information is provided on start-up and scale-up activity in Denmark's sector strongholds and emerging industries, based on data produced by the Danish Business Authority and Statistics Denmark using guidelines from the OECD. The subsequent three chapters present the opportunities and barriers to start-up and scale-up activities in each of the selected case study sectors, along with key takeaways from international policy experiences and policy recommendations for the selected sectors. Finally, overall conclusions and policy recommendations for Denmark's sector strongholds and emerging industries are offered, including a discussion on the resources, incentives and instruments that can be promoted by the national government, national cluster organisations and other policy actors to support start-ups and scale-ups in the sector strongholds and emerging industries.

2. Start-ups and scale-ups in Denmark's sector strongholds and emerging industries

This chapter begins by setting out the typical barriers faced internationally by start-ups and scale-ups that policy can help to overcome. This is followed by a review of the policies in place in Denmark to support start-ups and scale-ups and a subsequent analysis of how Denmark compares to its peers in terms of the prevalence and impact of start-ups and scale-ups. Finally, there is an analysis of the characteristics and economic contributions of start-ups and scale-ups in Denmark's 15 sector strongholds and emerging industries.

Introduction

A healthy stream of start-ups is a pre-requisite for a dynamic economy. The most productive start-ups within a start-up cohort bring novel products, processes and ideas into the market that are a crucial source of innovation (OECD, 2021^[1]). Moreover, challenger firms raise levels of competition by forcing incumbent businesses to either adapt or cede market share (Kritikos, 2014^[2]). In addition, scale-up businesses make an outsized contribution to economic growth (Audretsch, 2012^[3]). The definitions used in this report for start-ups and scale-ups are detailed in the Box below.

Box 2.1. Defining start-ups and scale-ups

Start-ups are defined in this report as businesses that are 0-5 years old. For example, in 2019, the population of start-ups comprised businesses that were established either in 2014, 2015, 2016, 2017, 2018 or 2019. It is important to note that the adopted definition of a start-up varies between studies, which can lead to differences in observed trends and results.

Scale-ups are defined as businesses that have experienced at least 10% annualised growth in either employment or turnover over a three-year period. An additional criteria for a scale-up is that the business had at least 10 employees at the start of the three-year period. This is in line with the definition of “scalers” used in the OECD’s recent work on understanding firm growth (OECD, 2021^[4]) and with the definition used in the OECD-Eurostat Entrepreneurship Indicators Programme underlying the data in the OECD Structural and Demographic Business Statistics database.

Supporting start-ups and scale-ups can help to achieve numerous economic and societal objectives. However, these businesses often face a set of challenges that is distinct from that of more established companies (OECD, 2021^[1]). This means that, in order to realise the potential benefits of start-ups and scale-ups, it is necessary to implement tailored policy interventions.

Key barriers to the success of start-ups and scale-ups

Two defining characteristics of most early-stage enterprises is that they are young and small. These attributes result in a number of common challenges as entrepreneurs seek to establish and grow their businesses. In many instances, policy interventions can be effective in ameliorating these issues, thus helping to unlock the benefits that successful entrepreneurs can bring to the economy and society. The following section presents some of the key barriers to the success of start-ups and scale-ups that policy interventions can address.

Access to finance

Given that many entrepreneurs have limited internal resources to invest in their ventures, external finance is essential in helping businesses to start-up, innovate and grow. The largest source of external finance for businesses is bank finance, including bank loans, overdrafts, credit lines and credit cards (Cusmano, 2015^[4]) (European Commission, 2021^[5]). However, new businesses typically have a limited trading history as well as a lack of collateral, which is a significant obstacle to accessing bank finance (Cusmano, 2015^[4]). Moreover, banks may find it more difficult to assess credit risks for start-ups engaged in innovative activities, leading to greater uncertainty and a reduced willingness to lend for this group (Carpenter and Petersen, 2002^[6]). On the demand side, young businesses are more likely to have an incomplete picture of the financing options that are available due to their limited experience and reduced access to skills and

networks. These information gaps can lead to fewer start-ups and scale-ups receiving bank financing than would be the case in a scenario with perfect information. Alternative sources of finance include venture capital, angel investors, corporate investors, peer-to-peer business lending and mezzanine financing (Denis, 2004^[7]) (Block et al., 2018^[8]). Despite these alternative sources of financing, entrepreneurial funding gaps remain a significant issue (Fraser, Bhaumik and Wright, 2015^[9]).

Entrepreneurship skills and capabilities gaps

Establishing a successful enterprise is a multi-step process, which involves developing a product or service, setting up a company, and growing a customer base. Each of these steps relies upon a distinct set of skills and knowledge. Product development requires technical skills and an ability to identify economic opportunities, while forming and growing a business requires entrepreneurs to be competent in navigating legal and regulatory frameworks, building networks, accessing external financing, leading teams and recruiting skilled personnel.

The varied and complex nature of the skills required to start a successful business can be an obstacle to many budding entrepreneurs, who may excel in some areas while falling short in others (OECD, 2020^[10]). For instance, entrepreneurs with excellent product development skills may subsequently struggle to take their products to market, while others with an aptitude for identifying economic opportunities may lack the technical knowhow to bring their ideas to life. In many instances, entrepreneurs have the option of accessing support from the private sector in order to build their competencies in certain areas. However, it can be difficult for entrepreneurs to quantify the benefits that these investments will deliver. This can lead to an under-utilisation of business support services and a consequent persistence of entrepreneurial skills and knowledge gaps, leaving a space for policy intervention in certain areas (OECD, 2020^[10]).

Access to international markets

Exporting can deliver many benefits to businesses, including an enlarged revenue base, risk diversification, technology transfer and an improvement in standards and efficiency (OECD, 2020^[10]). However, numerous studies have identified a range of size-related factors that inhibit the ability of smaller businesses to access international markets (Leonidou, 2004^[11]). For instance, small firms often have more limited information on export opportunities and processes than their larger counterparts. Small businesses' relatively low production volumes may also make it difficult for them to compete internationally on price, while the barriers to finance described previously can further inhibit exporting activities.

Access to networks

An integral part of entrepreneurship is forming relationships with other entrepreneurs, research institutions, established businesses, potential customers and investors. Networks can facilitate peer-to-peer learning and the formation of strategic partnerships, improve access to finance and resources, bolster entrepreneurship skills and help entrepreneurs to grow a customer base (OECD, 2020^[10]). When new businesses enter the market, they often have more limited access to networks than established businesses, which is a key part of the "liability of newness" experienced by start-ups (Stinchcombe, 1965^[12]) (Cafferata, Abatecola and Poggese, 2009^[13]).

Cultural attitudes

People's willingness to engage in an entrepreneurial venture is influenced by the set of shared ideas, values and norms embedded in the culture in which they operate (OECD, 2020^[10]). Therefore, in certain settings, culture can be a barrier to entrepreneurship. By instilling certain attitudes within individuals, culture can lead to preferences and perspectives that are not conducive to becoming an entrepreneur. Furthermore, culture shapes how certain actions will be perceived by others, which in turn feeds into the

decisions that people make. *Ceteris paribus*, individuals in cultures that celebrate and encourage entrepreneurship will be more likely to become an entrepreneur than those in cultures where entrepreneurship is viewed less favourably. Attitudes to entrepreneurship vary considerably across different countries (Bosma et al., 2021^[14]).

Summary

Most entrepreneurial ventures internationally experience a number of the barriers to success described above at some point of their development. Many of these issues are an inherent consequence of the age and size of new businesses and are therefore prevalent across most industries. That said, certain challenges are more acute in some sectors than in others. For example, due to higher transport costs, expanding to new markets can be harder for businesses that provide physical goods and services than for those that provide their products through digital platforms (Freund and Weinhold, 2002^[15]). This means that difficulties accessing international markets are likely to be more prevalent in sectors that are less digital intensive. Finance gaps also vary across sectors. As an example, deep tech companies face challenges in meeting their large capital requirements due to extended development timelines and the inherent technological and market uncertainty associated with their innovations (Nedayvoda et al., 2021^[16]). Similarly, despite increasing investments in green sectors, entrepreneurs in environmental sectors often face greater difficulties accessing finance due to perceived technological and policy risks as well as more extended investment horizons (Demirel et al., 2019^[17]). Cultural barriers to entrepreneurship will also vary across sectors, depending on the prevailing attitudes towards different types of entrepreneurial ventures and the operating practices of different industries. For instance, in some sectors, existing working practices and behaviours create an environment that may deter potential women entrepreneurs from entering the field (Bagilhole, Dainty and Neale, 2000^[18]).

Policy measures in Denmark

This section presents the main public policy measures currently in place in Denmark to support start-ups and scale-ups in overcoming each of the barriers identified previously. These include initiatives that cover all sectors, as well as those that are targeted towards specific sector strongholds or emerging industries. It is important to note that these public policy measures are only part of the wider business promotion system in Denmark, which also includes a number of private organisations and initiatives.

Access to finance

Policies that improve entrepreneurs' access to finance can help to overcome the funding difficulties that start-ups face due to their lack of trading history, networks or collateral (OECD, 2020^[10]). Direct financial support can be provided through the allocation of grants (e.g. the Small Business Innovation Research programme in the US), loans (e.g. the start-up loans offered by the Business Development Bank of Canada) and equity injections (e.g. the European Investment Fund's investments into selected equity funds). Public policies can also help businesses to access funding through the private sector, for instance through government loan guarantees as well as programmes to raise the financial literacy of entrepreneurs (e.g. the US Small Business Administration's Money Smart for Small Business programme) (OECD Publishing, 2020^[19]). Furthermore, governments can establish dedicated organisations that provide funding to start-ups and scale-ups, such as public sector venture capital funds (e.g. the government-backed High-Tech Gründerfonds and Coparion funds in Germany) or angel investors. Below are set out some of the key policy interventions in Denmark relevant to start-ups and scale-ups in these areas.

Grants

The Danish Board of Business Development

The Danish Board of Business Development is a decentralised board that promotes business growth and development by concentrating on the needs of enterprises in the regions. The Board has the task of ensuring that the decentralised business initiatives across the regions are coherent and that there is no overlap between publicly funded actors and programmes.

The Danish Board of Business Development has at its disposal approximately DKK 300 million annually. Additionally, it will implement DKK 1-2 billion worth of EU Structural and Investment Funds in 2022-2027 in areas including, among others, innovation, green transition, business development, skills and entrepreneurship.

Innovation Fund Denmark

Innovation Fund Denmark is a public investment fund, which issues grants to entrepreneurs, businesses and researchers with high risk projects that may otherwise find it difficult to access finance. Projects are evaluated based on social and environmental factors in addition to financial results.

The fund focuses on three areas:

- Climate, environment and green change;
- Life science, health and welfare technology, and;
- Technology and innovation that creates value and growth.

In the agreement on the 2021 research reserve, DKK 1.2 billion of investment was assigned to the Innovation Fund to invest in green research initiatives, DKK 340 million was assigned to life science, health and welfare technology, and DKK 190 million was assigned to technology and innovation that creates value and growth.

Technology Development and Demonstration Programmes

Denmark has in place a number of technology development and demonstration programmes, which are an important source of funding for entrepreneurs looking to develop innovative technologies. The Energy Technology Development and Demonstration programme supports new technologies in the field of energy that contribute to Denmark's climate objectives. DKK 543 million was made available in the most recent round of funding in 2021. Meanwhile, the Danish Ministry of the Environment oversees the Environmental Technology Development and Demonstration programme. In 2021, DKK 140 million was made available to companies, research institutions or individuals for the development of environmental technology solutions. The Ministry of Food, Agriculture and Fisheries runs the Green Development and Demonstration programme, which funds projects that solve important challenges for the Danish food industry while contributing to food, business and environmental policy objectives. In 2020, the programme had a total budget of DKK 259 million.

European Innovation Council

Funding opportunities are also available to Danish start-ups and scale-ups through the European Innovation Council (EIC), which was established under the European Union's (EU) Horizon Europe programme. The EIC has a budget of EUR 10.1 billion for the 2021-2027 period, with the aim of developing and expanding breakthrough innovations. In 2022, EUR 1.2 billion was allocated to the EIC Accelerator programme, which provides finance to prospective entrepreneurs, start-ups, SMEs and, in rare cases larger businesses with up to 499 employees. The EIC Accelerator programme offers grants for innovation activities as well direct equity investments and convertible loans to support market deployment and scaling

up activities. Meanwhile, a budget of EUR 350 million was allocated to the EIC Pathfinder programme, which distributes grants of up to EUR 4 million to consortia comprising at least three independent entities established in at least three different eligible countries. The purpose of these grants is to help the selected consortia to develop proofs of concept. The EIC Transition scheme, which provides grants of up to EUR 2.5 million to support the validation and demonstration of technologies and the development of market readiness, was assigned a budget of EUR 131 million in 2022.

Loans and equity investments

Danish Growth Fund

The Danish Growth Fund is Denmark's state investment fund, financed by capital contributions from the Danish Ministry of Business. The fund seeks to fill financing gaps left by the private sector by providing a range of financing support measures to primarily start-ups and SMEs, including start-up loans, growth loans, venture debt loans and loan guarantees. In addition to this, the fund nurtures potential scale-ups, for instance through the provision of convertible loans of up to DKK 3 million to young enterprises with a high growth potential but who are not yet able to access venture capital funding. This scheme targets businesses with a scalable business model, high annual growth rate expectation and a global market for their products. In 2020, the Danish Growth Fund issued DKK 2.9 billion of loans, although this figure is inflated by the DKK 1.8 billion of COVID-19 related loans that were provided that year.

The Danish Growth Fund also makes direct equity investments in Danish companies, which in turn supports potential scale-ups in realising their growth ambitions. In 2020, the fund made DKK 236 million worth of equity investments. Typically, 5-10 companies receive equity investments each year, with most capital injections ranging in value from DKK 5-20 million. In addition to this, the fund provides support to businesses in collaboration with private funds and business angels.

While the vast majority of the Danish Growth Fund's support mechanisms are accessible to businesses from all sectors, elements of the fund's operations are more suited to specific areas. In its investment activities, the fund has a strong focus on the IT, medtech and industrial technology sectors. These areas align closely with the digital technologies, life science and welfare technology, and advanced production and manufacturing sector strongholds. The Danish Growth Fund also has a dedicated team that specialises in providing support to agricultural businesses, offering a range of bespoke loan products and loan guarantees.

Danish Green Investment Fund

In partnership with financial institutions, the Danish Green Investment Fund lends up to 60% of the costs of environmentally beneficial projects in the areas of energy, food and agriculture, buildings and infrastructure, materials and resources, and transport and mobility. It provides loans of up to DKK 400 million, with a maturity of up to 30 years. The state guaranteed lending limit currently stands at DKK 8 billion. In 2020, the value of outstanding loans issued by the fund stood at DKK 1 649 million. A recent example of the Green Investment Fund's work is the agreement of a DKK 100 million loan to GreenMobility in order to fund the expansion of the company's fleet of electric vehicles. Support is available to private companies of all sizes as well as housing associations and independent public sector institutions, meaning that the fund's activities are only to a limited extent aimed at start-ups.

As part of the 2022 agreement "*Danmark kan mere 1*", the Danish Growth Fund, EKF and the Danish Green Investment Fund will gradually be merged into a single fund: the Danish Export and Investment Fund. The rationale for the merger is to facilitate synergies between the different funding entities and to make it easier for the design of government funding opportunities to adapt to international developments in a coherent manner.

Entrepreneurship skills and capabilities gaps

The public sector often has a role in providing a range of business services to start-ups and scale-ups. This support includes advice, coaching, and mentoring. There are various methods of provision the formation of networks that facilitate peer-to-peer learning, and signposting to services from the private sector (OECD, 2020^[10]). Business incubators and accelerators are a key method of delivery of business advice to start-ups and scale-ups. Another type of support provided involves access to public research and innovation knowledge through research and technology organisations.

Advice, coaching and mentoring

Danish Business Hubs

Denmark has six business hubs with branches offering nationwide specialised business service. The hubs are a one-stop shop for business services, providing specialised advice on business development as well as grants, access to financing, networks and support services. The business hubs act as a juncture in the business promotion system, helping companies to navigate the various support measures that are available to companies from a range of different organisations. The business hubs operate the IværksætterDanmark programme, which offers online and in-person courses for businesses on a range of topics. The IværksætterDanmark programme also offers the NextStep course, which provides businesses with demonstrable growth ambitions with access to an experienced business developer as well as grants of up to DKK 255,000.

In 2021, 4 790 businesses received specialised guidance through the business hubs, with three-quarters of these companies also referred to appropriate public or private advisers. The total budget allocated to the six business hubs in 2022 is DKK 171 million. Each hub covers multiple municipalities. More localised business development and government administrative services are provided by the municipal business development offices.

Virksomhedsguiden

In 2019 the Danish Business Authority launched the platform Virksomhedsguiden (virksomhedsguiden.dk). Virksomhedsguiden is a digital one-stop shop, which provides companies with business guidance and information regarding rules and business support services in Denmark. In 2021, the website had approximately 1.5 million page views and 600 000 visitors. Virksomhedsguiden works in close collaboration with the different Danish authorities and the regional business hubs to ensure that accurate and up-to-date information is provided.

Incubators and accelerators

Business incubators and accelerators are a key vessel for the delivery of accommodation, guidance, training, contacts and funding to entrepreneurs (European Commission / OECD, 2019^[20]). Business incubators focus on nurturing businesses during their early start-up phase, while business accelerators typically take equity in companies, enrol businesses in fixed-duration programmes to develop scale-up skills and have more stringent performance requirements. Although these organisations are generally privately operated, they often require government support in order to remain viable. Denmark has a large and diverse network of publicly-supported incubators and accelerators. The remainder of this section provides an illustrative overview of the network of publicly-supported incubators and accelerators in Denmark, with examples of initiatives that nurture start-ups and scale-ups from a broad range of fields as well as incubators that focus more narrowly on specific sectors.

Beyond Beta

Beyond Beta runs incubation and acceleration programmes to support entrepreneurs. Accelerace, the Danish Business Hubs and the Danish Design Center jointly founded and operate Beyond Beta. The 14 national cluster organisations are also involved in the programme. The role of the business hubs is to screen the companies entering the programme, while the role of the cluster organisations is to apply their sector-specific knowledge in order to arrange activities for target groups.

Beyond Beta offers modules to start-ups at varying stages of development. For businesses with a concept or prototype but without a customer or user base, eight industry-specific incubator programmes were available as of March 2022. Through these programmes, businesses are provided with a contact in the relevant national cluster organisation, who then connects the businesses to relevant organisations within the industry. Businesses are also provided with access to mentors, workshops and networks in order to support their further development. For businesses at a more advanced stage, typically with a proof of concept and initial customer base, Beyond Beta offers a pre-accelerator and accelerator programme. The pre-accelerator is a freely available online platform comprised of a series of modules. The subsequent accelerator programme is broken down into three phases, with only selected start-ups progressing through to each new phase. From phase 2 onwards, start-ups can utilise Beyond Beta's resource platform, which provides access to tools, software, interns and Beyond Beta's resident CEOs. The final phase sees entrepreneurs introduced to relevant investors and prepared with the skills and knowhow necessary to conduct successful funding negotiations. For the 2021-2023 period, the programme has been assigned a budget of DKK 112 million from the REACT programme, in addition to a core budget of DKK 34 million for the period 2019-2022.

Innofounder

Innofounder is a 12-month development course for entrepreneurs operated by Innovation Fund Denmark. The programme aims to accelerate the process in which innovative entrepreneurial ventures become financially sustainable either through generating sales or through obtaining investment. Programme participants receive a monthly allowance of DKK 27 500 to enable them to work full time on developing entrepreneurial idea. Development grants of DKK 100 000 are also distributed upon commencement of the course, which can cover technological development expenses such as equipment rental, prototype development, software and external advice. During the course, entrepreneurs have access to workshops, mentoring and networking with other entrepreneurs in order to facilitate the development of entrepreneurial skills and capabilities.

Incubators and accelerators at research institutions

Denmark has numerous incubators and accelerators that are housed within publicly-funded research institutions. For instance, the Copenhagen School of Entrepreneurship offers a range of incubation and acceleration services. The Incubator Proof Programme consists of a 3-month proof of concept phase and a 6-month proof of business phase, during which entrepreneurs are provided with office space, professional services, access to a network of start-ups and the opportunity to talk to potential customers. Meanwhile, the Go Grow Accelerator Programme has helped 140 start-ups to scale up. Businesses in the programme are supported through the provision of free specialised consultancy services, expert advice and mentoring, access to investors and office space.

Another example is the Technical University of Denmark's (DTU) Skylab, which acts as a focal point for innovation and entrepreneurship, providing physical facilities such as labs and work areas alongside networking opportunities, funding and acceleration services. The DTU's Science Park operates the GreenUp Accelerator, which is a 20-month acceleration programme that provides participants with a DKK 1 million convertible loan and more than 75 hours of free counselling. The ambition is to create climate tech start-ups that are ready to tap into international capital markets upon completion of the programme.

DTU also leads an incubator that is part of the European Space Agency's pan-European network of 22 business incubation centres. The incubator aims to support 40 space-related start-ups in Denmark between 2020 and 2024 by providing access to international networks, funding, business development services and favourable office rates.

Other incubators and accelerators operating within public universities in Denmark include Aarhus University's Kitchen start-up hub, the SCIENCE Innovation Hub at the University of Copenhagen, the University of Southern Denmark's Entrepreneurship Labs and the Aalborg University Inkubator.

Other publicly-funded incubators and accelerators

Significant public funding is provided to a number of private organisations that are important in the provision of incubation and acceleration support. For example, in partnership with Digital Hub Denmark, Copenhagen Fintech runs the Nordic Fast Track Programme. The two-month programme is for non-Danish fintech start-ups with a live product or prototype. The aim is to bring these solutions to the Danish and European markets by providing start-ups with local contacts and accelerating the process of learning about the Danish market. Similarly, Game Hub Denmark is an incubator with public funding that focuses on start-ups in the computer games industry. With a presence in several Danish cities, Game Hub Denmark provides a variety of services including office space, mentoring, certifications, access to workshops and conferences, and legal and financial consulting. Another publicly-funded incubator is the Odense Robotics StartUp Hub, which is housed within the Danish Technological Institute and aims to accelerate the growth of promising start-ups in the field of robotics. It does this by offering access to a network of companies in the industry as well as high-quality testing facilities and coaching. Start-ups are also supported in accessing financing from investors. Since 2015, the hub has helped start-ups to secure more than EUR 20 million from external investors.

Access to research and technology

Open Entrepreneurship

The Open Entrepreneurship initiative, which is led by the Danish Industry Foundation and the Danish Ministry of Higher Education and Science, seeks to connect entrepreneurs with researchers in order to create new commercial opportunities. Several Danish universities are partners in the initiative, as well as the University of California, Berkeley. Each participating university has an Open Entrepreneurship business unit, where entrepreneurs and investors can obtain a desk in order to become embedded in the research environment. The Open Entrepreneurship initiative also places researchers within companies, and runs a 3-6 month accelerator programme.

GTS Institutes

In Denmark, there are seven government-approved Research and Technology Organisations, which are referred to as the GTS Institutes. These organisations work on developing technologies, knowledge, solutions and standards for Danish businesses, which in turn supports start-ups and scale-ups in remaining competitive. The degree of specialisation and research focus varies from institute to institute. For instance, DHI specialises in the water, environment and health sectors, while DBI focuses on fire safety. Meanwhile, the Danish Technological Institute works across a broader range of areas.

Technology Transfer Offices

Many of Denmark's public universities, including the University of Copenhagen and Aarhus University, house technology transfer offices. These work to facilitate collaborations between universities and other actors, encourage the development of spin-out companies, assess the commercial potential of research outputs, and manage intellectual property.

Access to international markets

Exporting can be an effective way for a business to scale-up. Indeed, tapping into global value chains can encourage investment, specialisation, organisational change and knowledge spillovers, each of which contribute to overall business growth (OECD, 2019_[21]). Measures to help start-ups and scale-ups to export include tax incentives, export credit guarantees (e.g. the German government's issuance of export credit guarantees through *Hermes Cover*), informational campaigns and the provision of advice and logistical support services (e.g. the US Department of Commerce's Startup Global initiative) (OECD, 2020_[10]). Trade missions can also promote a country's businesses to buyers in overseas markets.

Trade Council

The Trade Council of the Ministry of Foreign Affairs of Denmark provides support and expertise to Danish companies in order to help them realise their export aspirations. Each year, it assists around 3 000 Danish companies. The Trade Council has a presence in more than 70 countries, meaning that it can provide knowledge of local markets, as well as relevant contacts at overseas companies and trade organisations. There are teams of expert advisors that specialise in specific sectors such as design, furniture and fashion, energy, technology, water and the environment, health, and food and agriculture.

The Trade Council offers the Export Sparring Programme to SMEs, which provides assistance in developing an export plan followed by up to 15 hours of free sessions with a Trade Council export advisor. Additionally, the Trade Council operates a Strategic Business Alliance programme, which seeks to bring together Danish companies that are looking to export, thus facilitating the exchange of local market expertise, networks and resources. Furthermore, the SCALEit programme helps businesses to expand internationally. The scheme includes preparatory workshops based in Denmark as well as a networking week during which Danish start-ups and SMEs are connected with ecosystem actors in overseas markets.

Through its Incubator Scheme, the Trade Council offers physical and virtual incubation services at 23 locations in 15 countries. The incubators provide Danish businesses with office space, access to meeting rooms and bespoke advice. The incubators also provide companies with a local address in an overseas location, which in turn can boost local sales and streamline administrative processes.

Innovation Centre Denmark

Innovation Centre Denmark introduces companies and research institutions to strategic partnerships, technology networks and investment opportunities, utilising the Trade Council's knowledge and contacts in overseas markets. Innovation Centre Denmark has innovation centres in Boston, Munich, New Delhi, Sao Paulo, Seoul, Shanghai, Silicon Valley and Tel Aviv. These centres promote Danish competencies internationally in order to attract investment. Innovation Centre Denmark also provides access to targeted learning programmes in order to support and accelerate business development.

Investment Fund for Developing Countries

The Investment Fund for Developing Countries (IFU) provides risk capital to companies in developing countries and emerging markets. Investments are made on commercial terms with a focus on businesses that are contributing to the green transition and economic and social development. The IFU has invested DKK 25 billion in more than 1 300 companies. While the IFU's operations are principally overseas, the fund has co-invested with more than 900 Danish companies, helping these businesses to access international markets.

EKF (Export Credit Agency)

EKF is Denmark's export credit agency. It provides assistance to businesses that are looking to export through a variety of channels including credit guarantees, acceleration services and the provision of information on overseas markets.

EKF Green Accelerator

EKF – Denmark's export credit agency – operates an accelerator programme dedicated to Danish companies looking to export clean technologies. A total of DKK 30 million has been made available to finance preparatory business activities as well as short-term visits to potential export markets.

Guarantees

One way that businesses can attract international customers is by offering competitive financing, whereby payments are made by the customer after the delivery of the goods or services. EKF's guarantees allow Danish businesses to offer finance to their overseas customers without assuming any credit risk and receiving payment immediately upon delivery. In effect, these guarantees represent the extension of finance from EKF to Danish exporters' international customers. EKF also helps Danish exporters to obtain bank financing to fund their expansion plans by issuing capital guarantees, through which EKF assumes the banks' credit risks.

Access to networks

Networks can bring many advantages to start-ups and scale-ups, including reduced costs of obtaining information, enhanced access to technological, human and financial resources, links to potential customers and suppliers, and reputational benefits (Hayter, 2013^[22]). Porter defines clusters as geographic concentrations of interconnected companies and institutions in a particular field (see, for example the Czech Republic's *Nanoprogress* cluster, *AFBW* in Germany and *Media City Bergen* in Norway) (Porter, 1998^[23]). Clusters aim to stimulate innovation and enterprise development by harnessing local knowledge and relationships, and are an effective way of embedding entrepreneurs into networks of businesses, investors and customers. Policy can strengthen clusters through direct funding as well as by supporting research collaborations and providing infrastructure, networks, education and training (OECD, 2009^[24]). Denmark has numerous publicly supported cluster organisations, including the 14 national cluster organisations and a variety of regional networks, which are described below. However, it is important to note that cluster organisations can have varying degrees of public involvement, and Denmark is also home to a number of private cluster organisations.

National cluster organisations

In order to strengthen innovation and co-operation within the sector strongholds and emerging industries identified by the *Business Promotion in Denmark 2020 – 2023* strategy and the Minister for the Ministry of Higher Education and Science, 14 national cluster organisations were launched on 1st January 2021. The national cluster organisations corresponding to each of the sector strongholds and emerging industries are as follows:

- Environmental technology: CLEAN
- Energy technology: Energy Cluster Denmark
- Food and bio resources: Food & Bio Cluster Denmark
- Maritime industry and logistics: MARLOG
- Life science and welfare technology: Danish Life Science Cluster

- Construction and building: We Build Denmark
- Design, fashion and furniture: Lifestyle & Design Cluster
- Advanced production: Manufacturing Academy of Denmark (MADE)
- Digital technologies: Digital Lead
- Finances and financial technology (Fintech): Copenhagen Fintech
- Robot and drone technology – emerging industry: Odense Robotics
- Animation, games and film – emerging industry: Vision Denmark
- Defence, space and security – emerging industry: Centre for Defence, Space and Security (CenSec)
- Sound technology – emerging industry: Danish Sound Cluster.

The numbers of members of the cluster organisations range from approximately 200 to upwards of 500. The public funding allocated to the national cluster organisations between 2021 and 2024 is approximately DKK 640 million.¹ In addition, most cluster organisations also receive funding from various national initiatives and EU funded programmes.

The national cluster organisations aim to promote innovation and build a bridge between Denmark's research and business communities, providing platforms to bring companies, research institutions and policymakers together. Knowledge sharing is strengthened through the creation of professional networks, such as the Danish Sound Cluster's network groups for audio companies. The national cluster also establish international networks in order to pool knowledge across different countries. For instance, the Danish Life Science Cluster is building a Danish-German partner network to drive innovation in the healthcare sector and address shared challenges. The national clusters support start-ups by supporting activities that focus on increasing innovation through e.g. knowledge and networks that can be a particular challenge for new businesses. By connecting businesses with potential domestic and overseas partners to spur innovation, national clusters also support scale-ups in realising their growth aspirations. For instance, the CLEAN cluster is a partner of the EU Techbridge project, which matches North American customers with European SMEs with innovative water and energy solutions. The share of members that are start-ups varies significantly between the national cluster organisations. For instance, the Manufacturing Academy of Denmark (MADE) has historically had few start-ups among its members, whereas other (regional level) cluster organisations have many start-ups as members, e.g. Odense Robotics and Copenhagen Fintech.

Further information on the national cluster organisations in the case study sector strongholds is provided in the next section.

Regional networks

In addition to the 14 national cluster organisations, there are also a number of publicly supported network organisations with a more regional focus. For instance, Copenhagen Science City is a partnership between the City of Copenhagen, three universities and a number of other entities including science parks and co-working areas. Copenhagen Science City seeks to identify synergies within its network and raise awareness of the facilities for innovation that are available. Another example of a regional network organisation is Life Science Innovation North Denmark (LSI). Through a variety of projects and events, LSI aims to bring together and foster collaboration among key players in North Jutland's health and welfare innovation ecosystem. Other regional networks with support from the public sector include Science City Lyngby and Medicon Valley Alliance (MVA). Science City Lyngby seeks to promote innovation and entrepreneurship in Lyngby by bringing together local businesses, public entities and research institutions. MVA is a bi-national cluster covering the island of Zealand and the Skåne region of Southern Sweden. Its core function is to foster co-operation between businesses, research institutions and public organisations

in order to strengthen the health and life science sector. MVA also works to market the Medicon Valley internationally.

Cultural attitudes

Public initiatives have a role to play in creating a culture that is conducive to entrepreneurship. Entrepreneurship education programmes (EEP) have the potential to increase entrepreneurial capacities and intentions, although it should be noted that previous impact evaluations of EEPs have yielded mixed results (Charney and Libecap, 2011^[25]) (Oosterbeek, van Praag and Ijsselstein, 2010^[26]). Entrepreneurship can also be championed through the organisation of events, awards and competitions for new businesses.

The Danish Foundation for Entrepreneurship was established by four Danish government ministries in 2010, with the goal of embedding entrepreneurship education into all stages of the education system. The Foundation had a budget of DKK 49 million in 2020. The Foundation's 2020-25 strategy sets out an aim for 300 000 pupils and students to receive entrepreneurship education during the 2023-24 school year. Another objective is for 20 000 teachers and educators to receive training from the foundation during the strategy period. Entrepreneurship education is supported through dedicated entrepreneurship programmes for pupils, students and teachers, the allocation of funding to entrepreneurship projects in educational institutions and the distribution of knowledge through events, networking and collaboration. In order to encourage young people to pursue their entrepreneurial ideas, the Foundation also provides grants of up to DKK 50 000 to new enterprises established by students.

Summary

Taken together, the suite of policy measures and initiatives that are in place in Denmark provide considerable support to start-ups and scale-ups. Public financing schemes help both start-ups and scale-ups to overcome the funding challenges associated with their often limited history in the market. Meanwhile, Denmark's entrepreneurship education initiatives, regional business hubs and national clusters improve businesses' competencies, knowledge and networks, which is of particular benefit to young businesses given their relative inexperience. A more structured pathway for transitioning from an idea to a start-up and from a start-up to a scale-up is provided by the network of incubators and accelerators in Denmark. Danish scale-ups are further supported by policy initiatives that make it easier to tap into overseas markets, enabling them to realise their growth potential. While some of Denmark's policy interventions target start-ups and scale-ups in specific sectors, such as the Green Investment Fund, the national cluster organisations and industry-specific incubators, most public policy support measures are available to businesses across a broad range of sectors. The interviews with stakeholders in the advanced production, energy technology, and food and bio resources sectors, together with the review of international examples of best policy practice, indicate that there is space for more tailored policy initiatives in some cases, as outlined in Chapters 3, 4 and 5 of this report and summarised in Chapter 6.

Figure 2.1. Summary of public policy measures to support start-ups and scale-ups in Denmark

Access to finance	Entrepreneurship skills and competences gaps	Access to international markets	Access to networks	Cultural attitudes
<ul style="list-style-type: none"> <input type="checkbox"/> Danish Growth Fund <input type="checkbox"/> Danish Green Investment Fund <input type="checkbox"/> Innovation Fund Denmark <input type="checkbox"/> Technology Development and Demonstration Programmes <input type="checkbox"/> European Innovation Council 	<ul style="list-style-type: none"> <input type="checkbox"/> Danish Business Hubs <input type="checkbox"/> Virksomhedsguiden portal <input type="checkbox"/> Beyond Beta <input type="checkbox"/> Innofounder <input type="checkbox"/> Incubators and accelerators at research institutions <input type="checkbox"/> Sector-specific incubators and accelerators 	<ul style="list-style-type: none"> <input type="checkbox"/> Trade Council of the Ministry of Foreign Affairs of Denmark <input type="checkbox"/> Innovation Centre Denmark <input type="checkbox"/> Investment Fund for Developing Countries <input type="checkbox"/> EKF (Export Credit Agency) 	<ul style="list-style-type: none"> <input type="checkbox"/> National cluster organisations <input type="checkbox"/> Regional networks 	<ul style="list-style-type: none"> <input type="checkbox"/> Danish Foundation for Entrepreneurship

Introduction to the national cluster organisations

Manufacturing Academy of Denmark

The establishment of the Manufacturing Academy of Denmark (MADE) as the national cluster organisation for the advanced production stronghold has provided opportunities to address the challenges faced by start-ups and scale-ups and enhance market opportunities throughout the supply chain. The basis of MADE's operation is a collaboration between companies, universities and Research and Technology Organisations (RTOs) in research, innovation and education.

MADE is a non-profit organisation, with members charged an annual membership fee that varies in size depending on the type of organisation and the number of employees. Members are then granted access to a variety of activities, events and services. Start-ups can join MADE free of charge, which means that they have ready access to expertise and networks across the supply chain through engagement with MADE's membership, which currently comprises of more than 220 companies, 5 universities, 3 RTOs and 8 educational institutions. MADE also provides start-ups with better access to EU networks. These networks provide start-ups and scale-ups with a better understanding of market opportunities and sources of support for innovation activity, which in turn can encourage them to enter the supply chain.

MADE's innovation activities are designed to introduce Danish companies to state-of-the-art knowledge, technologies, methods and processes. MADE also helps SMEs with the practical implementation of new technologies and knowledge by providing access to leading experts as well as support for demonstration projects. Furthermore, it has a Digital Innovation Hub, which positions and represents Denmark in international platform collaborations and projects.

Energy Cluster Denmark

Energy Cluster Denmark (ECD) has a key role in promoting start-ups and scale-ups in the energy technology sector stronghold and addressing some of the barriers faced. Half of ECD's 200 members are SMEs, and its core activities are to run, facilitate, help and fundraise, in order to facilitate engagement in innovation and collaboration. The ECD innovation model begins with concrete demand and ends with commercialisation. Many of its members are present across the whole supply chain. Over time, new firms from the digital, drone and robotics sectors may become integrated into the energy technology supply chain.

Food & Bio Cluster Denmark

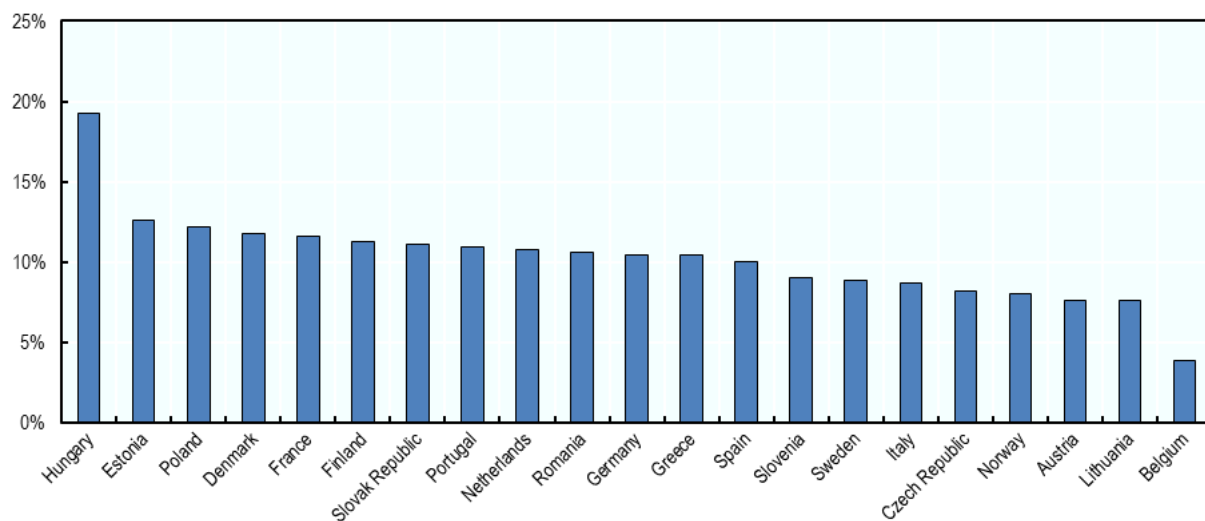
Food & Bio Cluster Denmark has taken responsibility from other major industry organisations for supporting start-ups and scale-ups in the food and bio resources sector, particularly with respect to innovation. By introducing disruptive technologies, new firms are a key source of innovation in the food & bio sector and an important driver of the green transition. Around one-fifth of the members of Food & Bio Cluster Denmark are start-ups. Furthermore, the cluster organisation has a clear strategy for supporting its start-ups through networking with other companies and universities and directing them towards funding sources. The cluster organisation also supports the incubation process, with three different incubators in three separate locations. Discussions are in progress regarding the launch of a large accelerator for start-ups with a narrow focus on a specific field, for example alternative proteins. This is where there is expertise in the cluster organisation. There is evidence that the business environment is now much more promising and the cluster organisation saw three real scale-ups financed in 2020 including for robots and new intelligent farming machinery and the first insect farm in Denmark.² The evidence suggests that there are promising prospects for scale-ups. 60-65 companies are hosted in the incubator and another 68 start-ups are located in the cluster. That is far from the entire group of relevant start-ups. There may be in total some 500 start-ups and scale-up companies, of which 200 are pre-start-ups, 200 that are really interesting, and 25-30 that are already scaling up.

International comparisons of Denmark's start-up and scale-up performance

Start-ups in Denmark

By international standards, Denmark has a dynamic start-up ecosystem. In 2019, the birth rate of employer enterprises in Denmark was 11.8%, which is higher than in most other OECD countries.

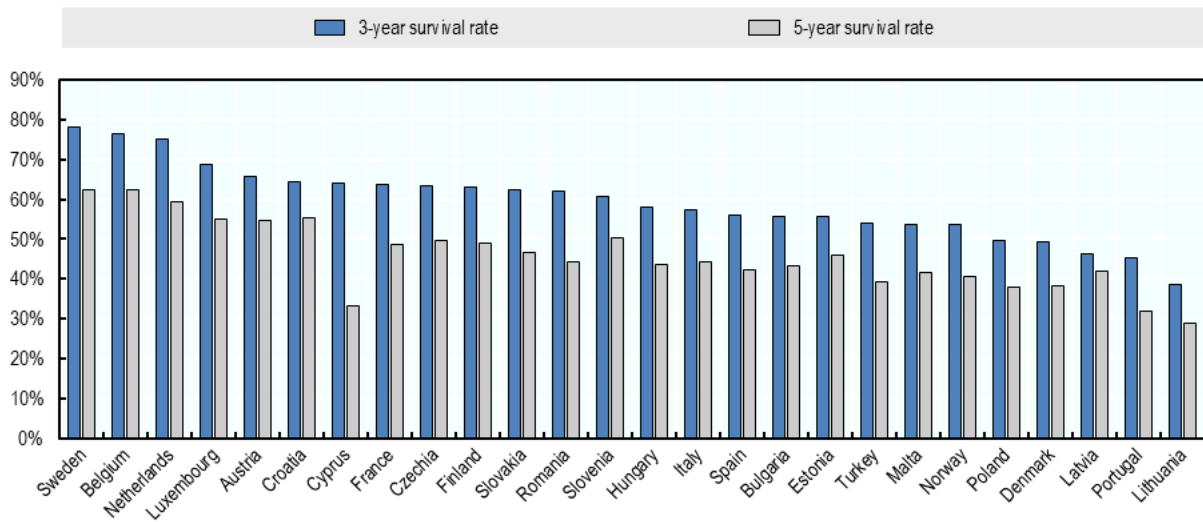
Figure 2.2. Birth rate of employer enterprises, 2019



Source: OECD Structural and Demographic Business Statistics

However, the share of newly created businesses that go on to close down in subsequent years is relatively high in Denmark. In 2019, the 3-year business survival rate in Denmark was 49%. This is the fourth lowest business survival rate in Europe. Meanwhile, the 5-year business survival rate in Denmark in 2019 was 38%, the fifth lowest in Europe.

Figure 2.3. Business survival rates

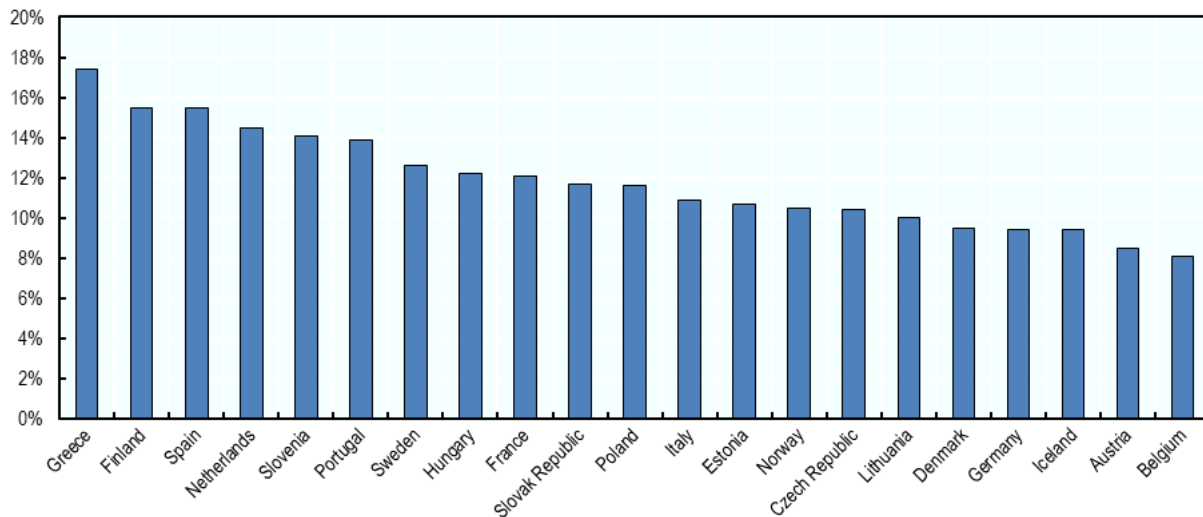


Source: Eurostat

Scale-ups in Denmark

Denmark lags behind its peers when it comes to the rapid growth of its businesses. In 2019, 9.5% of Danish enterprises with at least 10 employees were scale-ups. This figure is among the lowest in the OECD.

Figure 2.4. Rate of high growth enterprises as a percentage of the total population of active enterprises with at least 10 employees, 2019

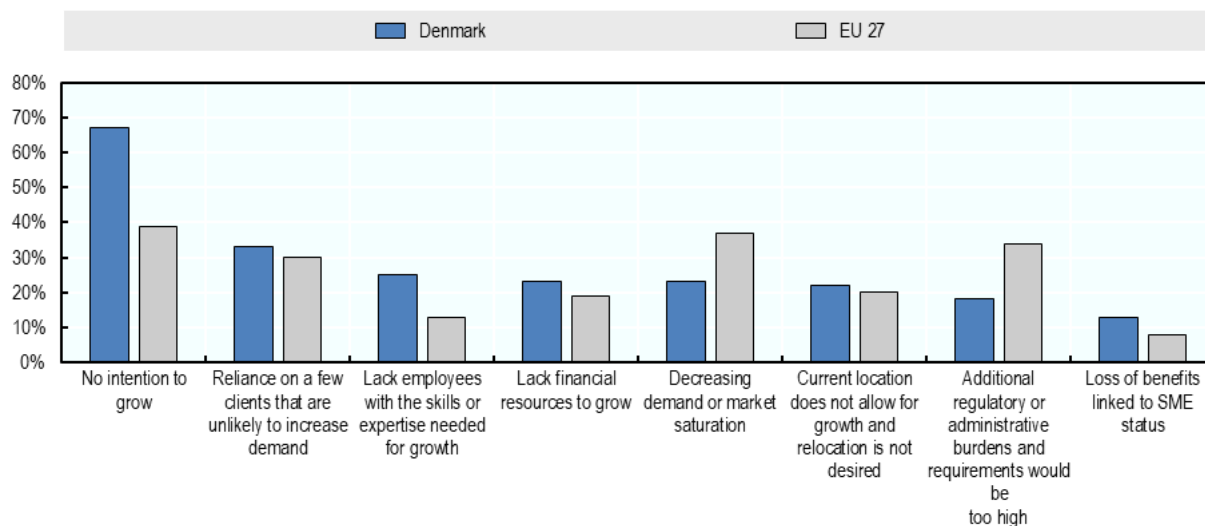


Note: The chart displays the share of businesses with at least 10% average annualised growth of employment over three years, with an employment level of at least 10 at the start of the three-year period.
Source: OECD Structural and Demographic Business Statistics

In 2020, a European Commission Flash Eurobarometer survey examined some of the key factors that constrain business growth in different countries (European Commission, 2020^[27]). Where Denmark stands out is in the share of businesses that do not have the intention to grow beyond their current size. Among

Danish businesses that are not planning to grow, 67% indicated that they had no intention to grow, which is the highest share in Europe. This suggests that a lack of growth ambitions among many Danish companies is an important factor underlying the low scale-up rates in the country. This finding is consistent with the Global Entrepreneurship Monitor's (GEM) Adult Population Survey (APS), which in 2014 found that fewer than one in five (19.1%) of Danes involved in early-stage entrepreneurial activity expected to create six or more jobs over the subsequent five years. With that being said, the share of Danish businesses citing skills shortages and financial constraints as barriers to growth in the Eurobarometer survey is also higher than the EU average (European Commission, 2020^[27]).

Figure 2.5. Barriers to scale up for companies not planning to grow



Source: European Commission Flash Eurobarometer 486

While business creation statistics provide useful insights into the volume of entrepreneurs in a country, it is also important to consider the extent to which these entrepreneurs deliver wider benefits. The innovations associated with entrepreneurial activities are a key way in which these ventures support economic growth. Survey evidence indicates that Danish entrepreneurs perform well in this area. Indeed, in 2020, the European Commission's Flash Eurobarometer survey found that 68% of Danish businesses had introduced an innovation over the preceding 12-month period. This compares to an EU-average of 58% (European Commission, 2020^[27]). Moreover, in the 2014 edition of the GEM survey, nearly half (46%) of Danes involved in early-stage entrepreneurial activities stated that their product or service is new to at least some customers and that few or no businesses offer the same product. This is the second highest share out of the 30 European and North American countries covered by the 2014 GEM, with Luxembourg being the only country in this group to score higher. The European Commission's Flash Eurobarometer survey suggests that the legal and administrative environment is the largest barrier to innovation in Denmark, with 44% of Danish businesses identifying this factor as a barrier to innovation. Only Spain saw a higher share of businesses citing this factor (European Commission, 2020^[27]).

Summary

The results presented above indicate that Denmark's entrepreneurial ecosystem is relatively successful in generating a healthy pipeline of new and innovative businesses. However, the low prevalence of scale-up businesses shows that the entrepreneurial ecosystem is less effective in producing the types of rapidly expanding companies that can make a significant contribution to economic growth.

Start-ups and scale-ups in Denmark's sector strongholds and emerging industries

Scale of sector strongholds and emerging industries

There is a high degree of variation in the scale of Denmark's sector strongholds and emerging industries. In terms of the population of businesses and the level of employment, construction and building is the largest sector, with 7 212 businesses and 287 865 jobs in 2019.³ However, the advanced production sector has the largest economic footprint in terms of revenue, with turnover of DKK 843 billion in 2019. The sector strongholds with the next highest revenue figures are the food and bio resources and construction and building sectors, with turnover of DKK 670 billion and DKK 669 billion in 2019. The smallest sector in terms of employment is the defence, space and security emerging industry, with an employment level of just 13 639 in 2019. Businesses in this sector generated DKK 11 billion in revenue in 2019, which is also the lowest figure out of the sectors analysed. The sector stronghold with the highest productivity is the energy technology sector. In 2019, the revenue per employee in this sector stood at DKK 6.3 million, which is more than double the economy wide average.

Table 2.1. Count, employment, revenue and productivity of businesses in sector strongholds and emerging industries, 2019

	Number of businesses	Employment	Revenue (DKK millions)	Revenue per employee (DKK millions)
All economy	282,487	1,385,073	4,111,653	3.0
Case study sectors				
Food and bio resources	45,123	207,824	669,930	3.2
Advanced production	13,637	256,046	843,452	3.3
Energy technology	9,211	89,979	564,898	6.3
Other sector strongholds and emerging industries				
Construction and building	73,212	287,865	668,761	2.3
Design, fashion and furniture	32,399	132,936	369,367	2.8
Life science and welfare technology	21,619	95,863	329,645	3.4
Maritime industry and logistics	21,474	171,575	688,674	4.0
Tourism	21,272	108,991	169,824	1.6
Digital technologies	19,256	120,963	313,948	2.6
Animation, games and film - emerging industry	11,336	28,558	72,662	2.5
Sound technology	9,670	39,750	99,821	2.5
Finances and financial technology (Fintech)	9,588	86,680	59,863	0.7
Environmental technology	9,381	33,003	78,223	2.4
Robot and drone technology - emerging industry	7,376	59,125	145,115	2.5
Defence, space and security	686	13,639	10,614	0.8

Note: Data include sole proprietorships, limited partnerships, unlimited partnerships and limited liability corporations. Funds, self-owning institutions, government institutions, foreign firms, subsidiaries and cooperatives are not included in the data. The employment figures cover private sector business activity only, not total economy activity. The total employment level in the Danish economy in 2019 was 2 280 998.

Source: Statistics Denmark and the Danish Business Authority

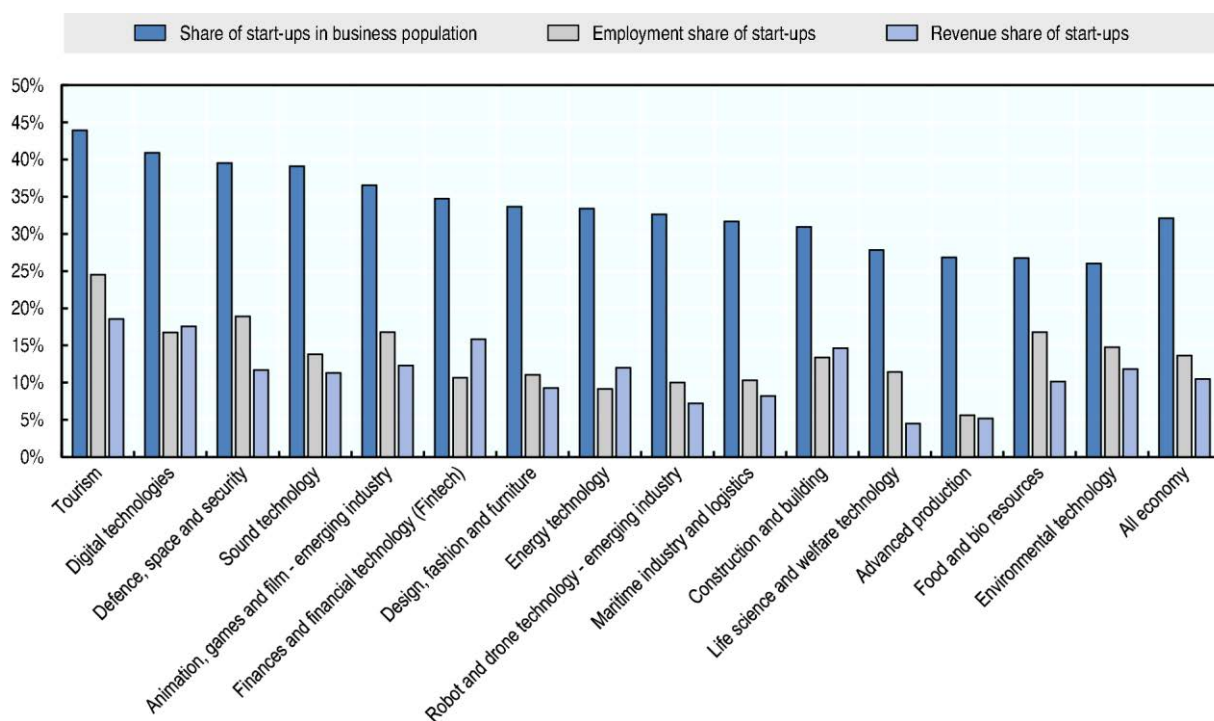
Start-ups within sector strongholds and emerging industries

Economic footprint of start-ups

On average across the 15 sector strongholds and emerging industries, 34% of businesses were start-ups (i.e. aged five years old or younger) in 2019. This is just above the average for the Danish economy. The share of start-ups ranges from 26% in the environmental technology sector to 44% in the tourism sector. In terms of the absolute number of start-ups, the construction and building sector stands out, with 22 656 start-ups in 2019.⁴ Food and bio resources, which was the sector with the next highest number of start-ups, had 12 076 start-ups in 2019. These are also the two sectors that had the highest total population of businesses in 2019. The advanced production and energy technology sectors had 3 662 and 3 076 start-ups in 2019.

Among the sector strongholds and emerging industries, start-ups' contribution to total employment in 2019 ranged from 6% in the advanced production sector to 24% in the tourism sector. In the food and bio resources and energy technology sectors, start-ups' contribution to employment stood at 17% and 9%, respectively. Meanwhile, across the 15 sectors, start-ups' contribution to total revenue ranged from 5% in the life science and welfare technology sector to 19% in the tourism sector.

Figure 2.6. Share of start-ups in business population, employment and revenue, 2019



Source: Statistics Denmark and the Danish Business Authority

Characteristics of start-ups

In 2019, the average employment level in Danish start-ups was two employees. Across the 15 sectors, the average level of employment in start-ups ranged from one employee in the animation, games and film, design, fashion and furniture, and sound technology sectors to ten in the defence, space and security sectors. Among the three case study sectors, the average number of employees is highest in the advanced

production sector, where the average start-up had an employment level of four in 2019. In the energy technology and food and bio resources sectors, the average employment level was three.

Start-ups' average revenue in 2019 was DKK 4.8 million, which compares to an average of DKK 14.6 million among the wider business population. Start-ups in the energy technology sector had the highest turnover, averaging DKK 22.1 million in 2019. Meanwhile, start-ups in the advanced production sector had an average revenue of DKK 11.9 million in 2019. The corresponding figure for start-ups in the food and bio resources sector was DKK 5.6 million.

Table 2.2. Number of start-ups and average employment and turnover in start-ups by sector, 2019

	Number of start-ups	Average employment level of start-ups	Average turnover of start-ups (DKK millions)
All economy	90,621	2.1	4.8
Case study sectors			
Food and bio resources	12,076	2.9	5.6
Advanced production	3,662	3.9	11.9
Energy technology	3,076	2.7	22.1
Other sector strongholds and emerging industries			
Construction and building	22,656	1.7	4.3
Tourism	9,340	2.9	3.4
Design, fashion and furniture	10,903	1.3	3.1
Digital technologies	7,876	2.6	7.0
Maritime industry and logistics	6,800	2.6	8.3
Animation, games and film - emerging industry	4,141	1.2	2.2
Finances and financial technology (Fintech)	3,331	2.8	2.8
Life science and welfare technology	6,021	1.8	2.5
Environmental technology	2,441	2.0	3.8
Sound technology	3,780	1.5	3.0
Robot and drone technology - emerging industry	2,406	2.5	4.4
Defense, space and security	271	9.5	4.6

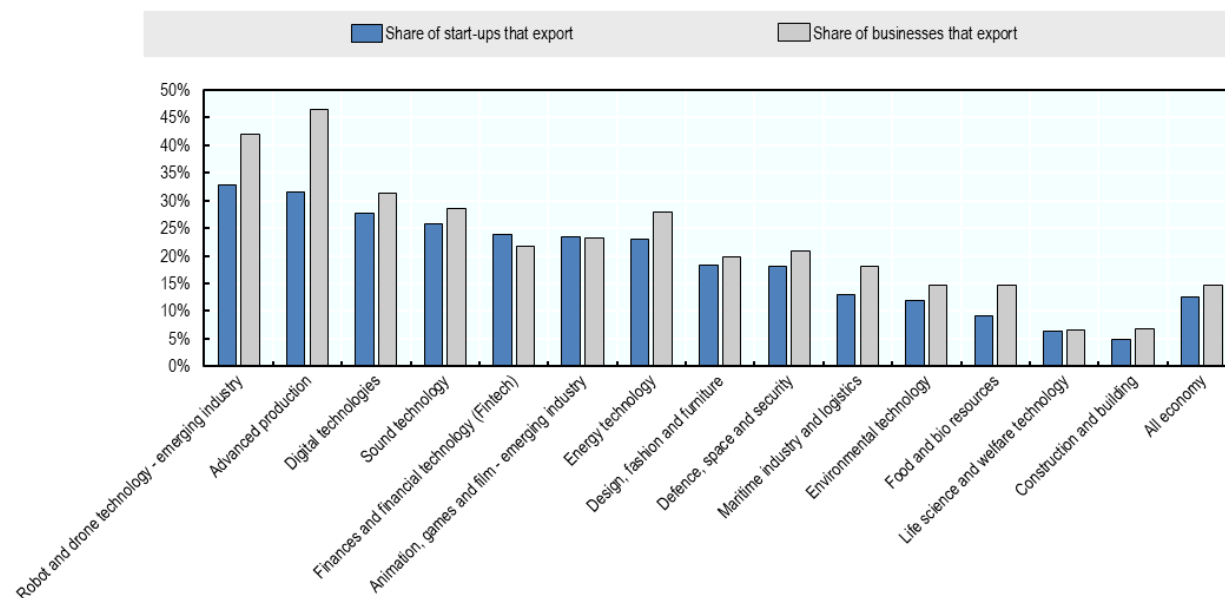
Note: Data include sole proprietorships, limited partnerships, unlimited partnerships and limited liability corporations. Funds, self-owning institutions, government institutions, foreign firms, subsidiaries and cooperatives are not included in the data.

Source: Statistics Denmark and the Danish Business Authority

Export activity of start-ups

In all of Denmark's sector strongholds and emerging industries with the exception of animation, games and film emerging industry and the finances and financial technology sector, start-ups are less likely to export than older businesses. For instance, in the food and bio resources sector, only 9.2% of start-ups were exporters in 2019, compared to a figure of 14.6% for businesses in the sector as a whole. In the advanced production sector, 31.6% of start-ups were exporters in 2019. While this is the second highest share out of the 15 sector strongholds and emerging industries, the figure is 15 percentage points lower than the share of all businesses that export in the advanced production sector.

Figure 2.7. Share of start-ups that export compared to share of all businesses that export, by sector, 2019



Note: The tourism sector has been omitted from the chart because the export concept works differently in tourism. Figures reported here exclude businesses with sales made in Denmark to overseas visitors, which is important in tourism.

Source: Statistics Denmark and the Danish Business Authority

Summary

There is not a large degree of variation in the share of start-ups in the business population between the different sector strongholds and emerging industries. Indeed, the share of start-ups in eight out of the 15 sectors is within five percentage points of the economy-wide average. In terms of employment, the profile of the average start-up across the different sectors is also relatively stable. In 14 out of the 15 sectors, the average number of employees in start-ups was less than five in 2019. In the energy technology and advanced production sectors, start-ups' average revenue was more than double the economy-wide average for start-ups in 2019. Excluding these two sectors, the average revenue of start-ups was within the range of DKK 2.2 million and DKK 8.3 million.

Scale-ups within sector strongholds and emerging industries.

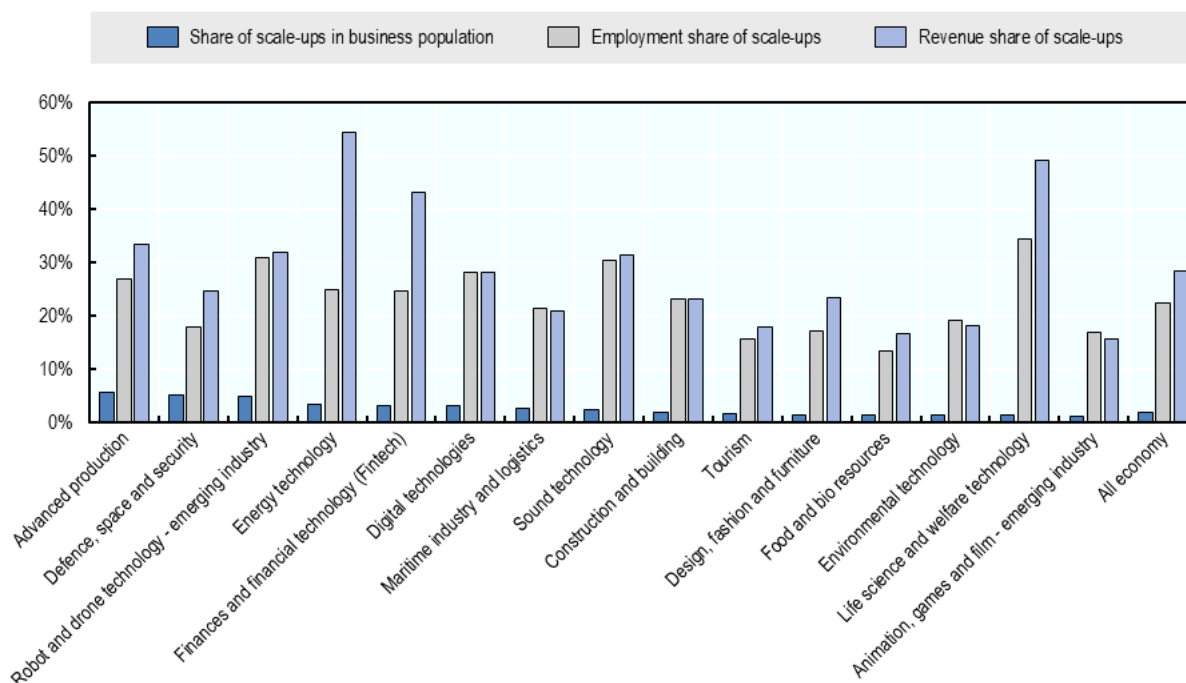
Economic footprint of scale-ups

Scale-up businesses are a rare phenomenon. In 2019, there were 4 957 scale-up businesses in Denmark, representing just 2% of the business population. The construction and building sector had 1 347 scale-ups in 2019, which is by far the highest out of the 15 sector strongholds and emerging industries. In the advanced production, energy technology and food and bio resources sectors, there were 766, 312 and 576 scale-ups in 2019, respectively.

On average across the 15 sectors, scale-ups accounted for 2.6% of businesses in 2019. The advanced production sector had the highest share of scale-ups in 2019, with 5.6% of businesses falling into this category. The lowest share was observed in the animation, games and film emerging industry, where just 1.0% of businesses were scale-ups.

Despite their scarcity, scale-ups have a sizeable economic footprint. In the sector strongholds and emerging industries, scale-ups accounted for an average of 23% of employment and 29% of revenue in 2019. In some sectors, scale-ups' contribution is even greater. For instance, in the life science and welfare technology sector, scale-ups accounted for 34% of employment in 2019. The employment footprint of scale-ups is lower in the three case study sectors. In 2019, scale-ups accounted for 27% of employment in the advanced production sector, 25% of employment in the energy technology sector and 13% in the food and bio resources sector. Meanwhile, scale-ups generated 33% of turnover in the advanced production sector and 17% of turnover in the food and bio resources sector in 2019. This is significantly below the figure of 54% in the energy technology sector.

Figure 2.8. Share of scale-ups in the business population, employment and revenue, 2019



Source: Statistics Denmark and the Danish Business Authority

Characteristics of scale-ups

The average scale-up business in Denmark employed 62 people in 2019 and had a turnover of DKK 235 million. The average employment level of scale-ups in 2019 ranged from 42 in the animation, games and film emerging industry to 121 in the life science and welfare technology sector. Scale-ups in the advanced production sector had an average employment level of 89 in 2019, which was the highest among the three case study sectors. In the energy technology and food and bio resources sectors, the average employment level among scale-ups was 71 and 48, respectively. The average revenue among scale-ups in the energy technology sector was DKK 984 million in 2019, which was the highest out of the 15 sector strongholds and emerging industries. Scale-ups in the advanced production sector had an average turnover of DKK 368 million in 2019, while those in the food and bio resources sector had an average turnover of DKK 192 million.

Table 2.3. Number of scale-ups and average employment and turnover in scale-ups by sector, 2019

	Number of scale-ups	Average employment level of scale-ups	Average turnover of scale-ups (DKK millions)
All economy	4,957	62.2	235.3
Case study sectors			
Advanced production	766	89.4	367.7
Food and bio resources	576	48.4	192.5
Energy technology	312	71.4	983.7
Other sector strongholds and emerging industries			
Construction and building	1,347	49.1	114.1
Digital technologies	568	59.5	155.4
Maritime industry and logistics	553	65.8	260.2
Design, fashion and furniture	429	52.7	200.0
Robot and drone technology - emerging industry	348	52.3	132.9
Tourism	321	53.2	94.5
Finances and financial technology (Fintech)	285	74.5	90.4
Life science and welfare technology	272	120.9	595.4
Sound technology	222	54.0	141.0
Environmental technology	130	48.6	107.9
Animation, games and film - emerging industry	113	42.2	99.3
Defense, space and security	34	71.3	76.7

Note: Data include sole proprietorships, limited partnerships, unlimited partnerships and limited liability corporations. Funds, self-owning institutions, government institutions, foreign firms, subsidiaries and cooperatives are not included in the data.

Source: Statistics Denmark and the Danish Business Authority

Summary

Although the share of scale-ups in the business population is less than 5% in 14 out of the 15 sectors, the variation in the share of scale-ups across sectors is somewhat higher than is the case for start-ups. In the advanced production, robot and drone technology, and defence, space and security sectors, the share of scale-ups is more than double the economy-wide average. The average employment and turnover of scale-ups is in the same order of magnitude in each of the sector strongholds and emerging industries. With that being said, the characteristics and challenges of a company with 42 employees (the average employment level among scale-ups in the animation, games and film emerging industry) will differ from those of a company with 121 employees (the average employment level among scale-ups in the life science and welfare technology sector). This suggests that it could be beneficial to tailor policy interventions in a way that reflects the characteristics of scale-ups in the targeted sector.

Growth of sector strongholds and emerging industries

All businesses

Between 2010 and 2019, employment levels increased in all of the 15 sector strongholds and emerging industries with the exception of the finances and financial technology sector, where employment declined at an annualised rate of 1.3%. The average annualised growth rate of employment between 2010 and 2019 was 1.6% among the 15 sector strongholds and emerging industries, which was in line with the total business economy. Revenue increased in all of the sector strongholds and emerging industries with the exception of the finances and financial technology sector. The average annualised growth rate of revenue across the 15 sectors was 4.0% between 2010 and 2019.

Start-ups

Across all sectors of the Danish economy, 143 113 businesses were created between 2010 and 2019. The construction and building sector had 33 871 new businesses created during this period, which is the highest out of the 15 sector strongholds and emerging industries. The next highest value was in the food and bio resources sector, with 21 746 businesses created between 2010 and 2019. In the advanced production sector, 5 638 new businesses were formed between 2010 and 2019, while in the energy technology sector there were 5 173 newly created businesses. As a share of the business stock in 2010, new business creation in 2010-2019 was relatively high in energy technology, but below the all economy average in food and bio resources and advanced production. Start-up rates over this period were particularly high in digital technologies; tourism; defence, space and security; sound technology; and animation, games and film.

Table 2.4. Number of businesses created between 2010 and 2019, by sector

Sector	Number of businesses created between 2010 and 2019	Number of businesses created between 2010 and 2019 as a share of business population in 2010
All economy	143,113	55%
Case study sectors		
Food and bio resources	21,746	44%
Advanced production	5,638	42%
Energy technology	5,173	60%
Other sector strongholds and emerging industries		
Construction and building	33,871	50%
Design, fashion and furniture	17,956	61%
Tourism	15,509	85%
Digital technologies	13,008	85%
Maritime industry and logistics	10,190	47%
Life science and welfare technology	7,594	37%
Animation, games and film - emerging industry	6,699	72%
Sound technology	5,448	73%
Finances and financial technology (Fintech)	5,048	54%
Environmental technology	3,983	44%
Robot and drone technology - emerging industry	3,575	52%
Defense, space and security	423	78%

Note: Data include sole proprietorships, limited partnerships, unlimited partnerships and limited liability corporations. Funds, self-owning institutions, government institutions, foreign firms, subsidiaries and cooperatives are not included in the data.

Source: Statistics Denmark and the Danish Business Authority

Between 2010 and 2019, the population of Danish start-ups declined at an annualised rate of 0.1%. Only six out of the 15 sector strongholds and emerging industries experienced an increase in the number of start-ups between 2010 and 2019. The economic contribution of start-ups in many sectors was also on the decline during this period. Indeed, employment in start-ups fell between 2010 and 2019 in ten out of the 15 sector strongholds and emerging industries. The sharpest drop took place in the design, fashion and furniture sector, where employment in start-ups contracted at an annualised rate of 4.6% between 2010

and 2019. Start-ups' collective turnover fell in eight out of the 15 sector strongholds and emerging industries during the same period.

Scale-ups

Overall, the economic footprint of scale-ups has been growing. The number of scale-ups increased in all of the sector strongholds and emerging industries between 2010 and 2019. Meanwhile, employment in scale-ups increased between 2010 and 2019 in 11 of the sectors. The fastest growth was seen in the construction and building sector, where employment in scale-ups rose at an annualised rate of 7.8% between 2010 and 2019. Revenue generated by scale-ups rose in 13 of the sector strongholds and emerging industries between 2010 and 2019, although declines were registered in the defence, space and security sector and the animation, games and film emerging industry.

Table 2.5. Annualised rate of growth of the number, employment and revenue of start-ups, scale-ups and all businesses in sector strongholds and emerging industries between 2010 and 2019

	Start-ups			Scale-ups			All businesses		
	Number	Employment	Revenue	Number	Employment	Revenue	Number	Employment	Revenue
All economy	-0.1%	-0.1%	0.5%	5.2%	2.7%	7.3%	1.0%	1.6%	4.2%
Case study sectors:									
Energy technology	0.0%	-0.9%	5.7%	6.2%	2.1%	17.4%	0.7%	2.0%	6.9%
Advanced production	-0.9%	-1.0%	-0.6%	6.6%	2.7%	6.3%	0.2%	1.6%	5.6%
Food and bio resources	0.1%	2.1%	0.1%	3.4%	-1.5%	2.3%	-1.1%	2.3%	3.0%
Other sector strongholds and emerging industries:									
Sound technology	1.9%	0.5%	0.0%	4.8%	3.5%	7.2%	2.9%	1.0%	2.8%
Digital technologies	1.2%	4.1%	8.0%	4.0%	0.7%	0.7%	2.7%	1.4%	3.4%
Defence, space and security	0.0%	15.7%	10.2%	3.9%	-4.8%	-1.5%	2.6%	0.7%	4.6%
Animation, games and film - emerging industry	0.9%	-2.4%	-3.9%	2.6%	-2.3%	-3.4%	2.2%	0.7%	1.7%
Tourism	2.2%	2.1%	0.6%	4.0%	-2.7%	0.6%	1.8%	3.5%	3.4%
Design, fashion and furniture	-0.2%	-4.6%	-4.8%	5.2%	4.3%	8.8%	1.0%	1.0%	3.1%
Construction and building	-0.8%	0.0%	3.2%	10.2%	7.8%	11.9%	1.0%	2.0%	4.6%
Robot and drone technology - emerging industry	-0.2%	-0.5%	-1.4%	6.4%	5.4%	7.9%	0.9%	2.3%	4.7%
Life science and welfare technology	-2.8%	0.4%	-1.0%	4.1%	1.8%	6.2%	0.6%	2.6%	6.0%
Environmental technology	-2.0%	-2.5%	-7.4%	5.0%	0.4%	4.1%	0.3%	2.3%	3.1%
Finances and financial technology (Fintech)	-1.1%	-1.0%	-1.8%	2.2%	2.5%	7.9%	0.3%	-1.3%	-0.1%

	Start-ups			Scale-ups			All businesses		
	Number	Employment	Revenue	Number	Employment	Revenue	Number	Employment	Revenue
Maritime industry and logistics	-0.6%	-3.1%	-0.7%	2.7%	1.4%	6.3%	-0.2%	1.1%	7.1

Note: Data include sole proprietorships, limited partnerships, unlimited partnerships and limited liability corporations. Funds, self-owning institutions, government institutions, foreign firms, subsidiaries and cooperatives are not included in the data.

Source: Statistics Denmark and Danish Business Authority

Summary

Between 2010 and 2019, the population and economic contribution of start-ups was falling in many of the sector strongholds. However, the economic footprint of scale-ups grew considerably during the same period. Across the sector strongholds and emerging industries, the share of start-ups in the business population ranges from 26% to 44%. Scale-ups are less prevalent, accounting for less than 5% of businesses in 14 out of the 15 sectors. In proportional terms, the cross-sector variation in the share of scale-ups is significantly higher than that of start-ups, which is fairly modest. Differences in the average size of start-ups and in particular scale-ups across the sector strongholds and emerging industries indicate that the extent of the size-related barriers discussed earlier in this section may also vary between sectors. This suggests that sector-specific policy interventions could help to ensure that the needs of different types of businesses are met.

Box 2.2. Summary portrait of advanced production, energy technology and food and bio resources sector strongholds

This Box provides a summary portrait of start-ups and scale-ups in the three case study sectors that are analysed in detail in Chapters 3, 4 and 5 of this report.

Economic footprint of start-ups and scale-ups

Figure 2.9 shows that start-ups in the advanced production sector make an unusually small contribution to total employment and turnover in the sector. Start-ups in the energy technology sector account for a larger than average share of turnover but a smaller than average share of employment. In the food and bio resources sector, the converse is true: start-ups' contribution to total employment in the sector is greater than the economy-wide average but their contribution to turnover is below average.

There is a different pattern when it comes to the economic footprint of scale-ups in the three sectors. In the food and bio resources sector, scale-ups' contribution to both employment and turnover is significantly below the economy-wide average, while in the advanced production sector, scale-ups account for an above average share of employment and turnover. Meanwhile, scale-ups in the energy technology sector accounted for 54% of total turnover in the sector in 2019, which is nearly double the economy-wide average.

Figure 2.9. Start-ups and scale-ups' contribution to employment and turnover by sector, 2019



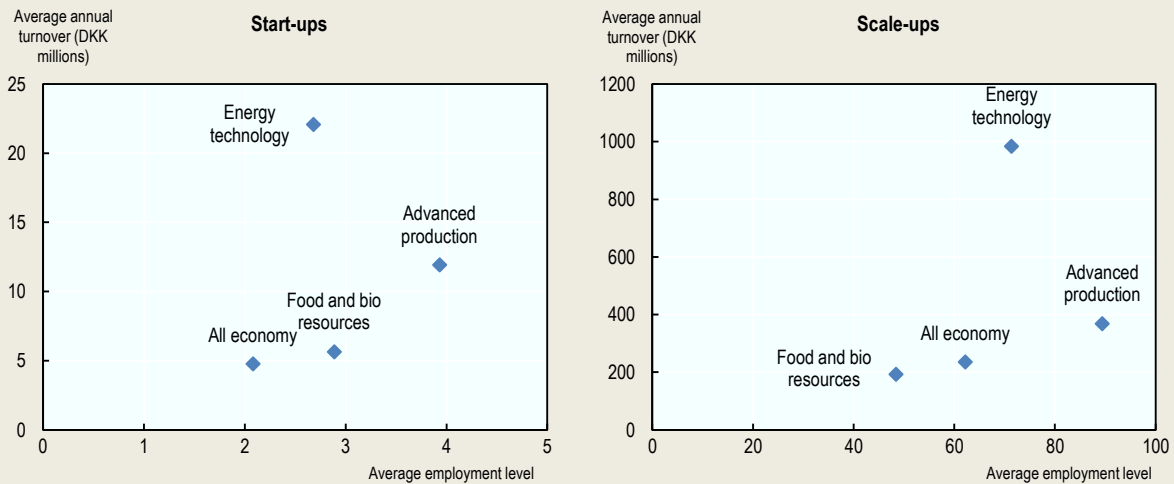
Source: Danish Business Authority, Statistics Denmark

Characteristics of start-ups and scale-ups

There is significant variation in the average size of start-ups and scale-ups in the advanced production, energy technology and food and bio resource sectors. Figure 2.10 shows that, in terms of average turnover, start-ups and scale-ups in the energy technology sector dwarf their counterparts in other sectors of the Danish economy. In 2019, the average turnover of a start-up in the energy technology was DKK 22 million, which is more than four times higher than the economy-wide average for start-ups. Start-ups and scale-ups are also larger than average in the advanced production sector, particularly along the employment dimension. In 2019, the average employment level of start-ups in the advanced production sector was higher than in any of the other sector strongholds and emerging industries, while the average employment level of scale-ups was higher only in the life science and welfare technology sector. The average level of turnover among start-ups and scale-ups in the food and bio resources sector is close to

the average observed across all sectors of the Danish economy. However, start-ups in the food and bio resources sector, on average, employ one more person than the average Danish start-up, while scale-ups employ 14 fewer people.

Figure 2.10. Average employment level and annual turnover of start-ups and scale-ups by sector, 2019



Source: Danish Business Authority, Statistics Denmark

References

- Audretsch, D. (2012), “Determinants of High-Growth Entrepreneurship”, *High-growth firms: local policies and local determinants* March. [3]
- Bagilhole, B., A. Dainty and R. Neale (2000), “WOMEN IN THE CONSTRUCTION INDUSTRY IN THE U.K.: A CULTURAL DISCORD?”, *Journal of Women and Minorities in Science and Engineering*, Vol. 6/1, <https://doi.org/10.1615/jwomenminorscieng.v6.i1.40>. [19]
- Block, J. et al. (2018), “New players in entrepreneurial finance and why they are there”, *Small Business Economics*, Vol. 50/2, <https://doi.org/10.1007/s11187-016-9826-6>. [9]
- Bosma, N. et al. (2021), *GEM Global Entrepreneurship Monitor 2020/2021*. [15]
- Cafferata, R., G. Abatecola and S. Poggese (2009), *Revisiting Stinchcombe's 'liability of newness': A systematic literature review*, <https://doi.org/10.1504/IJGSB.2009.032258>. [14]
- Carpenter, R. and B. Petersen (2002), “Capital market imperfections, high-tech investment, and new equity financing”, *Economic Journal*, Vol. 112/477, <https://doi.org/10.1111/1468-0297.00683>. [7]
- Charney, A. and G. Libecap (2011), “The Impact of Entrepreneurship Education: An Evaluation of the Berger Entrepreneurship Program at the University of Arizona, 1985-1999”, *SSRN Electronic Journal*, <https://doi.org/10.2139/ssrn.1262343>. [26]

- Cusmano, L. (2015), "New approaches to SME and Entrepreneurial Financing: Broadening the Range of Instruments", *OECD Analytical Report*. [5]
- Demirel, P. et al. (2019), "Born to be green: new insights into the economics and management of green entrepreneurship", *Small Business Economics*, Vol. 52/4, <https://doi.org/10.1007/s11187-017-9933-z>. [18]
- Denis, D. (2004), "Entrepreneurial finance: An overview of the issues and evidence", *Journal of Corporate Finance*, Vol. 10/2, [https://doi.org/10.1016/S0929-1199\(03\)00059-2](https://doi.org/10.1016/S0929-1199(03)00059-2). [8]
- European Commission (2021), *Survey on the access to finance of enterprises (SAFE) Analytical Report 2021*, European Commission. [6]
- European Commission (2020), *SMEs, start-ups, scale-ups and entrepreneurship*. [28]
- European Commission / OECD (2019), "Policy Brief on Incubators and Accelerators that Support Inclusive Entrepreneurship", *OECD SME and Entrepreneurship Papers*, Vol. No. 13. [21]
- Fraser, S., S. Bhaumik and M. Wright (2015), "What do we know about entrepreneurial finance and its relationship with growth?", *International Small Business Journal: Researching Entrepreneurship*, Vol. 33/1, <https://doi.org/10.1177/0266242614547827>. [10]
- Freund, C. and D. Weinhold (2002), "The Internet and International Trade in Services", *American Economic Review*, Vol. 92/2, <https://doi.org/10.1257/000282802320189320>. [16]
- Hayter, C. (2013), "Conceptualizing knowledge-based entrepreneurship networks: Perspectives from the literature", *Small Business Economics*, Vol. 41/4, <https://doi.org/10.1007/s11187-013-9512-x>. [23]
- Kritikos, A. (2014), "Entrepreneurs and their impact on jobs and economic growth", *IZA World of Labor*, <https://doi.org/10.15185/izawol.8>. [2]
- Leonidou, L. (2004), "An analysis of the barriers hindering small business export development", *Journal of Small Business Management*, Vol. 42/3, <https://doi.org/10.1111/j.1540-627x.2004.00112.x>. [12]
- Nedayvoda, A. et al. (2021), *Financing Deep Tech*, World Bank Group. [17]
- OECD (2021), *OECD SME and Entrepreneurship Outlook 2021*, OECD Publishing, Paris, <https://doi.org/10.1787/97a5bbfe-en>. [1]
- OECD (2021), *Understanding Firm Growth: Helping SMEs Scale Up*, OECD Studies on SMEs and Entrepreneurship, OECD Publishing, Paris, <https://dx.doi.org/10.1787/fc60b04c-en>. [4]
- OECD (2020), *International Compendium of Entrepreneurship Policies*, OECD Studies on SMEs and Entrepreneurship, OECD Publishing, Paris, <https://doi.org/10.1787/338f1873-en>. [11]
- OECD (2019), "Enabling SMEs to Scale Up", in *Strengthening SMEs and Entrepreneurship for Productivity and Inclusive Growth: OECD 2018 Ministerial Conference on SMEs*, OECD Publishing, Paris, <https://doi.org/10.1787/7fb3ae20-en>. [22]
- OECD (2009), *Clusters, Innovation and Entrepreneurship*. [25]
- OECD Publishing (2020), *Financing SMEs and Entrepreneurs 2020: An OECD Scoreboard*. [20]

- Oosterbeek, H., M. van Praag and A. Ijsselstein (2010), "The impact of entrepreneurship education on entrepreneurship skills and motivation", *European Economic Review*, Vol. 54/3, <https://doi.org/10.1016/j.euroecorev.2009.08.002>. [27]
- Porter, M. (1998), "Clusters and the new economics of competition.", *Harvard business review*, Vol. 76/6. [24]
- Stinchcombe, A. (1965), "Social structure and organizations", *Handbook of Organizations*. [13]

Notes

¹ <https://clustercollaboration.eu/news/14-new-superclusters-launched-denmark>

² <https://foodnationdenmark.com/news/danish-company-builds-the-norths-largest-insect-factory/>

³ Firms that are registered in the Danish Central Business Register have been allocated to different sector strongholds or emerging industries based on the NACE code of their main industry. There is a degree of overlap between the sector strongholds and emerging industries, meaning that a single NACE code can apply to multiple sector strongholds or emerging industries. For each sector, the figures reported include businesses with NACE codes that exclusively belong to that sector as well as businesses with NACE codes that belong to both that sector and one or more other sectors.

⁴ The population and characteristics of start-ups in different sectors will be influenced by idiosyncratic organisational practices. For instance, in the construction and building sector, the population of start-ups will be affected by the presence of companies that are formed specifically for a project and are later closed down following the conclusion of the project.

3. Advanced production

Out of the 15 sector strongholds and emerging industries, the advanced production sector has the largest economic footprint. It is notable for its high level of exporting, with nearly half of firms exporting in 2019. Its central strategic position in the Danish economy is also reflected in the Danish Growth Fund's funding priorities. However, evidence from the stakeholder interviews conducted for this report suggests that there are a number of challenges facing start-ups and scale-ups that need to be addressed. This chapter develops policy recommendations for Denmark's advanced production sector. This is informed by an analysis of the key opportunities and barriers for start-ups and scale-ups in the sector, followed by an examination of specific policy initiatives in Austria, Sweden and Canada.

Policy recommendations for Denmark's advanced production sector

- **Develop funding models** that address the long timeframe needed for deep-tech and hardware start-ups and scale-ups to become sustainable businesses.
- **Encourage closer collaboration between advanced production companies and universities.** This should cover inter alia: joint applied research, joint development of products, joint exploitation of intellectual property (IP), students involved with the company, and syllabus development and planning.
- **Increase the representation of start-ups and scale-ups** in the membership, committees and strategy making processes of the Manufacturing Academy of Denmark (MADE) national cluster organisation in order to secure more start-up and scale-up focused projects and initiatives and their inclusion in broader cluster projects.
- **Broker effective relationships between larger firms and start-ups and scale-ups.** The brokerage should focus on matchmaking between large firms and start-ups and scale-ups with complementary competences. The aims should include encouraging large firms to take roles in acting as first customers for start-ups and scale-ups, acting as open innovation partners, offering technology support to reinforce supply chain resilience, and participation in incubator and accelerator activities.
- **Promote a closer and more systematic co-operation between MADE and regional entrepreneurial ecosystem actors,** since spatial proximity better supports start-ups and scale-ups.
- **Provide MADE with longer-term and freer funding on a competitive bidding basis,** accompanied by regular evaluations, to enable it to take more strategic actions for start-ups and scale-ups.
- **Alleviate talent shortages** by working with other clusters and universities, as well as by addressing the lack of diversity in the sector.
- **Strengthen the visibility and branding of entrepreneurial successes** in the sector.

Introduction

The advanced production sector stronghold covers activities in the areas of manufacturing and automation technology. In Denmark, a significant portion of this sector is engaged in the manufacture of machinery. In 2019, 5.6% of businesses in the advanced production sector were scale-ups, making this the sector stronghold with the highest concentration of scale-ups. Despite this relatively strong performance, there exist numerous barriers to the formation and subsequent growth of businesses, which are partially reflected in the low density of start-ups that exist in Denmark's advanced production sector. This section describes the following obstacles that start-ups and scale-ups face in the advanced production sector:

1. Difficulties entering the supply chain
2. The structure of the Manufacturing Academy of Denmark (MADE)
3. The role of large firms
4. The role of regional clusters and ecosystems
5. Long development timescales

6. Access to finance
7. Branding, incubation and acceleration
8. Talent shortages
9. The role of universities
10. Public procurement
11. Testing facilities
12. Lack of diversity

This is followed by an in-depth review of relevant international policy experiences to address such barriers in Austria, Sweden and Canada.

Box 3.1. A promising advanced manufacturing start-up in Denmark – Technicon

A company that has gained a lot from joining MADE is Technicon, which grew from a two-man start-up 7 years ago to having more than 60 employees in 2022. Technicon joined MADE as it could provide very innovative machine solutions but needed a machine builder willing to take some risks and work on things coming out of the research. MADE enabled it to develop such a relationship and build numerous sales in parallel with developing the new product.

Barriers to start-ups and scale-ups

Difficulties in entering the supply chain

In 2019, the advanced production sector had less than a third the number of start-ups as the food and bio resources sector. A particular challenge identified by MADE is that some global manufacturing companies are hesitant about embedding start-ups' technologies into their global production lines. This is due to uncertainty surrounding whether the start-ups are robust enough to reliably deliver products over the longer term. Large firms in the industry should offer technology support to start-ups in an effort to support the integration of start-ups into their supply chains.

The nature of the advanced production sector in Denmark further limits the number of new firms entering the industry. Denmark specialises in machine building. As a consequence, the enterprise base is dominated by established SMEs building machine assembly equipment for the manufacturing industry rather than new start-ups developing disruptive technologies that drive innovation, customised solutions built on standardised and modularised platforms, expanded after-sales/service offerings or circular products and business models. Moreover, without a dominant defence or automotive industry, much work is undertaken in niches.

The structure of MADE

MADE was established in 2014 by a group of advanced manufacturing businesses in conjunction with some eminent universities as a non-profit association in order to encourage major companies to manufacture in Denmark instead of offshoring. These original aims are reflected in the composition of MADE's board, which is weighted towards industry or representatives from large companies. The board has a very small proportion of start-up and SME representatives. This lack of representation inhibits an in-depth understanding within MADE of how the sector as a whole could benefit from the innovation and agility of new and growing firms. MADE intends to boost the representation of SMEs through an anticipated increase in membership numbers and changes to its management structures. These are positive first

steps. However, the fact remains that the purpose of MADE's creation was to support the competitiveness of its members rather than that of the Danish economy as a whole, so it has consequently not had entrepreneurship or start-ups woven into its vision and practices. The limited presence of SMEs, start-ups and scale-ups also limits the potential knowledge spillovers of the intra-cluster knowledge system.

Another issue for MADE is its lack of long-term guaranteed government funding. Currently, only four years government funding is provided for running core cluster activities (promoting stronger cooperation within the cluster and between cluster firms and external organisations, e.g. universities), whereas EU state aid rules permit the basic funding of innovation clusters for up to 10 years. Other activities must be based on project funding as well as membership fees and private finance. These activities include research and development to increase the innovation activities of the cluster's firms and the development and implementation of special programmes to support start-ups and scale-ups. This cluster funding model contrasts to that found in other countries. For example, in Norway and Sweden, cluster organisations can in normal cases be funded for at least ten years. The relatively high reliance on short-term project funding for cluster organisations in Denmark leads to insufficient funding remaining for long-term strategic tasks.

The role of large firms

The importance of large firms in the advanced production sector can create a barrier to the progress of start-ups and, in particular, scale-ups, if large firms prioritise supply chain resilience and determine that innovative collaborations are too risky. MADE is working with other organisations, including universities, through conferences, workshops and mini-projects in order to help start-ups and scale-ups implement new technologies in their own companies. This helps ameliorate some of the risks for both scale-ups and large firms and their supply chains. The collaborations supported by MADE will create bigger and more internationally competitive companies by facilitating technological advancement within established companies and by helping new companies to better integrate into the market.

Culture is another barrier to start-ups and scale-ups in the advanced production sector in Denmark. Most large companies in the sector do not have an investment arm that works to generate spin-off companies or support start-ups. There is therefore a need for a partner organisation to support large firms in their interactions with start-ups and potential spin-outs. MADE is clearly an actor that can do this, although other start-up community actors could also undertake this sort of activity. Whichever organisation is involved they must be one that has a start-up culture of their own.

An issue that has been identified for the sector as a whole is that manufacturers need to adopt a customer-centric mindset and evolve business models to connect products using digitisation (EY, 2022^[1]). As newcomers to the market, start-ups and scale-ups could play a key role in changing the culture within the advanced production sector.

The importance of large firms in the advanced production sector means that collaboration between established firms and recent entrants is key to supporting start-ups and scale-ups. Brokering such collaborations should be an activity that MADE engages in more. Positioning start-ups and scale-ups within the manufacturing value chain is also important. A further issue is sustainability. Large companies will not invest in a new company with an exit strategy in place. Instead, they want long-term commitment to ensure a reliable production line.

The role of regional clusters and regional entrepreneurial ecosystems

Several interviewees emphasised that geographical proximity between stakeholders is especially important in supporting the development of start-ups and scale-ups. A frequently cited example is Odense Robotics, where a close spatial, organisational, and social proximity between industry, universities, municipalities, entrepreneurs and investors has facilitated successful outcomes. There is a role for MADE

in establishing co-operation channels between itself and regional entrepreneurial ecosystems in order to promote innovation, start-ups and scale-ups.

Long development timescales

In the advanced production sector, start-ups and scale-ups typically need 5-7 years before they are able to start to market new products. This is unlike the situation in software, for example. However, those start-ups and scale-ups that do make it to market with the necessary investment potentially represent the future in a rapidly changing sector. Denmark has the ambition of creating more scale-ups in advanced manufacturing and other sectors. However, in the case of advanced manufacturing this requires patient support involving a strong long-term investment capital strategy that fits with the time to market for new products in the sector.

Access to finance

A major barrier to start-ups and scale-ups in the advanced production sector is insufficient access to the large-scale capital resources needed, especially in the deep tech and hardware areas. Indeed, MADE has already identified more stable long term financing as the most pressing need for the sector. Other sources also suggest that both early-stage and later-stage companies in many sectors have trouble accessing loans (TechBBQ and Vaekstfonden, 2019^[2]). The result is that promising and dynamic new firms may cease trading within a relatively short period of time after having failed to attract capital.

A sustainable financial ecosystem is dependent upon collaboration between the ecosystem stakeholders (TechBBQ and Vaekstfonden, 2019^[2]). This is particularly true in the advanced production sector. Collaborations should involve philanthropic funds, such as the Novo Nordisk and Carlsberg Foundations, as well as private investors and larger companies. An example of a funding initiative within the hard tech ecosystem is TechStation Invest, which invests in innovative hard-tech companies with products that are still at the development stage. TechStation Invest expects market launch to be a maximum of 24 months away from the time of investment, with typical investment sizes ranging from DKK 500 000 to DKK 5 million.

Branding, incubation and acceleration

Start-ups and scale-ups need help with branding to give them international visibility. An example of this assistance is the support provided to Technicon by the Foreign Ministry to help the company to export.

Incubation and acceleration support is also typically a key element of start-up and scale-up support. They help address key challenges for start-ups and scale-ups include in the areas of having minimum viable product thinking and discriminating successfully between what is needed and not needed. There are a number of initiatives in place, including the collaboration between MADE and Accelerace on the Beyond Beta programme, which also involves the 13 other national cluster organisations. Another relevant programme is the Technical University of Denmark's Danish Tech Challenge, which supports 20 hardware start-ups each year by providing mentoring, workshops and access to investors. In addition, TechStation is a key technology incubator in Denmark with an associated investment arm, TechStation Invest. Following incubation, TechStation incubatees leave to go to their own premises or to accelerators. However, more incubation and acceleration activity is needed for the advanced production sector, such as guidance, demonstration projects, and development projects, which focus specifically on start-ups and scale-ups through successful incubation and acceleration.

Talent shortages

One of the main challenges for start-ups and scale-ups in the advanced production sector is finding employees, in particular engineers and talented researchers. Denmark has a shortage of the engineers

and other skilled personnel needed to drive growth and innovation within industrial companies (Sorivelle, 2018^[3]). MADE reports that the greatest challenge in this area is finding candidates with technical knowledge of computer science that can then be integrated into manufacturing. Moreover, knowledge and skills in the field of robotics are needed to take on evolving technologies. These skills are also in high demand internationally.

The role of universities

Linking to the skills shortages identified above, some of the stakeholders interviewed have suggested that there is scope for universities and university colleges to create further programmes that develop skills that are more aligned with the needs of the advanced production sector.

Some larger companies engage with universities over PhD students, but this practice is limited among SMEs. MADE's educational track is currently working with universities, university colleges and vocational training schools to develop more technicians and graduates. This programme could be expanded to involve SMEs, creating groups of players that work on a topic and develop solutions. This would enable the businesses to become more embedded within the ecosystem.

Danish universities also provide more direct assistance to start-ups and scale-ups. For example, the Technical University of Denmark (DTU) supports start-ups and scale-ups in advanced manufacturing. During the product development phase, DTU helps with approvals, and after businesses have made it to market, it provides assistance in creating after sales service and well-functioning logistics chains. TechStation Invest has a close collaboration with DTU on start-up projects.

In several stakeholder interviews, it was suggested that universities need to be more flexible on intellectual property issues and should provide reasonable access to research for firms of all sizes.

Public procurement and testing and regulation

The European Commission has identified Denmark as a good performer with respect to its public procurement for innovation (PPI) system (European Commission and PWC, 2021^[4]). Denmark's PPI system dates back to 2011, when grants were introduced to public procurers in the municipalities and regions to cover expenses associated with PPI, including market analysis, legal advice and the development of tender materials (Danish Business Authority, 2019^[5]). Between 2011 and 2015, 23 projects were funded under this grant scheme (the initiative ended in 2015). Between 2014 and 2019, Denmark operated a pre-commercial procurement of innovation scheme, which funded feasibility studies and prototype development. Meanwhile, the Innovation Partnerships scheme between 2017 and 2019, which was made possible by the Danish Public Procurement Act in 2016, involved the incorporation of development and procurement into a single contract.

Since 2015, a platform for ideas competition (challenges.dk) has been in place, which has raised awareness of better procurement practices and solutions and has stimulated new markets. However, a number of weaknesses were consistently identified in the stakeholder interviews regarding public procurement. Among these were the difficulty for new and small firms to get onto the approved list of suppliers to government agencies. At least one business has consciously avoided becoming a supplier to government because they feel that the process is too slow and too difficult. These difficulties are partly inherited from EU procedures, although some are also local to Denmark. The interviews suggested that new and small firms are not getting sufficiently involved because procurements are often large and complex for them, leading to work and risks not worth taking. Suggestions for responding to these problems include (not mutually exclusive):

- Effective brokerage to enable SMEs to become involved in a consortium to have access to smaller and more manageable contracts.

- Separately identified procurement of innovative components / finer granularity in general.
- Pre-tender expressions of interest.
- Support through the process for SMEs.
- Improved overview and information on the procurement processes.

Start-ups and scale-ups do not always have good knowledge of the testing facilities available to them. A mapping exercise has therefore been launched to show where piloting and testing facilities are available for start-ups and scale-ups in the advanced production sector. A digital tool provides an overview of the test facilities.¹

Lack of diversity

The advanced production sector has a very low representation of female university graduates and of women in general within the workforce. This lack of diversity contributes to talent shortages and also narrows the range of different perspectives on innovation and entrepreneurship in the sector.

International policy experiences

Austria – Plattform Industrie 4.0²

Overview

Austria has a strong focus on advanced production. In 2020, Austria's manufacturing industry accounted for 18% of GDP (International Trade Administration, 2021^[6]). The industry includes a number of multinational manufacturing firms, although the majority of Austrian firms are small to medium sized businesses with an average of 100 employees. In order for Austrian industry to become more internationally competitive and develop a brand, many companies need to increase their productivity by adopting cutting-edge innovative technologies. Industry 4.0 advanced manufacturing solutions are critically important to this effort.³

This section will examine the actions taken by Plattform Industrie 4.0 to help start-ups and scale-ups to adopt Industry 4.0 manufacturing solutions. It is particularly interesting as an example of support to start-ups and scale-ups in the hardware sector and is of relevance to the advanced production sector in Denmark.

Plattform Industrie 4.0 was established in 2015 as a membership-based non-profit organisation by the Federal Ministry for Transport, Innovation and Technology, the Association for the Electrical and Electronics Industries, the Association of Metaltechnology Industries, the Austrian Federal Chamber of Labour, the Austrian Trade Union for Production Workers and the Federation of Austrian Industries. Membership is open to companies, academic institutions, research organisations, NGOs and other institutions that are Industry 4.0 leaders in Austria. The core mandate of the platform is to facilitate the implementation of Industry 4.0 and to foster collaboration among relevant stakeholders with the aim of creating an innovative industrial production sector and boosting high-quality employment. The organisation considers technological innovation, new business models, knowledge transfer and the widespread deployment and implementation of digital technologies to be the key drivers of Industry 4.0.

The approach of the platform is to bring all stakeholders together to jointly address the challenges and opportunities of Industry 4.0 in an inclusive manner, in order to realise benefits for all parts of the industrial value chain. To do this, it connects relevant suppliers, research institutions, networks, social partners and interest groups from different policy areas and industrial sectors. Plattform Industrie 4.0 has nine thematic expert groups, which work in defined subject areas and consist of experts from their respective fields. The

groups aim for a balance between experts with scientific experience and those with practical and operational experience. Around 500 experts are involved in the work, with the outputs including roadmaps, guidelines, strategies, analytical documents, workshops and events.

Issue 1: Working groups with a focus on support for start-ups and scale-ups

Plattform Industrie 4.0's expert group on security and safety focuses on IT and data security and aims to provide hands-on expertise and best practice use cases for SMEs, including start-ups and scale-ups. Meanwhile, the expert group on pilot factories seeks to create a real and neutral testing and research environment in which development and testing can take place without disrupting ongoing production. This environment is open to both partner and non-partner companies. Research infrastructure, smart production labs and pilot factories are regarded as an important means of addressing challenges faced by SMEs in relation to the digital transformation. For instance, pilot factories facilitate the joint development of new products and processes and act as a test facility for complex and modern manufacturing systems. They are also a focal point for interdisciplinary research (e.g. mechanical engineering, mechatronics, electrical engineering, computer science, ergonomics) and provide an environment for training, further education and industry-related learning.

Issue 2: Qualifications and competences for Industry 4.0

Plattform Industrie 4.0's expert group on qualifications and competencies involves representatives of all founding members, as well as educational institutions, research institutions, policy makers, administrators, companies and interest groups. It acts as a central steering committee to focus on the content alignment of the activities of Plattform Industrie 4.0. The objective of the expert group is to support young people, companies and education and training providers in developing their skills and qualification programmes in a way that proactively exploits the opportunities offered by Industry 4.0 and digitalisation. The focus is:

- Qualification and competence requirements for Industry 4.0;
- Digital infrastructure in education and training and the digital skills of teachers;
- Recognition of non-formally and informally acquired competences.

Issue 3: Co-operation between Plattform Industrie 4.0 and the mechatronics cluster to roll-out the Austrian Industry Maturity Model

The Austrian Industry Maturity Model, developed by the Mechatronics Cluster of Upper Austria and the University of Applied Sciences Upper Austria, evaluates the readiness of firms for digitisation. In order to support businesses of all sizes and to promote Industry 4.0, Plattform Industrie 4.0 has launched a joint initiative with the Mechatronics Cluster of Upper Austria and the University of Applied Sciences Upper Austria. The initiative aims to promote the nationwide roll-out of the Industry Maturity Model. At the regional level, the Plattform Industrie 4.0 has sought to involve all of the regional business agencies.

Issue 4: Sources of funding

Plattform Industrie 4.0 is funded through a combination of membership fees and basic seed funding provided by the six founding members. Membership fees are charged annually with a three-tier subscription model. Large companies located in Austria with more than 1 000 employees contribute an annual fee of EUR 7 500. Smaller companies, research institutions and trade unions pay EUR 5 000. Businesses that fall under the start-up scheme make an annual contribution of just EUR 750.

Plattform Industrie 4.0's annual budget amounts to approximately EUR 600 000. These funds are used to cover the operational costs of the activities of the platform itself. Other sources of funding are used for any Industry 4.0 related activities. These could include, for instance, setting up a training scheme in a region, funding a relevant R&D activity or commissioning a study.

Issue 5: Added value of the platform

Having an organisation that oversees major developments in Austria at both a national and regional level and combines this knowledge with international trends delivers significant additional value to members and stakeholders. This is especially the case for SMEs, which may not have the capacity to conduct these activities independently. This information is developed in the expert groups. Several research collaborations have been started between companies and research organisations as a result of the platform.

Lessons for Denmark

A national organisation that oversees major developments in Industry 4.0 technologies, with good connections to regional innovation and entrepreneurial ecosystems and a special focus on the needs of SMEs, start-ups and scale-ups in the advanced production sector, is of great importance in promoting and accelerating innovation and technological development. This is necessary to maintain and increase international competitiveness. The national cluster for advanced production, MADE, could take on a similar co-ordinating and monitoring role in Denmark.

Of special importance to start-ups and scale-ups is the establishment of a pilot factory to create a real and neutral testing and research environment for the development and testing of new products and processes. This is because access to such facilities appears to be a limited resource for small firms.

SMEs, including start-ups and scale-ups, in the advanced production sector can face considerable obstacles to digitisation. The launch of the Austrian Industry Maturity Model to evaluate the digitisation readiness of firms is therefore of particular relevance to these businesses.

Recommendations for Denmark based on the Austrian case

- MADE could take on a co-ordinating and monitoring role in the area of Industry 4.0, overseeing major developments with a focus on the needs of start-ups, scale-ups and SMEs.
- Evaluate the need for establishing thematic groups within MADE that bring together experts with a combination of research knowledge and practical and operational experience.
- Establish a pilot factory to create testing facilities and for the development of new products and processes. This is especially important for start-ups and scale-ups. This could be carried out as a co-operative initiative between MADE and DTU.
- Launch a Danish Industry Maturity Model to evaluate the digitisation readiness of firms. This could be organised by MADE in co-operation with one of the technical universities.

Sweden – Robotdalen (Robot Valley) and Automation Region

Overview

Sweden is one of the most innovative countries in Europe, ranking second in the World Intellectual Property Organization's 2021 edition of the Global Innovation Index. The advanced production sector is one of Sweden's strongest sectors, with world leading companies such as ABB, Atlas Copco, Volvo and Scania. All of these companies are either mainly located or have a strong presence in the East Central Sweden region, which is composed of five counties around Stockholm. The region is classified as an innovation leader in the EU's Regional Innovation Scoreboard. Several of the region's universities have science parks, incubators and test beds. Examples include the Linköping Science Park, which runs the largest incubator in Sweden, and the Ängen test bed in Örebro Science Park. Other science parks exist in cities closely connected to local industry, such as the Robot Application Center (RAC) in Munktell Science Park in

Eskilstuna and the Automation Center in Västerås. These areas are associated with very vibrant start-up and scale-up ecosystems.

The “Vinnväxt – Regional Growth through Dynamic Innovation Systems” programme aims to contribute to Swedish innovation capacity by supporting the emergence of internationally competitive research and innovation environments in specific high value creation growth areas within regions. Robotdalen and Automation Region are two Vinnväxt clusters funded by Vinnova, the Swedish National Innovation Agency. Vinnova provided the two clusters with funds of up to EUR 1 million per year for 10 years, extendable to 16 years with tapered annual funding. Regional partners are required to provide matching funding. Thus the funding for each cluster amounts to EUR 1 million from Vinnova and 1 million from regional triple helix stakeholders. Long-term funding from Vinnova facilitates strategic and long-term planning for the cluster and its participating firms’ innovative development. It also supports closer co-operation between the cluster firms and regional universities and helps with securing a strong national and international branding and presence. The funding is accompanied by regular evaluations to verify that the clusters fulfil the goals set out in their funding bids. If not the funding for the cluster from Vinnova is terminated.

Robotdalen

Robotdalen belongs to the first generation of Vinnväxt cluster. It was established in 2003 and was funded up until 2016. Since the termination of national funding, Robotdalen has continued its activities through two different organisations. One belongs to Mälardalen University (MDH) and the other is owned by the four regional co-funders all located in the East Central Sweden Region. The overall strategy for the ‘new’ Robotdalen is to exploit the resources, networks and competencies that have been created to strengthen support for the commercialisation of new products through start-ups and scale-ups. By bringing together industry, academia and the public sector, the organisation has developed, implemented and commercialised robotics solutions for an array of applications. It has also built a strong network of key players that has an active role in realising Robotdalen’s vision of becoming an internationally acclaimed innovation environment that enables the commercial success of new robot solutions.

Issue 1: Longstanding commitment to start-ups and scale-ups

Since its inception, Robotdalen has placed an emphasis on new enterprise creation and has supported innovators, start-ups and scale-ups in bringing ideas to market through prototyping and product development processes. This is carried out in co-operation with incubators that target start-ups and scale-ups seeking to transition from an idea to commercialisation. Robotdalen estimates that 20 new products and 19 new companies were created during its first ten years.

Issue 2: Role of large firms

Large firms have been fundamentally important for Robotdalen for a number of reasons. Firstly, they connect the region to the global market. Secondly, they can provide markets for start-ups and scale-ups. Finally, collaborations between small and large firms promoted by Robotdalen strengthens the innovative capacity of large firms and provides small firms, start-ups and scale-ups with crucial market channels.

Issue 3: Funding and infrastructure

Robotdalen supports SMEs, start-ups and scale-ups in finding relevant sources of funding, including for the fast commercialisation of innovations. Through its network and partners, businesses can also access support in developing prototypes and accessing universities, customers and incubators. The approach includes joint pilot and test environments, facilities and infrastructure, where partners can produce and test their first prototypes. Robotdalen has two test centres for the development of robot applications.

Automation Region

Automation Region is an innovation platform where SMEs, large corporations, academia and the public sector collaborate on interdisciplinary projects. It seeks to market Swedish automation expertise, stimulate innovations and secure the industry's long-term skills provision by facilitating collaboration, networking, inspiration and skills development. It was established in 2016 and is one of the latest Vinnväxt clusters. It is financed by funds from the EU, the Swedish Agency for Economic and Regional Growth, Vinnova and various regional actors. Mälardalen University (MDH), with leading research in areas such as embedded systems and future energy systems, is the host organisation for Automation Region.

Automation Region has 150 member organisations, including both small firms and large firms, which are the cornerstone of its business engagement. However, activities and events are open and inclusive and provide a means of expanding the membership base further. The presence of world leading firms such as ABB and Siemens is equally important as the involvement of smaller innovative firms. MDH's role as the host organisation means that academia has been closely engaged. Automation Region has also taken the strategically important and successful decision to actively tap into the broad academic knowledge base outside the immediate region by involving Chalmers University of Technology in Gothenburg, Luleå University of Technology, Umeå University and Linköping University. This enables academic collaboration between the institutions, prevents unnecessary duplication and utilises available expertise.

The Automation Region Research Academy (ARRAY) is a recent initiative that enjoys the active support of the Swedish Knowledge Foundation (KK), MDH and several industrial partners (ABB, Volvo CE, Skanska, Sandvik and First Control Systems). Regional stakeholders have shown themselves to be engaged with the Automation Region and its vision. This is demonstrated by the variety of partners that support the accelerator Synerleap, which brings start-ups and ABB together for access to ABB's network, clients and technology. The aim is to help start-ups accelerate and expand into global markets, with support from ABB. Other important elements of the regional ecosystem include:

- CREATE, a business incubator in Mälardalen. CREATE is associated with Expectrum, which is a hub for the diffusion of knowledge of technology to a broad group of stakeholders ranging from secondary school pupils and teachers to firms and organisations.
- SICS/RISE, a large national applied research organisation in Sweden.

Automation Region intends to develop its role as a system integrator. This entails having a good understanding of how the regional innovation system works and where the bottlenecks and drivers exist. It also involves expanding the network of large firms and connecting these world-class players, as well as research institutions, with start-ups, scale-ups and SMEs.

Issue 1: Practical support for start-ups and scale-ups

Activities organised by Automation Region include breakfast meetings and seminars to increase knowledge of technology and market trends, as well as workshops for advanced learning in selected areas. There are also opportunities for businesses to find new collaborations with the private, academic and public sectors. Through the Automation Expo – a miniature trade fair hosted by one of the members or another relevant company – businesses have the chance to present their products and services in a time and cost-efficient way.

Issue 2: Support from national government for infrastructure

Vinnova encourages and supports small companies by providing infrastructure such as incubation offices, test centres and verification resources. It finances structures that make it easier for start-ups to execute their ideas, test their products, identify and connect with potential customers, join networks and form relationships. Generally, all innovative start-ups can get support from Vinnova either directly or via the

excellent incubator programme, which will support 20 incubators in Sweden with a total of SEK 350 million during the four-year period between 2021 and 2025. In addition to financial support, the incubators receive a special quality stamp from Vinnova, which is important in helping them to obtain funding from other sources. Gender equality and sustainability have become priority development areas for the incubators.

Issue 3: The role of Ignite Sweden

Ignite Sweden works as a national network for local and regional ecosystems, comprising incubators, science parks, Vinnväxt clusters and other initiatives funded by Vinnova such as its strategic innovation programmes. It is co-ordinated by Swedish Incubators and Science Parks (SISP) and was developed and established by a number of incubators (Minc, Malmö, LEAD, Linköping, Sting, Stockholm, Things, Stockholm and Uminova Innovation, Umeå). Kista Science City and Sahlgrenska Science Park have also recently joined as lead incubators. It also collaborates closely with Automation Region. Ignite Sweden is co-funded by Vinnova and the Swedish Energy Agency.

The aim of Ignite Sweden is to connect large companies with start-ups and scale-ups as first customers. Since 2017, Ignite Sweden has connected 761 start-ups with 243 corporates, resulting in 4 087 meetings and, most importantly, more than 230 commercial collaborations. The funding from Vinnova means that Ignite Sweden's services can be free to use for start-ups, while large companies and the public sector must pay. Ignite Sweden focuses especially on the automation, automotive and energy sectors. Generally, it is very important to engage deep tech start-ups with customers from as early a point as possible. This is because of the large amount of time (10 years or more) needed to develop new products and processes, with this process involving both engineering and manufacturing. Thus, it is important to find as many commercial collaborations as possible. The aim is to find 1-5 customers for each start-up. It is an important signal for a start-up is obtaining a well-known company such as Volvo or ABB as a first customer, as this makes it easier for the start-up to find funding and new customers, both domestically and internationally.

Start-ups within the energy sector focusing on the green transition and sustainability enjoy extra funding opportunities from the Swedish Energy Agency, which invests in early phase start-ups, and from ALMA, Sweden's most active early stage investor, whose green tech investment fund is backing Swedish early stage start-ups that significantly reduce greenhouse gas emissions. ALMA has EUR 65 million under management.

Ignite Sweden has started using functional public procurement for innovation (PPI) in its collaboration with the public sector. Both Ignite Sweden and public sector agencies are still involved in a learning process, but Ignite Sweden sees great opportunities to develop functional PPI into an important policy measure for finding first customers in the public sector for start-ups coming up with innovative and sustainable solutions to solving societal challenges.

Lessons for Denmark

The long-term and generous funding from Vinnova to clusters such as Robotdalen and Automation Region pays dividends. Regular evaluations by international researchers are taking place, to identify whether the clusters fulfil and live up to their development plans. The professor's privilege and absence of intellectual property rights for the universities make the co-operation between universities and industry easy and smooth, and also leads to more academics initiating start-ups, often in incubators run by universities.

Long-term funding gives the clusters the opportunity to carry out strategic planning on how to promote the innovativeness and competitiveness of the clusters and their participating firms. This is significant in enabling strong engagement with start-ups and scale-ups, especially in deep tech sectors, which have a longer time horizon for their innovation journey than software sectors.

As part of supporting start-ups and scale-ups, the cluster organisations systematically work to connect start-ups and scale-ups with large companies as first customers and channels to international markets.

This focused and systematic work is in addition to that which large companies themselves are doing. It offers a key rationale for why the Swedish start-up scene has become one of the strongest in Europe.

The experience of Ignite Sweden also provides some important potential lessons for Denmark. It is an example of a very successful national network initiative, co-ordinated by Swedish incubators and science parks, to connect large companies and the public sector with start-ups and scale-ups as first customers. It is noteworthy that the focus of Ignite Sweden is on deep tech sectors such as advanced production and energy, where patient, knowledgeable and internationally-oriented companies often play an important role as first customers for start-ups and scale-ups.

Recommendations for Denmark based on the Swedish case

- MADE should focus more on new firm formation and supporting innovators. Of vital importance is taking ideas to market via prototyping and product development processes. This includes working with regional incubators and accelerators that help start-ups and scale-ups through the commercialisation process. Longer-term funding of the cluster could be instrumental in achieving these goals. An incentive to the cluster organisations to work with start-ups could be provided by making start-up support a criteria for evaluation of cluster organisation success in delivering on their public funded mandate.
- Evaluate the idea of establishing a Danish Ignite to encourage large firms to work with start-ups and scale-ups. This would strengthen the capacity of both large and small firms to innovate. In particular the organisation could broker connections leading to large firms acting as first customers and channels to international markets for start-ups and scale-ups. Such an organisation could be established by a collaboration between MADE and regional clusters.
- Provide cluster organisations with long-term funding, which enables them to take on strategic actions and contribute more to building national and regional entrepreneurial ecosystems. Long-term funding must be accompanied by regular evaluations to see whether the cluster is fulfilling the goals that were set out when the original competitive funding was awarded, using performance indicators supplied by government.
- Infrastructure and funding are essential for the scaling up process, particularly for joint large and small firms' test and pilot environments and facilities.
- Host networking events, for example breakfast meetings, to encourage interactions within and between national and regional entrepreneurial ecosystems.

Advanced Manufacturing Supercluster, Canada

Overview

The Innovation Superclusters Initiative (ISI) programme, launched in 2018 as part of the Innovation and Skills Plan from 2015, is a policy initiative introduced by the Canadian federal government. It has been designed and implemented as a policy to support innovation and growth among promising clusters and industries. The ISI has a budget of CAD 950 million from the government and matching funding from the private sector, universities and other levels of government (the triple helix partners) in the regions. The aims are to bridge the gaps between science and commercialisation and provide support for start-ups and scale-ups. By fostering partnerships between businesses and research, educational and financial institutions, the ISI seeks to encourage the development of skills needed by industry and create opportunities for growth and innovation. These partnerships are also designed to facilitate technology transfer and the application of new ideas in the marketplace. The heart of the approach is building the right kind of partnerships across supply chains that lead to new efficiencies and mutual economic benefits for both large and small firms.

A central challenge is that relatively few companies scale into globally-competitive companies operating at the cutting edge of innovation. Helping researchers to commercialise their discoveries and supporting entrepreneurs, in particular women and indigenous people, in attracting investment are key in enabling businesses to start up, scale up and become globally competitive. Certain sectors, such as clean technology and other hardware or deep tech sectors, face particular difficulties in finding sufficient late-stage and patient capital. Canada needs a clear path to growing more companies by focusing on capital markets, participating in emerging markets, and providing incentives for Canadian companies to expand and have a long-term presence in Canada.

The activities of the superclusters are centred around four key strategic priorities:

- Attracting cutting-edge research, investment, and talent;
- Increasing R&D and technological activities;
- Supporting entrepreneurship and commercialisation of new products, processes, and services with the objective of scaling up existing firms, and;
- Fostering a critical mass of firms and strengthening collaboration between private, academic, and public sector organisations.

One such supercluster is the Ontario-based Advanced Manufacturing Supercluster (AMS), which seeks to build up next-generation manufacturing capabilities, incorporating technologies such as advanced robotics, additive manufacturing, the internet of things, machine learning and cybersecurity. AMS promotes the adoption and integration of all aspects of advanced manufacturing. In 2018, the not-for-profit organisation Next Generation Manufacturing Canada (NGen) was awarded CAD 230 million from the federal government to manage the AMS. It received an additional CAD 20 million in federal funding in 2021. At the end of December 2021, NGen had 4 500 members including 1 000 researchers and other industry experts. A third of its members are based outside Ontario. NGen has approved CAD 234 million of funding for 167 projects that are worth a total of CAD 605 million, leveraging CAD 317 million in additional industry investments. Its 167 projects involve 579 project partners, which include 207 research teams from colleges, universities and other research centres, and 372 companies, of which 328 are small companies. 40% of project partners funded by NGen come from outside Ontario, and one quarter of the projects are interregional.

The supercluster works with innovation centres and industry organisations across Canada's manufacturing industry. To develop the ecosystem, NGEN has recently recruited members (no fee) and provided funding for developing advanced manufacturing regional and technological clusters across the country. There are now 17 advanced manufacturing clusters in Canada. There are quarterly meetings between the supercluster and the regional and technological clusters it supports. The supercluster uses a syndicated leverage approach, acting with other funders.

All projects need to integrate technology into manufacturing, which implies that all technology firms involved in cluster projects need to have a manufacturing partner and projects need to have an approval from a manufacturing expert.

Issue 1: Gaps in the ecosystem

The AMS has a high proportion of tech start-ups and a strong ecosystem but there remain important tasks that are needed to fill gaps in the ecosystem. There is a funding gap, especially for scale-ups, since developing devices for manufacturing takes a longer time than, for example, software solutions. This means that funding from NGen must address gaps in innovation financing. This includes providing later stage funding for pilot development and feasibility evaluation and the testing of new manufacturing applications.

Issue 2: Building consortiums involving large and small firms

A focus of NGen is involving small firms in the development of manufacturing applications. For companies to receive financial support from the supercluster, their projects have to be collaborative and involve at least one small company and potentially also educational institutions. Research, technological development and manufacturing are required to be brought together and integrated into a manufacturing solution. Part of the challenge has been finding out how to integrate the start-ups into applications that deliver broader economic value. The rationale for the strategy of embedding start-ups into collaborations on manufacturing applications is the potential for SMEs to be part of an integrated approach to delivering unique solutions for manufacturing.

In practice, this means that collaborations require bringing together firms with expertise in different technologies. AMS actively seeks out SMEs with the potential to develop applications and manages their development through its small business management project. A lot of work is conducted up front in matchmaking and identifying and assessing the capabilities of the partners in the project itself. During this process, it is important to take on board the expectations of the manufacturing firms. A unique aspect of the initiative is the independent project selection process, which involves an assessment by a panel of experts. This ensures that the projects are industry driven and approved by industry experts. NGen also works with the project team to help them to commercialise the technology.

All of the projects involve a variety of technologies. A criticism has been made about a lack of targeting of one area of technology or one area of manufacturing. The strategy is, however, that in order to develop a solution for manufacturing, a number of different technologies need to be involved, with tech companies working together to develop a unique solution that may then be commercialised in a variety of manufacturing applications.

To make consortiums involving large and small firms work effectively, upfront collaboration agreements between partners are important. These collaboration agreements have to specify the project team, which ensures that the people on the project can deliver the intended outcomes, as well as IP sharing arrangements. The project consortium receives funding from NGen when collaboration agreements are concluded. The participating companies take joint responsibility for carrying out the project. If there is a major change in the team, then the contract is renegotiated. All projects are evaluated by independent industry and technical experts.

Small firms are generally happy with the model but receiving buy-in from large firms, which is a necessary pre-requisite for project approval, can be more challenging. An important guiding principle for creating a consortium is not to involve competing businesses. Another is to bring in small companies and start-ups that provide unique competencies and/or technologies. The large manufacturing company in the collaboration does not usually want to buy the small firms, but may wish to license the technology. NGen supports projects that attempt to develop integrated solutions on the basis of a meaningful collaboration between project partners. This provides the smaller firms with an opportunity that they would not otherwise have had on their own as well as a chance to involve partners in developing IP arising from their project further down the line. Each company can develop its own IP, alongside owning the IP of the project.

Collaboration with the universities is problematic because each has its own strategy for IP ownership. For this reason, collaborations work better between the companies. NGen has an IP manager who works with all teams to help them understand the value of the IP and how to manage its commercialisation. The main types of IP involved are industry secrets, trade secrets, knowledge, skill sets and patents.

Issue 3: The role of Innovation Solutions Canada – public procurement of innovation and governmental challenges

NGen is mainly focused on commercial applications in manufacturing. There is a procurement challenge in Canada's public sector, which does not see always see procurement priorities through the lens of

supporting Canadian innovation and scale-up. PPI to address governmental challenges such as climate change is an important instrument for supporting start-ups and scale-ups. To date, 3% of the government's budget for environmental technology is aimed at start-ups. The public sector is not yet consistently bringing together the right companies. The supercluster model may be a highly effective way of meeting these challenges.

Innovative Solutions Canada (ISC) is a procurement programme, which aims to direct government procurement towards innovators and entrepreneurs. It is modelled on the US Small Business Innovation Research (SBIR) programme. It positions the federal government as a first customer, issuing specific challenges and looking for proposed solutions. The programme supports the development of early-stage, pre-commercial innovations with the potential for global commercialisation. The challenges are designed around solutions and desired outcomes, rather than known products or process specifications. This is referred to as functional public procurement of innovation (PPI). ISC also helps Canadian firms generate and leverage new intellectual property. Another objective is to encourage procurement from companies led by people from underrepresented groups, such as women, Indigenous people, youth, disabled individuals, LGBTQ+ people etc.

Issue 4: Evaluation

Continuous evaluation is key to the success of the AMS. NGen monitors the projects it funds and contractually has quarterly meetings with the project teams where financial claims are reviewed and progress is discussed. These meetings with project teams allow NGen to evaluate how to further help the projects to commercialise, for instance by identifying whether there are other companies that can be brought in or whether there are other types of funding support that can be leveraged. When projects close within a 5 year timeframe, the project team is required to report their sales and employment data to NGen, as well as outcomes with respect to other economic, workforce, social, and environmental impacts.

At the end of December 2021, 39 of 167 projects were closed, involving NGen investments of approximately CAD 45 million. As a result of sales of products, IP and licensing, the projects had generated CAD 1.85 billion in sales, representing a forty-fold economic return on investment. NGen monitors many indicators including sales, IP, licensing, the number of jobs in projects and the number of students in projects.

Issue 5: Larger firms' concerns about working with small firms

One of the biggest challenges in working with the large companies is that they do not necessarily want to share their IP. This is addressed by undertaking financial due diligence of small firms, getting to know the firms and helping them develop stronger management capabilities. It also involves working with the large manufacturing companies to encourage them work with the small technology companies as meaningful partners in the development of solutions as part of an open innovation partnership. In many cases, this depends on re-engineering the product to simplify supply chains to reduce the risk. However, some large companies see the partnership as merely buying and selling technology and as a consequence fail to have their projects approved for supercluster funding.

Issue 6: Skills shortages

The skills required in the sector are evolving, including a growing need for more digital understanding. To learn more about this issue, AMS, in partnership with Statistics Canada, conducted a survey of 6 000 manufacturers. Most surveyed firms said that they did not achieve business objectives from their investments in technology because they lacked the skills required to run the technologies productively. To help deal with this management challenge, the cluster has a transformation leadership programme. This can provide a roadmap that advises companies on how they can ask the right questions, add value and find opportunities for improvements in their technology solutions and processes and skill sets. This is

important for smaller companies, which often have a limited idea of their skill requirements in 5 years' time and do not know how to find this out.

Issue 7: Supporting inclusive entrepreneurship objectives

Equality, diversity and inclusion are a major part of AMS' focus and a key part of the organisation's programming. The 16-person board has nine women and is chaired by a senior female manufacturing leader. The organisation is diverse at the top and is investing in a number of equality, diversity and inclusion initiatives, particularly on the workforce development side. For example, a number of initiatives support entrepreneurship education for black youth and for indigenous youth.

Lessons for Denmark

- The majority of NGEN's members are smaller firms. The cluster has a strong focus on supporting smaller firms, including start-ups and scale-ups. All projects must have smaller firms as partners.
- Identifying how start-ups and scale-ups can deliver unique solutions fosters engagement of these firms in working with manufacturing applications.
- Collaboration agreements must be signed upfront before they receive funding. This is important because the expectations and the whole nature of the partnership need to be made explicit, including IP sharing arrangements. It is also vital that the project teams have the right people to deliver the intended project outcomes. The supercluster has an IP manager working with the project teams.
- Adopting a hands-on approach by working with companies to help them identify what they need in projects, IP, or training is important. Also key is talking to tech and manufacturing companies on the topic of current and future challenges.
- The supercluster works in a systematic way to support regional and technological clusters across Canada.
- Adopting an organisation-wide ethic of equality, diversity and inclusion.

Recommendations for Denmark based on the Canadian case

- Ensure that all cluster projects have smaller firms as partners.
- Initiate a programme for qualifying smaller firms that helps them to adopt advanced technologies and develop managerial capabilities.
- Assist in providing funding for later-stage scale-ups engaged in building new manufacturing applications.
- Establish an IP manager in MADE that works with project teams.
- Establish a systematic strategy for organising collaboration between the national cluster and regional science parks, incubators and accelerators to develop the entrepreneurial ecosystem.
- Adopt a similar national public procurement programme to ISC, which in turn is based on the US's very successful SBIR programme. It has the advantage of supporting early-stage companies to meeting challenges around solutions and desired outcomes and encourage diverse and inclusive innovation and entrepreneurship.

References

- Danish Business Authority (2019), *Innovative public procurement*. [5]
- European Commission and PWC (2021), *The strategic use of public procurement for innovation in the digital economy*. [4]
- EY (2022), *Advanced Manufacturing*. [1]
- International Trade Administration (2021), *Austria: Country Commercial Guide*. [6]
- Sorivelle, M. (2018), “Danish Manufacturing: Key Trends of Tomorrow”, *Medium.com*. [3]
- TechBBQ and Vækstfonden (2019), *From startup to scaleup: An overview of the Danish financial ecosystem for entrepreneurs and scaleups, 2019*. [2]

Notes

¹ See [Digitalt værktøj: Danske Testfaciliteter | Virksomhedsguiden](#) (in Danish).

² A key source for this section is Boog et al., 2019[18]

³ Industry 4.0 refers to the fourth revolution that has taken place in the manufacturing sector, characterised by automation and smart, autonomous systems and facilitated by data and machine learning.

4. Energy technology

There is higher share of start-ups in all businesses in Denmark's energy technology stronghold than the all-economy average and the advanced production and food and bio resources strongholds. The average revenue of energy technology start-ups is more than four times' higher than the economy-wide average. Energy technology also has a relatively high share of scale-ups. The revenue share of scale-ups is higher in energy technology than any other stronghold or emerging industry. There is a basic infrastructure in place to support for start-ups and scale-ups in the sector. However, stakeholders in Denmark identified a number of gaps in policy support. This chapter presents key policy recommendations to support start-ups and scale-ups in Denmark's energy technology sector. It includes an assessment of the opportunities and barriers currently faced by start-ups and scale-ups in the sector, as well as an examination of inspiring practice policy initiatives for start-ups and scale-ups in energy technology from Norway, the United States and the United Kingdom.

Policy recommendations for Denmark's energy technology sector

1. **Work with the private sector to develop a stronger sector-specific finance ecosystem**, including both early-stage finance and longer-term patient finance (aimed at the deep tech segment of the sector), potentially including R&D tax incentives adapted to start-ups and scale-ups.
2. **Establish an energy accelerator programme** that specialises in supporting start-ups and scale-ups in the sector, including access to experienced technology managers, market development and regulation experts. The accelerator should work with large firms and investors and include support for access to international markets as well as support with regulations.
3. **Focus on bringing more start-ups and scale-ups into the sector**, and especially into the supply chain, including start-ups and scale-ups based on use of energy data.
4. **Support large firms to work more closely with start-ups and scale-ups** as first customers.
5. **Review the public procurement process and especially the early pre-tender stages to address current barriers** to the participation of start-ups and scale-ups. This should include simplifying the tendering process, facilitating participation in bidding consortia, raising awareness of opportunities, and increasing granularity of contracting.
6. **Develop physical infrastructure, including piloting and testing facilities and relevant science parks** to bring Denmark in line with competitor countries.
7. **Promote a closer and more systematic co-operation between the national cluster organisation and regional entrepreneurial ecosystem actors**, including clusters, science parks, incubators and accelerators.
8. **Provide Energy Cluster Denmark with longer-term and freer funding** to enable it to take more strategic actions, provided as a result of competitive bidding and backed up by regular impact evaluations to steer funding.
9. **Address talent shortages** in key sectors such as the offshore wind sector and incentivise skilled people in the digital sector to move into the energy sector, and promote opportunities in the sector to entrepreneurs of diverse backgrounds, including women, by including diversity objectives in public programmes.
10. **Involve start-ups and scale-ups in the design of regulations** to develop a net-zero energy market.

Introduction

The energy technology sector encompasses technologies related to energy production and energy efficiency. Denmark's net zero commitments and advances with renewables, in particular wind technology, make it a leader in this sector internationally (International Energy Agency, 2022^[1]), and there will be numerous new opportunities for start-ups and scale-ups as Denmark's green transition efforts progress. For instance, Innovation Fund Denmark has announced that it will invest DKK 700 million in four mission-driven innovation partnerships,¹ two of which will be focused on Carbon capture and storage and Power-to-X.

In addition to the national cluster organisation (Energy Cluster Denmark), there are a number of other networks that operate in the energy technology sector. These include Wind Denmark, which is a network

with 275 companies and 2 400 members in the wind sector, and Danish Federation of Energy Industries (DI Energy), with more than 800 members. The 2022 agreement “*Danmark kan mere 1*” also sets aside funding for eight local business lighthouses, tasked with future-proofing Danish strengths. Three of these business lighthouses will have a focus on energy technologies.

DI Energy finds that there is the potential for start-ups arising from changes in the areas of digitisation, data driven systems and smart energy systems. Although few of DI Energy’s members are start-ups, there is interest in encouraging new start-ups within the broad field of fast energy technologies. Another relevant initiative is Center Denmark, which is an independent non-profit company with a digital platform providing access to data and tools to promote data driven innovation in the energy technology sector, in partnership with a commercial firm and the four technical universities. Center Denmark is intending to set up an accelerator to support early start-ups. It provides data infrastructure to support the green transition, sharing data between its members rather than delivering solutions. It is targeting 100% renewable energy by digitalisation of the system and sector coupling, linking systems for electricity, water and waste water.

The next section describes the following key barriers that start-ups and scale-ups face in the energy technology sector in Denmark:

1. Difficulty bringing radical innovations to market
2. Industry structure
3. Incubators and accelerators
4. The role of large firms in the cluster
5. Access to finance
6. Talent shortages
7. The role of universities
8. Procurement, testing and regulation.

Relevant policy approaches that have been adopted in Norway, the United States and the United Kingdom are then presented, with an analysis of the lessons and takeaways for Denmark.

Barriers for start-ups and scale-ups

Difficulty bringing radical innovations to market

Areas of innovation where start-ups and scale-ups could contribute to dynamism in the supply chain include the development or deployment of new or different materials, reducing the costs of products, and building sustainability into the design of new products. However, there is a shortage of start-ups that develop completely novel solutions to producing energy. Such endeavours require 10-15 years of development and significant amounts of capital, and there are not many investors who are open to this type of commitment. The challenge is greatest when large physical hardware is involved, such as turbines. While it is easier for firms providing services to enter the supply chain, there is still a need to demonstrate and validate their services before deployment.

Industry structure

Wind Denmark reports that the main sources of start-ups are either from within the existing supply chain or spin-offs from universities, building on the very strong research at Danish universities. However, there is a strong tendency in the sector for new firms to merge quickly into existing companies in order for them to access resources and safeguard their future. Moreover, track record, especially in the offshore sector, is vital for large investments, and start-ups can struggle to attain this without undergoing mergers and

acquisitions. The industry is therefore characterised by a steep pyramid with very few companies at the top. This pattern can restrict innovation, but on the other hand, it does align with customer requirements for stability.

Incubators and accelerators

There are relevant incubator and accelerator programmes for the energy technology sector in Denmark. For example, GreenUp is an accelerator programme at DTU which has accelerated 150 climate tech start-ups. In the GreenUp accelerator, a climate tech business goes through a start-up programme, a gear-up programme, and a scale-up programme over the course of 20 months. After this, the business will be ready to enter international markets and launch a Series A financing round. In addition, Next Step Challenge has supported more than 120 companies in its energy technology accelerator programme. Furthermore, as part of the Beyond Beta start-up incubation programme, Energy Cluster Denmark together with Next Step Challenge is running an Energy Incubator for start-ups with innovative solutions for the energy sector.²

The role of large firms in the cluster

Large firms in the energy technology sector, such as Danfoss and Siemens, can offer opportunities for start-ups and scale-ups to provide innovation that can support their own product and process development. Public initiatives could encourage more active involvement of large firms with start-ups and scale-ups for this purpose, including matchmaking services and offering financial support and advice to start-ups and scale-ups working with large firms. In particular, there is an opportunity for large firms to act as first customers for new innovations by start-ups and scale-ups. In this respect, large firms could adopt the role of problem owners, with problem solving being delegated to a number of separate but collaborating SMEs and/or knowledge institutions. While the large companies can undertake their own innovation projects, they acknowledge that complex innovation requires collaboration between multiple companies. Sometimes, the larger companies in the sector initiate innovation projects and then customise the results for their own technological advances. Start-ups and scale-ups can bring specialised know-how to these collaborations, for example in the green transition and associated technologies.

The wind industry is also pushing for greater innovation and needs larger firms to be innovative and involve start-ups and scale-ups in innovation processes. Vestas Wind Systems is a major energy company, which designs, manufactures, installs, and services wind turbines. It has approximately 3 000 engineers, half based in Denmark, who work on technology for small flat turbines and the energy system as a whole. Scale-ups are supported through Vestas Ventures, Vestas Wind Systems' venture capital arm. Rather than supporting start-ups, Vestas Ventures focuses on firms at a later development stage, and wants to see proof of concept or proof of sales before investing. It defines a framework of support and takes minority investment in the SMEs, as part of syndicates with other investors. It has screened over 70 companies worldwide but has so far only invested in three Swedish companies. Vestas Ventures reports that it finds fewer start-ups in the energy technology sector in Denmark than in other countries.

One of the barriers to innovation in the supply chain identified by Center Denmark is that some of the larger energy firms have a conservative culture and are facing challenges in adopting digital technologies. These large companies therefore have a need for an ecosystem where start-ups and scale-ups can play an active role in providing new solutions for them. To assist with this, Center Denmark recommends that the government incentivises energy companies to make their data freely available for start-ups and scale-ups to mine, in order for them to develop new business models that can meet the innovation challenges. Current economic incentives are not strong enough in this area. Center Denmark offers a subscription service to its data platform, which receives daily energy consumption and production data from tens of thousands of Danish households.

Germany's EUREF Campus was highlighted by DI Energy as an example of an initiative that could be a model for Denmark's energy technology sector. The private sector organisation has generated a scale up environment for firms focusing on renewable energy in the heart of Berlin. It operates as an innovative community of businesses and researchers, with a climate-neutral energy supply, an intelligent energy grid, energy-efficient buildings and a testing platform for future mobility, as well as numerous research projects.

Access to finance

A barrier to more start-ups and scale ups in the energy technology sector is the lack of a sector-specific finance ecosystem. While there are new opportunities emerging in the energy sector (Butcher, 2021^[2]), the consensus in the stakeholder interviews was that there needs to be a more integrated investment environment involving public and private bodies and more funding for innovation projects. This includes collaborative projects with knowledge institutions. It is expensive to be a start-up in the energy technology sector, especially in deep tech fields such as new power sources where there is a scarcity of investors. This points to a need for specialised support that recognises the importance of different types of funding at different stages. This includes more risk capital at early stages where market opportunities are less certain and more patient capital at mature stages in growth when businesses are scaling up, to support activities such as building the management base, piloting and testing. A major barrier identified in the stakeholder interviews is a lack of funding at the late stage of commercialisation, particularly for scale-ups when they reach a medium size. Funding designed for later stages, both for projects and knowledge institutions, would help drive more innovative start-ups and scale-ups. Existing public grant schemes provide insufficient financing volumes and tend to focus on the early stage development of firms. They need to be complemented with further financial instruments including equity and loans at later stages. There also needs to be more clarity on which public funding schemes for the green transition are appropriate for which kinds of firms.

Denmark's Green Investment Fund, which co-finances projects that promote the green transition in the areas of renewable energy, energy savings and resource efficiency is sufficiently well resourced that it has the potential for appropriate projects to significantly close the financing gap in the energy technology sector. The Danish Growth Fund has attempted to invest in the energy technology sector but the market was insufficiently mature and so investments in early stage technologies were lost. There is also some evidence that US funds are coming to Denmark in the deep tech segment of the sector, but for that part of the supply chain, stronger environments and more programmes like GreenUp are needed to encourage further inward investment.

Talent shortages

Several stakeholders suggested that there is a lack of skilled workers for start-ups and scale-ups in the energy technology sector. For instance, there is a need for engineers in the offshore wind sector in Esbjerg. More broadly, there is a need for people from the digital sector to move into the energy technology sector. Sometimes, talent can be recruited from abroad to overcome national shortages. Evidence from the stakeholder interviews also indicates that the energy technology sector is unappealing to women, especially at higher levels. This is evidenced by the low participation of women in the sector. For instance, DI Energy has only two women on a board of 30.

The role of universities

Several stakeholders stated that insufficient sharing of knowledge from research between universities, firms and projects is a barrier to innovation in the energy technology sector. There are a variety of potential factors contributing to this, including the intellectual property regime, researcher incentives and the structure of public funding schemes. An example of an initiative to address this is a new development by the National Center for Energy Storage, which will work with all Danish universities to support spin-outs.

Another model of collaboration is the Danish Centre for Environment and Energy (DCE), which is Aarhus University's central unit for knowledge exchange within the areas of nature, environment, climate and energy. DCE delivers science-based advice and solutions that contribute to the greening of the economy and promote sustainable growth at local, national and international levels. Its customers include the Danish Ministry of the Environment and Food, the Danish Ministry of Energy, Utilities and Climate, Greenland's Government, the Danish municipalities, private businesses and the European Commission.

Public procurement, testing and regulation

A consensus among stakeholders is that the public procurement system needs to be revised to encourage the participation of start-ups and scale-ups. This would include adapting the tenders to the capacity of start-ups and scale-ups in terms of smaller and manageable tenders and removal of restrictions on the involvement of early stage firms. In addition, it is necessary to provide support and brokerage for start-ups and scale-ups to form consortia with other bidders. More positively, it was reported Denmark is ahead of other countries in the areas of testing and regulations for prototypes.

International policy experiences

Norway – Three energy clusters and two catapult centres

Overview

Norway has been a large energy producer for more than 100 years. In the beginning of the 1900s, hydroelectric power was a major source of energy. This was funded by foreign capital, although there were requirements to use Norwegian inputs, such as labour or components, as part of the conditions to be granted concessions to exploit the waterfalls. The same principles were applied to the exploration and exploitation of offshore oil and gas at the end of the 1960s. With the decline of oil and gas production, there is an increased focus on renewable energy sources such as wind power and hydrogen. The lengthy Norwegian coastline offers excellent conditions for offshore wind power installations. Moreover, the construction of platforms for the windmills can exploit the existing value chain for the production of drilling platforms and other equipment used by the oil and gas industry. Norway's abundance of natural gas (primarily methane) will be the basis for blue hydrogen as an energy source for land, sea and air transport. In combination with carbon capture and storage (CCS) technology, which is also a focus area in Norway, the production of blue hydrogen provides a low emission energy source. The Norwegian government has launched a strategy and a roadmap for the safe use and production of hydrogen.

Norway has an internationally-recognised cluster programme, Norwegian Innovation Clusters. The programme is organised by Innovation Norway jointly with SIVA (The Industrial Development Corporation of Norway) and the Research Council of Norway. Norwegian Innovation Clusters groups the clusters it supports into three levels:

- Arena clusters, which are new or immature clusters in emerging industries and sectors. They are funded for 3-5 years.
- Arena Pro clusters, which promote a continued development of the strategic importance of the cluster beyond being an arena for interaction and collaboration. Arena Pro clusters receive funding for 5 years.
- Global Centres of Expertise, which are world-leading clusters with the potential for growth in international markets. These clusters receive funding for a ten-year period.

In general, for all the cluster levels there are four main focus areas: Increased innovation, internationalisation, strengthened attractiveness, access to relevant competence.

The Norwegian Catapult Programme is a government scheme designed to assist the establishment and development of catapult centres, which seek to accelerate the process of moving from a product's concept phase to market launch. The purpose of the programme is to support the innovative capabilities of SMEs in specific industry areas in Norway. The programme is administered by the Industrial Development Corporation of Norway (SIVA) on behalf of the Norwegian Ministry of Trade, Industry and Fisheries, in partnership with Innovation Norway and the Research Council of Norway.

This international case looks at the following three clusters and two catapult centres, which each have a focus on offshore wind or hydrogen energy sources. As the focus of these clusters is on new emerging technologies, the three clusters are classed as Arena clusters.

- The Norwegian Offshore Wind Cluster (Offshore Wind) aims to have the world's strongest supply chain for the floating offshore wind sector. Norway has a very strong petro-maritime supply chain, meaning that Offshore Wind is well placed to attain and retain this position. Companies like Equinor, Aker Solutions and Kværner are already at the forefront, along with a number of other Norway-based companies. Membership of the cluster is open to all companies and organisations either from Norway or the rest of the world. The cluster has a focus on start-ups with a special, low membership fee of NOK 5 000.
- The Ocean Hyway Cluster is a Norwegian hydrogen cluster aiming to realise the maritime use of hydrogen-based fuels. It is Norway's leading network for hydrogen-based fuels in maritime applications. The members of the cluster are active throughout the hydrogen value chain, including in energy and hydrogen production, processing and distribution, storage and bunkering, ship design, as well as R&D. The membership of the cluster ranges from international companies to start-ups.
- The Norwegian Hydrogen Cluster (H2 Cluster) is working to promote the Norwegian hydrogen industry internationally. The cluster was established as a result of the Norwegian Innovation Clusters programme, which mapped the various activities taking place within the hydrogen industry in Norway in order to identify whether there was a basis for a co-ordinated efforts to promote hydrogen internationally with the clusters as a point of departure. As many as 13 clusters, along with a number of CEOs from leading companies within the hydrogen industry, are actively participating in the international promotion of hydrogen. This has resulted in a positioning project, which aims to develop a branding strategy for presenting Norwegian hydrogen technology and competence to an international market, and to create a competitive advantage and increased value creation for Norwegian companies in the field. Since many of the 13 clusters are Arena clusters, SMEs, start-ups and scale-ups are well represented in the H2 Cluster. Many of Norway's clusters work to a varying degree and in different ways with hydrogen. This trend is increasing and clusters that today do not work with hydrogen have plans to do so in the future.
- The Ocean Innovation Norwegian Catapult (OINC) is a national centre for the effective design, prototype development and verification of new solutions for blue growth and green transition of the ocean space. The centre provides equipment, competence and premises for companies to test, simulate and visualise technologies, components, products, solutions, services and processes. OINC is also a hub for interactions between industry and R&D institutions and can provide opportunities for new relations and the basis for continued co-operation. The catapult centre is especially focused on SMEs, start-ups and scale-ups. However, large companies, R&D institutions and educational institutions can also use the centre.
- The Sustainable Energy Norwegian Catapult Centre was established in 2018. Its focus is on green transition and in particular the transition to more renewable energy sources. The catapult centre assists companies in developing and testing sustainable solutions for the production, storage, distribution and control of energy, covering the development and testing of prototypes in a laboratory as well as the testing of finished products in operative facilities on land, ships or in the ocean space. The centre provides the competence and testing facilities that companies need to

transition from idea to market. It can also assist companies applying for project support from relevant grant and subsidy schemes.

Issue 1: The role of catapult centres for innovative start-ups and scale-ups

The catapult centres assist companies in developing prototypes and offer expertise and equipment for testing, visualisation and simulation in order to turn innovative ideas into new products and services in an effective manner and at a lower risk. The centres also provide expertise, contacts and facilities in various technological areas, and can assist companies in accessing new markets and capturing interest from other potential business partners. Such assistance is of key importance to start-ups and scale-ups as they have limited access to such expertise and facilities due to scarce financial resources.

Issue 2: Financial support for start-ups and scale-ups

Start-ups and scale-ups can apply for general support from Innovation Norway and the Research Council of Norway. Innovation Norway is the most important agency for supporting new ventures and innovation at an early-stage (Ali, 2021). The Norwegian system provides a range of direct financial support measures for start-ups within the clusters. These include:

- Establishment grants (phase 1 up to NOK 100 000 and phase 2 up to NOK 750 000). This constitutes a 50-70% subsidy of the actual costs. These grants are specifically aimed at supporting technology-related ideas that are scalable.
- Development grants (industrial R&D grants and public sector R&D grants in the range of NOK 1 to 25 million).
- Innovation Norway offers risk loan and grants for companies that want to develop and commercialise technologies within renewable technology sectors.
- Precubator/technology transfer office funding of up to NOK 100 000 for feasibility studies through regional incubators, which receive public funding.

Issue 3: Tax incentives for R&D investments that are accessible to start-ups and scale-ups

The most important support instrument for start-ups and scale-ups from Research Council Norway is SkatteFUNN, the tax reimbursement scheme for R&D investments. Firms can receive a tax deduction of up to 20% (18% for large companies) of the cost of R&D projects. The maximum deduction is NOK 8 million. SkatteFUNN is a tax scheme that is designed for smaller companies rather than for larger companies. For start-ups and scale-ups with a deficit, SkatteFUNN provides cash reimbursement, making this incentive particularly interesting for start-ups and scale-ups that have not yet generated a surplus. Among firms applying for SkatteFUNN, there are three times as many with a deficit than with a surplus.

Lessons for Denmark

- Long-term funding for the clusters of up to 20 years (but with 10 years as the normal length), accompanied by regular evaluations, provides the resources necessary for strategic actions.
- Providing different entry levels for clusters may be especially important for new or emerging firms in new sectors.
- The programmes include a focus on more specific technologies than the broader energy technology sector identified in Denmark. The more specific focus is particularly important for emerging new technologies such as hydrogen by helping to concentrate resources to secure a faster development.

- The catapult centres play an important role in accelerating the process of moving from concept to market and in providing testing, simulation and visualisation facilities for design, prototype development and verification. They have a particular focus on SMEs, start-ups and scale-ups.

Recommendations for Denmark based on the Norwegian case

- Secure national co-ordination, beginning with the mapping of existing and planned activities for the development of new technologies, as is done in Norway with the hydrogen industry. Energy Cluster Denmark could take on this task.
- Expand the national acceleration infrastructure to support entrepreneurs in taking ideas from inception to scale-up by offering specialist support in areas such as prototyping, expertise and equipment. What is provided by the two GTS institutes, FORCE Technology and the Teknologisk Institut, is currently insufficient. In co-operation with regional ecosystems, Energy Cluster Denmark could provide additional access to testing and piloting, as well as information on technology, markets and networking opportunities.
- Provide specialised indirect financial support, such as tax reimbursement schemes for R&D investments. For start-ups and scale-ups with a deficit, cash reimbursement can be applied.
- Provide clusters with long-term funding, which makes them capable of taking on strategic actions.

United States – Small Business Innovation Research (SBIR) Programme in Energy

Overview

The US' Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programmes encourage domestic small businesses to engage in research with the potential for commercialisation. Through a competitive, awards-based approach, SBIR and STTR enable small businesses to explore technological potential and provide the start-up funding to profit from the commercialisation of the developed technology. The SBIR programme is strongly focused on small businesses, which take a lead in the research process. In the STTR programme, the small business is required to partner with a federally-funded research institution such as a national laboratory or a federally-funded university. However, as with the case of the SBIR programme, the small business leads the process.

In total, ten Federal Agencies have either an SBIR or an STTR programme. One of these is the Department of Energy. Within the Department of Energy, the Office of Energy Efficiency and Renewable Energy (EERE) provides grants to small businesses through the SBIR/STTR programmes. EERE's mission is to support transformative science and emerging energy efficiency, renewable power and sustainable transportation. Knowledge generated by its R&D activities facilitates the development and deployment of innovative energy technologies by businesses and entrepreneurs. It is estimated that about half of start-ups involved in the SBIR programme originate in universities but there is little detailed data on the source of start-ups. A majority of start-ups have a university background, but they are not necessarily affiliated with the university at this point.

EERE provides funding to competitively selected energy efficient and renewable energy technology small businesses on an annual cycle. New financial awards are known as Phase 1 awards. Follow-on awards made to previous Phase 1 awardees are known as Phase 2 awards. All of the EERE's SBIR/STTR awards follow the "Release 2" schedule. The small businesses selected are those with innovative ideas that can align with the Department of Energy's mission. Phase 1 lasts for 6-12 months and Phase 2 lasts for two years. Since 2011, Phase 2 can be repeated if the firm continues to work on the project and it remains promising. This extension is very helpful for energy projects because, at least in the advanced manufacturing area, much research is not ready to be commercialised within three years. In 2018, a third

iteration of Phase 2 was made possible for the same reasons, namely that in the energy sector, lead times are considerable and research is capital intensive for a longer period. In the SBIR programme, Phase 1 grants amount around USD 250 000. Phase 2 grants are typically around USD 1 million, as are subsequent grants. The phases may correspond to differing capital needs within the project, such as a demonstration phase with demonstration funding which is only just being put in place. It covers the “valley of death” that occurs between coming out of R&D and commercialisation. The Department of Energy is starting to address this difficult part of many SMEs’ journey.

Some 20% receive funding the first time around. Of those that survive, 35% go through to Phase 2. Approximately 25% of Phase 1 awardees do not apply for Phase 2. However, there is reason to believe that this may be due to the receipt of funding from venture capitalists in many cases.

Issue 1: Concerns over intellectual property rights (IPR) and regulation

The small business owns the intellectual property (IP) it generates in the project unless it is a national lab intellectual property, in which case the national lab retains ownership of the IP. Obtaining IP from universities is a significant problem, since universities have cracked down on ownership. In response to this challenge, the Technology Transfer Opportunity programme has been introduced. Rather than the EERE proposing a topic where the small business solves a problem, small businesses instead work on a topic where there is some existing IP from the National Lab, which the small business then commercialises. The TTO programme provides funding to the small business to commercialise the technology from the university or lab test. The holder of the IP has to give the small business a licensing option. This means that the EERE has some leverage over the universities and national labs because the IP is paid for by the Department of Energy.

The EERE programme does not deal with the regulatory process. There have been programmes where it tries to collect information on and publicise regulatory barriers, but this particular programme is focused on R&D.

Issue 2: Entrepreneurial skills

One of the gaps identified by the SBIR is that of ensuring that small businesses have the entrepreneurial knowledge needed to successfully commercialise technologies. The National Science Foundation’s Innovation Corps programme is designed to address this gap. It is specifically designed to provide the necessary skills to small businesses surrounding entrepreneurship and commercialisation, helping to bridge the gap between R&D and commercialisation.

Issue 3: Areas covered

While the types of clean energy projects that are funded vary, the percentage of funding dedicated to this technology area has increased over the years, as has the amount of funding per project. Increasingly, the Department of Energy adopts a strategic approach by compiling a disseminated list of priorities, which then affects the bids received. In 2021, decarbonisation was a priority area that was carried forward and agriculture became a new priority. Waste in the food and agricultural sector also emerged as a major concern.

In 2021, the EERE programme within SBIR encouraged proposals in the areas of:

- New energy sources and resources, power generation, energy storage, and electronic systems for energy sources used in mobile technologies and off-grid type applications.
- Oil and gas and related processes.
- The intersection of energy technologies and data across all areas where integration to energy technology applications is the primary thrust, including computational technologies.

- Nature-inspired processes for sustainable energy solutions and carbon storage, reducing the carbon and resource intensity of hydrocarbon extraction, energy conversion, and its uses.
- Energy storage from the scale of wearable devices to power plant, and energy conversion.

Issue 4: Evaluation

The programme is evaluated every four years by the National Academy of Sciences as a requirement of the SBIR. An evaluation of data from 40 000 projects (Howell, 2017[19]) reported that many clean energy start-ups face a challenging funding environment because their development cycles are long, risky, and capital-intensive. The study found that early-stage grants make a significant difference to young clean-energy firms and increase clean innovation. It concluded that the SBIR grant is most useful in sectors that generate large positive spillovers, such as hydropower, carbon capture and storage, and building efficiency and automotive technologies. However, there was no measurable effect for conventional energy technologies, such as natural gas and coal, suggesting that these sectors are not as financially constrained.

The analysis also found that early-stage grants have large, positive effects on subsequent venture capital investment, firm revenue, survival, and successful exit (IPO or acquisition). However, a larger, later stage grant did not have similar measurable effects. The overall conclusion of the evaluation was that providing more one-off grants to small, young firms could be more effective in driving innovation than a smaller number of larger grants that are allocated to firms through several stages of technology development.

Issue 5: Success factors

The programme's main success factors lie in the evaluation of the potential of applicants and the leverage that having an award gives the award holders. The programme is rigorous and merit based and has a standardised review process. Each project requires a commitment from the applicants to meet particular targets. As part of the technical merit analysis, applicants are judged on whether or not they will meet these requirements.

Another key success factor is having hands-on technology managers who are government employees. Prior to the COVID-19 pandemic, these managers were funded to conduct site visits to advise on progress. Some technology managers have introduced firms to their research networks. Testimonials from award recipients refer to how the expertise, knowledge and networks of the technology managers significantly helped their respective start-ups.

The geographic distribution of projects funded is interesting, since there are advantages for start-ups and scale-ups to be located in centres of expertise, especially top universities. The geographic distribution of research funding is similar for the SBIR and STTR programmes and similar to that of National Science Foundation funding. The bulk of funding goes to places with elite research universities such as California, Massachusetts and Connecticut. These are locations that small businesses gravitate towards because, even without a direct link to a university, they represent a good place to hire suitably skilled and motivated staff. There were efforts in the previous SBIR initiatives to work with regional authorities to build innovation ecosystems, but these were very short lived.

Issue 6: Contribution of the policy to inclusive entrepreneurship objectives

One of the goals of the SBIR programme is to increase the involvement of women, minorities and underrepresented groups in scientific and technical innovation. Evaluations by the National Academy of Sciences are helping to highlight needs in this area. One of the lessons learned is that it is important to include this aim at the foundation of the programme, rather than attempting to achieve the diversity at a later stage. This implies having those diverse stakeholders involved in the development of the programme, allowing diversity to be embedded.

Lessons for Denmark

The first lesson is that it is very difficult to enable some areas of technology to be commercialised, especially in the later stages of projects where it is important to ensure that commercialisation happens. Demonstration is a piece of the puzzle, so it is important to include additional government funding for demonstration projects. In addition to the SBIR programme, there is a loan programmes office in the US, which helps to fund viable energy projects. The loans may be large in scale, typically around USD 100 million in value. Without demonstration of the success of the technology, commercial players are not comfortable with investing due to the higher associated risks.

It is important that potential later-stage funders, and funders more generally, are included in the programme strategy development to ensure their buy-in. This is essential in guarding against the “cliff of funding” that projects can encounter as government support is withdrawn.

It is necessary to have a clear understanding of the goals of a programme. If the goal is to spur the small business energy ecosystem, then the programme has to take a different shape to one that is aimed at commercialisation. Too many programmes in other countries are the former. In programmes that focus on commercialisation, the entire ecosystem needs to provide input, not only those elements involved in R&D. It is also vital that the full pathway from start-up through to commercialisation is covered by programmes.

In the US, SBIR funding is strongly focused on areas where commercialisation makes sense. These correspond to areas in which there is some other available funding, a very strong potential customer base and an existing robust supply chain that provides a place for the technology. Finally, there needs to be a clear market for the product defined early in the process, before too much R&D has been undertaken.

Recommendations for Denmark based on the US case

- Appoint experienced technology managers, with experience in technology commercialisation, when designing programmes of this kind. SBIR testimonials show that their expertise, knowledge and networks are crucial resources for start-ups and scale-ups.
- Carry out regular evaluations of programme performance to identify value added from early stage funding. SBIR evaluation found that early stage grants make a significant difference to young clean-energy firms by increasing clean innovation and raising the chance of getting venture capital or other private funding by 50%.
- Provide additional funding for demonstration projects, which are essential to the commercialisation process.
- Be clear about the goals of a programme. If the programme is centred on commercialisation, then the whole ecosystem rather than just the elements directly involved in R&D need to be included. This ensures that there is a place for the new technology in the supply chain.
- Build diversity into the programmes, with specific programme goals in this area. Include and align programme metrics, evaluation and award selection criteria with diversity, equity and inclusion. Ensure programme leaders are experienced in ensuring diversity.

United Kingdom – Energy Systems Catapult

Overview

The Energy Systems Catapult (ESC) was set up to accelerate the transformation of the UK’s energy system. The catapult offers technical expertise and insights from a whole-system perspective, with specialists in consumer insights, digitalisation, modelling, markets, policy and regulation, bioenergy, carbon capture and storage, hydrogen, energy storage, energy networks, nuclear and renewables. With

its Living Lab of real-world smart interconnected homes for the trialling of commercial and technical innovations, ESC has established a deep expertise in market-orientated demonstration environments.

ESC works to bridge the gaps between industry, government, academia and research. It takes a whole-systems view of the energy sector to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest possible cost. It has approximately 235 staff based in Birmingham with a variety of technical, commercial and policy backgrounds. It collaborates on R&D and bid funding opportunities, connects with industry partners, investors or test facilities, and convenes with domestic and international stakeholders including governments and regulators. A third of the funding comes from the government, a third comes from awards of public money that have been bid for and a third comes from commercial income e.g. from assets, royalties and licensing income.

One of ESC's missions is to understand the future of the energy system and to support innovation by working with start-ups and larger innovators where applicable. Changes in the energy system are often broken down into four key trends, referred to collectively as the "four Ds" of energy system transformation (Soutar, 2021^[3]). These are decarbonisation, decentralisation, digitalisation and democratisation. Energy Systems Catapult sees digitalisation and democratisation as currently stimulating the largest changes, with digitalisation in this context referring to the move towards smart energy systems.

ESC's other core mission is to support innovators in commercialising energy products and services through performance validation, real-world consumer insights, business model analysis and system integration. It works with start-ups and scale-ups, especially innovators with disruptive ideas who are seeking to ground their ideas in viable business models, grow their position, acquire investment or refine their approach. The catapult has knowledge of the energy sector and the core skills needed to support innovators. This skill set includes social scientists with an understanding of consumers and engagement and the ways in which service propositions might change.

Energy Launchpad is ESC's innovator support platform. Energy Launchpad works with selected start-ups with high-growth potential, providing support at various stages from innovation assessment to commercial validation. Currently, Energy Launchpad works more with early-stage businesses than with scale-ups. This is a reflection of the evolving yet immature markets and new market spaces, which means that there is a high volume of new firms coming through. The platform also serves as a collaborative meeting place for innovators in the energy sector.

Energy Launchpad has a specific focus on the green transition, with the philosophy that innovation is crucial to transforming the energy system to achieve net zero carbon emissions. In order to stimulate innovation in specific areas of the energy system, Energy Launchpad runs numerous Challenge Calls. These challenges provide innovators with access to ESC's expertise and specialist business support. To date, Challenge Calls have been launched in a variety of areas including digital energy, smart heating and cooling, digital platform and data services, smart buildings and estates, low carbon interoperable energy solutions, and smart energy innovations for international markets.

Issue 1: How the Energy Launchpad works with start-ups and scale-ups

Energy Launchpad is designed to help overcome systemic barriers that prevent products, services and business models from getting to market at scale. It is free to join, with all members provided with a range of support measures including the provision of insights about the UK's energy system and ESC as well as help in finding partners and accessing events and workshops. Partner organisations provide the delivery support network of existing experts and other accelerating incubators that provide more conventional business support.

Via the Challenge Calls, Energy Launchpad provides two additional tiers of support to SMEs:

- **Incubation:** The incubator programme is designed for innovative start-ups that are looking to advance the Commercial or Technology Readiness Levels of new products and processes and

secure early-stage seed funding. The incubator provides tailored support to selected SMEs, utilising the ESC's capabilities and tools, as well as those of its delivery partners. This includes business model development, energy system integration assessments, consumer insights guidance, digital fitness, market testing and validation, investor readiness, specialist advice, and identification for acceleration support. Experienced incubation managers work closely with SMEs throughout the process. An area that is being explored is bringing start-ups together to develop end-to-end integrated solutions.

- **Acceleration:** Energy Launchpad's accelerator programme is designed for more established SMEs looking to scale up and trial solutions in demonstration environments, such as the ESC's Living Lab, export to new markets or secure later stage investment. It provides scale-up support for selected SMEs with high impact potential. The support provided includes help to access demonstration environments, such as the ESC's Living Lab, engagement with potential corporate clients and investors, and links to international opportunities. The alumni group is a means of keeping in touch with and providing continued support to firms that have completed the programme over the longer term.

Typically, each challenge has 30-50 applicants, of which six are selected based on a range of criteria including the potential for innovation, the carbon impact, the characteristics of the team and the additionality or impact that ESC can likely deliver. A new criteria is for businesses to have both software and hardware developments, for example sensors and equipment that enables monitoring and management of assets because this can be associated with greater scale up potential. 56 SMEs were helped through the first six innovator challenge calls, while a further 190 have been assisted through the wider support offerings.

Energy Launchpad's impact from the first six calls was reviewed in January 2021 (Energy Systems Catapult, 2021^[4]). The review showed high levels of satisfaction from participating SMEs, with over 81% reporting the achievement of at least one beneficial outcome. Of these, 96% felt that the support had led to enhanced outcomes or accelerated the rate at which they had been achieved. The benefits delivered to SMEs that have participated in the programme include support in obtaining financing, signposting of valuable contacts and access to networks, supplying pitch enhancement to help secure funding, as well as the injection of momentum and confidence. Many start-ups and scale-ups also report that there are reputational benefits from working with Energy Launchpad.

Together, the universal, incubator and accelerator support packages draw on the range of capabilities, tools and testing labs from ESC and its partners in order to accelerate deployment and turn innovators into entrepreneurs. The lack of specialist facilities and capabilities for energy firms was a motivation behind the establishment of the incubator and accelerator.

Issue 2: Infrastructure, pilots and testing

The Living Lab is a unique asset. It is where the Energy Launchpad is fully interconnected with real homes, enabling innovators to pay to trial both technical and commercial solutions. The consumer insights team helps SMEs to trial and interface with the end users, with support in areas such as service proposition or interacting with certain pieces of technology.

Issue 3: Ownership of IP

Even in collaborative projects, the SMEs own the IP rather than Energy Launchpad. The objective is to help the firms develop their IP. The exception to this is if the IP belongs to ESC.

Issue 4: Involving start-ups and scale-ups in regulation design

ESC's regulation team works with the government, regulators, SMEs, innovators, and academia to develop practical, solution-focused market design, policy and regulatory options. A key focus is on designing

policies and regulations to create a net-zero energy market. In the markets, policy and regulation teams, there are policy experts who consider how the market might change and what the corresponding regulation or policy changes may be. ESC also publishes a large amount of thought-leadership work, such as their recent 'Rethinking Electricity Market Design' report.

Issue 5: Diversity

Addressing the lack of diversity in entrepreneurs and workforces in the UK's energy system is a core part of ESC's mission. ESC has consciously decided not to develop specific targets or initiatives, instead focusing on its approach to recruitment. ESC has also published data on the composition of its workforce, broken down by gender and ethnicity.

Fuel poverty is a topic that receives a lot of consideration at Energy Launchpad. There is a risk with the energy transition that more disadvantaged households are left behind. Work is therefore being conducted on how the energy sector might develop in a more equitable way.

Lessons for Denmark

The key lessons for Denmark are that start-ups and scale-ups are strategically important as innovators in the energy sector, especially in green transition approaches. Energy Launchpad provides three levels of support for SMEs, including incubation and acceleration services. The latter involve working with large firms and investors as well as providing access to international markets. Energy Launchpad also involves SMEs in regulatory policy design, building on their innovation capacity. It has a clear commitment to internal diversity but has not addressed diversity in the organisations with which it works.

Recommendations for Denmark based on the United Kingdom case

- Sector support organisations need to adopt a philosophy of working with high-potential start-ups to take them from innovation assessment to commercial validation. Innovation is crucial to transforming the energy system to achieve net zero carbon emissions.
- Sector organisations which have different remits should offer different levels of support to their start-up and scale-up members, based on their stage of development. Of central importance are the availability of capabilities, tools and testing labs.
- Energy Cluster Denmark and public authorities need to involve start-ups and scale-ups in regulation design to develop a net zero energy market.
- All sector support organisations should have a clear policy on equality, diversity and inclusion.

References

- Butcher, M. (2021), *6 Copenhagen investors share their outlook on investing in 2021*, Tech Crunch. [2]
- Energy Systems Catapult (2021), *Insights and Impact from the first 3 years of the Energy Launchpad*. [4]
- International Energy Agency (2022), *Denmark Country Profile*. [1]
- Soutar, I. (2021), *Dancing with complexity: Making sense of decarbonisation, decentralisation, digitalisation and democratisation*, <https://doi.org/10.1016/j.erss.2021.102230>. [3]

Notes

¹ <https://innovationsfonden.dk/en/programmes/green-missions/roadmaps-mission-driven-green-research-and-innovation-partnerships>

² See [Energy Incubator - Beyond Beta](#).

5. Food and bio resources

The food and bio resources sector stronghold in Denmark is characterised by growing opportunities for start-ups and scale-ups, in line with the advancement of the green transition agenda and an increasing consumer appetite for new kinds of food. Despite these sources of opportunity, there are also a number of barriers. This chapter presents policy recommendations that could strengthen start-up and scale-up activity in food and bio resources. It assesses barriers and policy gaps for start-ups and scale-ups in the sector and presents inspiring practice policy initiatives for start-ups and scale-ups in food and bio resources in the Netherlands, Ireland and Finland, including key takeaways that can be applied to the Danish context.

Policy recommendations for Denmark's food and bio resources sector

1. **Provide public sector support for improved physical piloting and testing facilities** for the food and bio resources sector, including state of the art facilities for a variety of tasks, such as handling waste, and access to capital equipment for piloting prototypes. This could include a national test centre.
2. **Address the funding gap faced by scale-ups when they reach medium size.** This includes finding ways to incentivise private investors to provide longer-term patient capital.
3. **Develop processes for public procurement of innovation from start-ups and scale-ups** in food and bio resources. This includes modifying pre-tender processes to make them easier for start-ups and scale-ups and introducing flexibility to procure products involving new types of food and ingredients or produced with innovative technologies. Technical and legal competences for public procurement of food and bio resources innovations should be developed across government. Other public programmes should support start-ups and scale-ups with their procurement capabilities. Targets could be set for SME participation in public procurement for innovation in this sector.
4. **Support start-ups and scale-ups with compliance with food and drug regulations.** The Food and Veterinarian Administration can provide advisory support and materials and consult with the sector to improve regulatory ease for introducing new products to the market.
5. **Promote the internationalisation** of the sector's innovative start-ups and scale-ups, including an initiative to support Danish food and bio start-ups and scale-ups with branding, support for connections with international partners, and provision of internationalisation advice. Business incubators and accelerators can play an important role.
6. **Broker and facilitate closer dialogue between large firms and start-ups and scale-ups** in order to help start-ups and scale-ups to solve their innovation problems and to validate their products.
7. **Introduce a prioritised focus on some specific niche target fields** within food and bio resources, working in collaboration between the public sector and industry players.

Introduction

The food and bio resources sector covers the production, processing and distribution of food, with a focus on biological residuals and environmentally-sustainable alternatives. Shifting consumer priorities represent a sizeable opportunity for this sector. For instance, there is a growing consumer awareness of climate issues, meaning that locally-produced food with smaller environmental footprints can represent much more attractive markets for retailers. Furthermore, efforts to reduce greenhouse gas emissions in the sector are creating opportunities in the development of plant-based foods and other organic alternatives to traditional dairy and meat-based products, such as seaweed, hemp, kale and insects. Other opportunities are provided by alternative/biobased proteins, which are proteins for food produced via fermentation technology that converts biological sidestreams into protein ingredients without the environmental costs associated with animal-protein production. Meanwhile, efforts to reduce waste in the food sector are creating a space for innovations in product development.

Public procurement is also beginning to be used to stimulate the food and bio resources sector in Denmark, for example in organic food (Holmbeck, 2020^[1]). Public procurement represents a potential market for this

sector and can offer many opportunities for start-ups and scale-ups in alternative food production as, for example, procurement of food deliveries to schools and health care facilities can relatively easily be adapted to small-scale producers such as start-ups. A difference between the food and bio resources sector and sectors that are capital-intensive and require long-term patient capital, is that entry barriers are lower, and early stage companies can be agile and responsive to market changes.

Another relevant development for the food and bio resources sector in Denmark is the consortium for biosolutions. Biosolutions includes fermentation techniques for development of new sources of protein for food using biological sources such as algae and biological sidestreams. The consortium was formed in early 2022 following a recommendation from the growth team for the Zealand region as part of proposals to achieve a green restart of business communities at the local level after the Covid-19 pandemic. Food & Bio Cluster Denmark is expected to take a lead role in implementing the growth team's recommendations for supporting biosolutions as a potential new business area.

Despite these opportunities, start-ups and scale-ups in Denmark's food and bio resources face a number of challenges:

1. Access to international markets
2. Limited firm-level innovation capabilities
3. High levels of start-up failure rates
4. Limited testing and piloting infrastructures
5. Slow and burdensome regulation
6. Lack of entrepreneurial finance
7. Skills development
8. University mindsets
9. Lack of branding
10. Lack of innovation engagement of large firms in the cluster
11. Lack of diversity

The remainder of this section describes each of the challenges listed above, before analysing examples of successful policy approaches in the Netherlands, Ireland and Finland.

Box 5.1. A promising food and bio resources start-up in Denmark – Faunaphotonics

This company was born out of technology developed in a Swedish university (Lund University). The company took the intellectual property and made the first prototype. It has raised about USD 18 million and has 35 employees. It makes next generation insect monitoring tools for the agriculture sector, seeking to find new ways of digitising insect data in agriculture. It has its own network of farmers and is now in the scale-up phase. It has just raised USD 6 million and is in the process of hiring more people.

Barriers for start-ups and scale-ups

Access to international markets

Start-ups in this sector stronghold are much less likely to export than more established businesses, which in turn are less likely to export than firms in most other sector strongholds and emerging industries (Statistics Denmark, 2022). Denmark's membership of the Enterprise Europe Network can assist in this

area by providing connections to international partners, support for innovation and advice for international growth. Business incubators can also provide an important contribution in these areas.

There is scope in Denmark for an organisation that focuses on branding new innovations emanating from start-ups and scale-ups in the food and bio resources sector. Some of the existing organisations are dominated by large firms in the dairy, brewing and meat processing industries, and therefore are not providing start-ups with the international visibility they need. Food Nation Denmark is a national branding effort that could focus more on profiling new firms.

Stakeholders have suggested that the food sector as a whole should be promoted by government departments and Food & Bio Cluster Denmark, with the aim of increasing the internationalisation of the sector. In the past, there has been a lot of regional support in food clusters and the small regions want to promote it individually. However, the competitive advantage for Denmark's food and bio firms is international.

Limited firm-level innovation capabilities

A traditional barrier to scaling up in this sector in Denmark is that new companies often focus on developing incremental improvements, such as a new flavour of food, rather than more radical developments. Thus, the sector has only to a limited degree seen the creation of start-ups based on radical technological developments. This is due in part to the sheer scientific complexity of identifying how to operationalise the process of making new materials into functional and nutritious foods. This requires a broad set of competencies in and knowledge of processing, food safety, compliance and the wider market. Many start-ups do not have these competencies. While there is a high number of start-ups in the sector in Denmark compared to advanced production and energy technology, the ecosystem would benefit from more new businesses as this would lead to an increased variety of innovation.

High levels of start-up failure rates

A barrier to the sustainability of the food and bio resources sector is that the majority of start-ups die within the first five years. Stakeholders have suggested that a particular problem in the sector is that 40-45% of those that fail do so because they do not have the right market fit and do not understand the needs and demands of their customers. Therefore, an important part of the very early validation process is to verify that the product fits the market in a way that will generate sales. Food & Bio Cluster Denmark can play a crucial role in helping start-ups and scale-ups to understand their markets because of the cluster organisation's relationships with 300 established companies, some of which are among the largest in the industry with the resources and market access to assist with the validation of products. Another issue is that there are entrepreneurs in incubators in the sector that do not have the ambition of scaling up. In these cases, it is not necessarily advisable to push them in this direction.

Limited testing and piloting infrastructures

Stakeholders have identified that a major barrier to growth for start-ups and for scale-ups, particularly in high technology fields, is the lack of physical piloting and testing facilities in Denmark's food and bio resources sector. Start-ups and scale-ups increasingly need state of the art facilities for a variety of tasks, such as handling waste. For some companies, it is also difficult to find hardware or capital equipment for piloting prototypes when transitioning to the scale-up phase when access to costly stainless steel is required. Moreover, some equipment that is needed for the scaling-up process is required at a larger than laboratory scale, such as that found in universities or research and technology organisations (GTS Institutes).

It is difficult for a private company to achieve the economies of scale necessary to make operating these facilities economically viable for them. Access to this type of infrastructure could be organised by an

integrated body with numerous interconnected functions (see the case of the Netherlands Food Valley described later in this chapter). The endpoint would be to facilitate the development of products that are affordable for customers and profitable for producers. This would be particularly beneficial in the raw material sector because of the high cost of piloting prototypes. A related challenge is making prototypes cheaper and smaller. To this end, Denmark would benefit from a national test centre, which attracts companies of all sizes in order for the sector to compete globally. This could have a focus on sensor technologies.

Some of the incubators run by Food & Bio Cluster Denmark have offered these kinds of facilities. However, this provision is not sustainable without government support. A problem is that many government support schemes for incubators focus on salaries and seldom provide funding for the purchase of materials or for investing in facilities. New schemes that include support for these types of activities would be needed to help with the establishment of facilities that can be used by multiple companies.

Universities, such as the Technical University of Denmark (DTU), also have testing and piloting facilities. However, the difficulty is that firms can only use them on the rare occasions when there is not a scientific project in progress. It would make a significant difference to start-ups and scale-ups if universities were to provide facilities that are exclusively for businesses' use. A next step might be to work with universities to develop specific test and pilot facilities where start-ups and scale-ups can benefit from the knowledge of university researchers and those operating the facilities on a day-to-day basis. GTS Institutes do have facilities for the food sector, although stakeholders report that for some companies, it is still necessary to go to the Netherlands for the piloting and testing stage of the innovation process.

Denmark does have some very good specialist competencies and technical institutes that can support with certification or initial hardware testing for start-ups. For example, the Danish Knowledge Centre for Agriculture (SEGES) is a limited partnership company and the main supplier of professional knowledge for the agricultural professions. The organisation can help with field trial designs for new and growing firms, and works closely with the government, universities and professional and industrial bodies.

Slow and burdensome regulation

A key challenge in the food and bio resources sector is compliance, especially for start-ups in the food sector. This is because of the high level of regulation surrounding the operation of a food business, particularly if the business is doing something radically new or different to established practices. There is a regulatory divide in the sector between the traditional way of making foods and the high-tech area where more compliance is needed. For example, there are a lot of regulatory obstacles to using protein-based insects as a basis for food and to the use of new proteins or cell-based food more generally (Danish Veterinary and Food Administration, 2021^[2]). It takes on average two years for a business to receive regulatory approval from the European Union (EFSA) in the sector. Due to the large amount of documentation needed to achieve regulatory compliance, it is essential for new firms to think about compliance from an early stage. The Danish Food and Veterinary Administration provides advice to start-ups on this topic, and is also working to reduce regulatory barriers. However, there is a need to increase awareness of its services among early-stage start-ups. This could be organised for example with support from the cluster organisation and regional business hubs and universities that are in contact with start-ups.

A mapping of regulatory barriers to biosolutions companies in Denmark and other selected European countries conducted by the Danish Business Authority has shown that current European regulation in several areas constitutes a barrier to the development and market introduction of new biosolutions to the market. Furthermore, long case handling times for approval of biosolutions at the national and European level are also a significant barrier. This means that large biosolutions companies look to markets outside the EU and also place their R&D departments outside EU, while smaller companies and start-ups may not succeed.

Lack of entrepreneurial finance

There is a gap in funding for scale-ups when they reach medium size. The most important issue for hardware manufacturers is the length of time taken to reach maturity, which may be 10 years in some cases. Long-term thinking by investors is an essential ingredient that is missing in Denmark, not only in the food and bio resources sector. In traditional food companies, investors expect to see a return within a very short period of time. This means that some start-ups with excellent potential but a slower route to market do not progress further because of lack of long-term funding. While there is a lot of public support in the entrepreneurial finance system, there is a need for longer-term private investment i.e. patient capital. Denmark lacks specialised investors, which means that some firms find it easier to access foreign capital from countries such as the US, France or Germany.

The Danish agriculture sector is characterised by high but declining levels of investment (European Commission and European Investment Bank, 2020^[3]). There are, however, local initiatives that involve EU funding. For example, in Central Jutland, the Future Food Innovation (FFI POP) project has helped participating companies grow through the development of new products, services and processes.

Skills development

Skills shortages are not generally reported to be a barrier in the food and bio resources sector. Some of Denmark's universities, colleges and vocational institutions have excellent teaching programmes in the field and students from related programmes have good job opportunities. It is also possible for businesses to recruit foreign workers, for example from Spain and the Czech Republic. However, it is important for the sector to work with universities to ensure that they nurture the skills needed for future developments in the sector. This is because a diversity of skills and competencies are needed for a start-up or scale-up to succeed.

University mindsets

Firms in the food and bio resources sector have traditionally had close links with research institutions, including through joint projects between SMEs and universities. An obstacle has nonetheless been the lack of an entrepreneurial mind set within universities, where career progression is predominantly related to research and publishing rather than collaborations with companies. With some exceptions, universities have tended not to value the expertise of staff who collaborate with companies, although this appears to be changing. A challenge is to identify a start-up's capacity for co-operation and absorbing knowledge before establishing a collaboration. This external facilitator role is one for Food & Bio Cluster Denmark.

Lack of innovation engagement of large firms in the cluster

There is a pressing need for start-ups and scale-ups to be engaged in a dialogue with the largest companies in the food and bio resources sector. While larger companies are looking at innovations, the process of shifting to new market areas appears slow. The historical context is that the largest companies have a close connection to primary production, both in agriculture and fishing. Food & Bio Cluster Denmark is therefore trying to introduce new forms of co-operation between the large firms and new and small firms, in order to bring more innovation into these traditional markets. One of its measures is a new process whereby it goes to the four largest member firms to identify some of their major innovation and product development issues in a particular area, for example plant-based foods. Food & Bio Cluster Denmark then takes these problems back to start-ups, university students and others who are willing to work with the large firms on the identified issues. A barrier to progress in this area is the need for start-ups to be able to supply the innovations at a large volume. Furthermore, the large firms need time to validate the inputs before commencing production.

Some of the larger food companies in Denmark are looking at new technologies and moving towards an open innovation model. They are working with start-ups in specific areas to create more innovation and new ways of thinking on topics including hardware and software for laboratory analysis, inputs based on alternative proteins and developments in packaging, such as waterproof and oxygen proof layers in cardboard. For example, one of the large firms has invested in a venture company called Rock Start Agrifoods in order to work with start-ups in Denmark and internationally. However, the start-ups need to reach a certain level of maturity so as to be able to demonstrate proof of concept to the larger company, including food safety compliance. There is a need for new policy tools to support this process (see the example of Vista Milk in Ireland later in this chapter).

Lack of diversity

Employment in the food and bio resources sector is not representative of the wider workforce and the industry's consumers. This is due in part to a shortage of women in the sector. Greater diversity could be supported by increased branding on inclusivity, a process that start-ups and scale-ups could be an important part of.

International policy experiences

Netherlands – Foodvalley NL

Overview

Foodvalley NL is an independent, international platform for innovation and facilitating the transition of the global food system. Since 2004, Foodvalley NL has been developing and strengthening the Food Valley ecosystem, which is an international ecosystem of organisations that work together to realise this transition. The cluster works closely with corporations, SMEs and governments at every level, as well as with leading educational and research institutions. It currently employs 25 staff and has an international membership of over 280 organisations. The funding model is multi-partner finance, involving local province funding, EU funding and membership fees. Membership fees are structured such that smaller companies pay less than larger ones.

Foodvalley NL started as an innovation cluster focused on accelerating innovation, tech transfer and R&D activities between research providers and businesses. It then moved to stimulating entrepreneurship by helping entrepreneurs to start and grow a business. Its philosophy is that entrepreneurs need to play a key role in the transition to a sustainable food system worldwide, providing tasty, healthy and affordable food for everyone. This approach also necessitates interaction with consumers.

Foodvalley NL is pro-active in seeking out and connecting the most promising businesses and entrepreneurs. It supports entrepreneurs along their innovation journey by providing access to partners, up-to-date information, facilities and capital. Through these activities, Foodvalley NL builds an entrepreneurial community that collaborates both locally and internationally, with the overarching goal of building a global sustainable food system.

Foodvalley NL sets the innovation agenda and then initiates and develops programmes to scale up innovations more quickly and to help member and partner organisations to develop and grow more swiftly. Members have access to potential investors and partnerships worldwide, excellent facilities, and resources across a wide range of industries and disciplines. Specific target fields relate to the Protein Shift, Circular Agrifood and Food and Health.

Issue 1: Shared facilities

Through Foodvalley NL's shared facility finder, members can access a wide range of innovation facilities by finding and sharing research equipment, laboratories, testing facilities and technologies. The facility focuses on four areas: research equipment, demonstration and testing, scale-up and production, and investment and funding.

The approach is to systematically review the facilities that are available in a certain field, for example the protein shift. An inventory is then drawn up of all relevant partners, including those conducting testing, extraction, upscaling, prediction or the development of equipment. The inventory helps to accelerate the process of obtaining information on the availability and accessibility of facilities. There are three staff members working in the area, who act as a point of contact for those with questions that the inventory can address. Through this channel, Foodvalley NL can then offer guidance or consultancy, make connections and refer businesses or entrepreneurs to relevant partners.

Issue 2: Accelerator support for start-ups

Foodvalley NL has two accelerators: StartLife Accelerate and ScaleUpFood. The programmes are organised in partnership with Oost NL, Rabobank, ScaleUp Company, ScaleUpNation, StartLife and Wageningen University & Research and World Food Center Development.

Each programme typically involves companies at different stages of development: early-stage start-ups, late-stage start-ups that are ready to scale, and upstream scale-ups. For instance, StartLife Accelerator is the most effective programme for early-stage start-ups to validate their technology and business model, acquire connections in the food and agriculture ecosystem, and pitch to investors. There are selection criteria for each of the programmes and the selection process involves an intake interview. A formal procedure is followed, which involves a decision tree that analyses the future of the idea and the possibility of failure, the quality of the current business model, and the openness or adaptability of the people in the company. Progress is then continuously monitored and discussed throughout the programme.

Issue 3: Working with corporates in start-up and scale-up programmes

On certain projects, large firms directly define and monitor specific projects for Foodvalley NL. Some large companies have innovation scouts looking for new opportunities and have staff members available and developing expertise in developing new innovation projects with partners. Others are more traditional in their approach. Overall, there is currently a rapid shift towards the increased participation of larger firms in Foodvalley NL networks.

Issue 4: Research and entrepreneurship training with universities

Wageningen University is a key partner for Foodvalley NL, and this link enables the provision of significant amounts of research training for individuals from across the world. Wageningen University is also one of the entry points for entrepreneurship, particularly for student entrepreneurs. Foodvalley NL collaborates with many other universities in the Netherlands and internationally in order to install appropriate teams for specific projects.

Issue 5: Policy on inclusive entrepreneurship objectives

There is no statement about equality, diversity and inclusion on Foodvalley NL's website.

Lessons for Denmark

Foodvalley NL has evolved a way of working that is flexible and adapts to specific needs that exist. Previously, Foodvalley NL spent a lot of time getting the "right" ecosystem in place. Recently, the focus

has shifted, with the current emphasis being on bringing more people and organisations together. As a consequence, the ecosystem is developing organically. The current priority is to steer efforts towards certain topics, which are purpose driven and thereby address the challenges that are out there rather than simply being a response to the needs of a community. Another priority is to evaluate every action undertaken in order to address the question: “how does this action assist in the transformation that Foodvalley is after?”.

In practice, this strategy involves:

1. Establishing dialogue across the entrepreneurship and innovation value chain so that start-ups and scale-ups are involved, partnerships are formed and collaboration is made easier, with a key target being to facilitate partnerships with global reach.
2. Sharing facilities between large and small organisations.
3. Establishing accelerators that address the needs of start-ups and scale-ups at different stages in their development.
4. Developing strong links between corporates and start-ups and scale-ups.

Recommendations for Denmark based on the Netherlands case

- Food & Bio Cluster Denmark needs to be proactive in finding promising start-ups and scale-ups, matching them to potential partners and connecting them to resources. More long term and free funding would be instrumental in achieving this.
- Food & Bio Cluster Denmark’s strategy needs to be one of setting the innovation agenda, including the identification of specific target fields.
- Of crucial importance to start-ups and scale-ups is access to piloting and testing facilities. This means developing a co-ordinated approach to carrying out an inventory check that identifies the location and availability of relevant facilities and facilitates the sharing of knowledge and access.

Ireland – Science Foundation Ireland Research Institutes (BioOrbic and Vista Milk)

Overview

Similar to Denmark, Ireland is a leading producer of food and agricultural products and its agricultural research is world leading. The food and bio resources sector in Ireland provides peer learning and support at an advanced level. Of particular interest to Denmark is the close co-operation between universities, industry and research institutes, with this co-operation intermediated by Science Foundation Ireland’s (SFI) research institutes. SMEs as well as large firms, both national and international, participate in these networks. Key features include coherent planning, technology transfer from universities, national branding efforts, cluster development, public-private partnerships and business promotion.

SFI funds research at industry-themed research institutes. They are university based, with universities as lead actors. However, the research activities are conducted in close co-operation with SMEs and large firms in selected industrial strongholds. The research promotes and assists the development and competitiveness of industry, enterprise and employment in Ireland.

SFI funds both oriented basic research and applied research. Oriented basic research is research that is carried out with the expectation that it will produce a broad base of knowledge that is likely to form the background to the solution of recognised or anticipated problems or possibilities. Applied research is an original investigation undertaken to acquire new knowledge directed primarily towards a specific practical objective. The results of applied research are intended primarily to be applicable to a single or limited number of products, operations, methods or systems.

In the field of food and bio resources, the relevant SFI research institutes are:

- The SFI Bioeconomy Research Centre (BiOrbic), which was founded in 2017. BiOrbic undertakes research projects to use biological resources sustainably in order to produce goods such as bioactive molecules, chemical building blocks, plastics, fuels and energy. It has a particular emphasis on converting the residues from the agri-food and marine sectors to create new business opportunities for high-value products. The development of new value chains will allow these industries to diversify and add value to the sector, increase resource efficiency and complement food production activities. BiOrbic also considers how consumers will react to these new products.

A primary function of BiOrbic is to bring small and large companies together, so that the former have access to knowledge and can engage with a variety of stakeholders. BiOrbic also works closely with policy makers to establish priorities for the industry that reflect its needs and wants. It has a prominent position in the National Bioeconomy Forum, which was established for industry to come together to identify priorities, sources of investment, methods for bringing research to market, and market challenges and solutions.

BiOrbic has a strategy of encouraging spin-out companies. So far there are two. One spun-out from a large firm and has maintained a close relationship with the parent company, which is now considering buying shares in the spin-out.

- The SFI Research Centre for Digitalising Dairy Production and Processing (Vista Milk) is funded by SFI and the Department of Agriculture, Food and the Marine (DAFM). The research centre represents a sectoral collaboration between research institutes and leading Irish and multinational companies in the food and information communication technology (ICT) sectors. The centre is hosted by the Teagasc Food Research Centre, in partnership with the Tyndall National Institute, Ireland's national microelectronics institute, the Telecommunications Software & Systems Group (TSSG) at the Waterford Institute of Technology, the Insight Centre for Data Analytics and the Irish Cattle Breeding Federation (ICBF). Vista Milk aims to develop electronic monitoring and actuation technologies to transform the dairy production chain. It specifically addresses pasture-based dairy production, improved processability and the generation of novel, higher-value-added products. Particular focus is given to developing state-of-the-art analytical techniques applied to large-scale sensor datasets, using advanced network and communication technologies.

SFI research institutes' support for start-ups and scale-ups is complemented by a range of national enterprise development programmes, principally through Enterprise Ireland. Enterprise Ireland offers a comprehensive range of support measures to high potential, export-focused entrepreneurs and companies. This includes the provision of business funding, advice, mentoring, introductions, and practical help to enter overseas markets. Additional policy tools to support start-ups and scale-ups in the food and bio resources sector include research and development tax credits. A new initiative is Knowledge Box, which offers a preferential tax rate on certain types of assets, including patents, which are located and managed in Ireland.

Issue 1: Overcoming fragmentation

A major issue is the fragmentation of the food and bio resources sector, which includes many small firms spread across farming, forestry and fishing. This fragmentation can make engagement a challenge. A key role of BiOrbic is to guide small players through the policies that are going to impact their businesses, an example of which is the carbon tax. Start-ups and scale-ups account for around half of the approximately 20 companies that BiOrbic works with, and there is a push to engage with more of these types of companies.

Another area of focus is waste streams. Larger companies are now more open to working with smaller companies with new ideas that promote sustainability. For instance, one of BiOrbic's spin-off companies is working with a large dairy company in developing a net zero approach. This promises to deliver benefits

both for the project partners and for the farming industry more broadly. As well as contributing to the green transition, the innovative ideas that are generated create opportunities for new high-value products.

Vista Milk also acts as a broker and intermediary between large and smaller companies. A key feature is the independence of the organisation, which gives it legitimacy and credibility. All companies are treated equally, often through personal relations.

Issue 2: Working with different kinds of start-ups

Start-ups involved with BiOrbic fall into two main groups. Firstly, there are the classic start-ups in biotechnology that develop products that improve human or animal health. Secondly, there are start-ups that focus on sustainability, essentially acting as service companies to help farmers and others understand their environmental impact through an analysis of factors such as biodiversity, carbon footprint, and impacts on air and water quality.

Vista Milk has 50 partners in the milk industry, including seven very early stage start-ups. However, start-ups are not a key priority as they do not bring money into the organisation. Vista Milk has two models of engagement. The first is a new model, where people sign-up and receive a free monthly newsletter and invitations to industry meetings. The second is a more traditional and targeted model, where Vista Milk analyses companies' activities and their usefulness for Irish farming. Promising companies are then provided with experts who work with the firm for free.

Issue 3: Testing infrastructure and help with regulatory compliance

BiOrbic provides key access to testing facilities and help with compliance with food and safety regulations, particularly for smaller start-ups. This support is provided through the skills and expertise of researchers, as well as the facilities, infrastructure and experts at the research centre. The firms benefit from a fast track because they are advised on whether their products need to go through regulatory approval.

In situations where BiOrbic does not have suitable facilities, the SMEs are guided elsewhere. For instance, if pilot scale facilities are available at another institution, BiOrbic will reach out and encourage a collaboration. In some cases, a memorandum of understanding is designed and agreed. Some key facilities are housed within universities. A challenge faced by those working in rural areas and/or are starting a company for the first time is that they may not have experience interacting with universities. In these situations, facilitation by BiOrbic is needed to connect the entrepreneur with the research institution.

Vista Milk also provides support for start-ups and scale-ups through access to infrastructure, which enables field trials and the use of specialised equipment. The firms can consult subject matter experts and can utilise the infrastructure at considerably lower costs than they would otherwise have access to. An experimental system is rented out for EUR 70 000 plus up to 40% in overhead costs. However, the firm retains ownership of the IP and the data. The firms give Vista Milk their product for testing and engage with them on the experimental design. Vista Milk then generates the results, typically over a six-week period, and may analyse results and or provide the firm with the data. Through this, start-ups are provided with the infrastructure at a considerably reduced cost. If the product is successful, then a two-year period of infrastructure access can be discussed. Management of intellectual property is much more complicated when the firms have to deal with universities. Vista Milk has also run workshops on R&D tax credits, which start-ups have attended.

Issue 4: Regulation and food standards

Vista Milk has a representative of the food safety authority on its Industry Advisory Committee. Thus, when, for example, new dairy products are being developed by a firm, the firm is introduced to the food authority for early discussions.

Issue 5: Intellectual Property Rights (IPR)

In Ireland, IPR can be a considerable barrier to collaboration between start-ups and scale-ups and universities and research institutes. This is because universities wish to profit from patents and licences, which can often make them prohibitively expensive for start-ups or scale-ups to obtain. However, Vista Milk appears to allow their researchers some discretion and flexibility in this area in their collaborations with start-ups. For example, they may not charge the start-up for their initial involvement in a project, allowing intellectual property to flow freely.

Issue 6: Policy for inclusive entrepreneurship

There is an inclusive approach and an effort to bring all sections of society together within BiOrbic and Vista Milk. BiOrbic formed its Equality, Diversity and Inclusion Working Group in 2020, but it is recognised that a broader, more intersectional approach would be beneficial. Vista Milk has an equality, diversity and inclusion policy. It also recently introduced a new key performance indicator, namely that women should have at least 40% representation in its leadership. Female representation in Vista Milk's leadership currently stands at 38% and it is one of the best SFIs with respect to gender equality. Staff originate from 28 different countries, so there is also good cultural diversity. In recognition of the importance of diversity, equal opportunities and transparent decision-making, a current recommendation is to undertake a cultural audit.

Lessons for Denmark

The main messages from BiOrbic relate to:

- Helping SMEs that do not traditionally work with universities to overcome barriers to university collaboration. Support for collaboration ensures more up-to-date product development portfolios for SMEs and universities.
- Supporting links between start-ups and scale-ups and larger companies helps these larger companies to diversify into new product areas, for instance when they are compelled to address green transition issues.
- Facilitation of access to facilities in Ireland.
- Providing help for start-ups and scale-ups with regulatory issues, particularly associated with novel foods.
- Ensuring inclusivity in the approach to working with start-ups and scale-ups, to allow the voices of all sections of industry, society and policy to be brought together so that innovation processes are fully informed of opportunities and challenges. Social enterprise represents one of the opportunities for start-ups and scale-ups.

For Vista Milk, a key message is that start-ups should be invited into the research process, “have coffee with the researchers” and be facilitated in deploying their technologies on the farm.

Recommendations for Denmark based on the Irish case

- Food & Bio Cluster Denmark should work with policy makers to establish priorities for what new products and services industry wants to develop
- Food & Bio Cluster Denmark should develop the capacity to guide small players through the policies that are going to impact their businesses, such as carbon tax.
- The cluster organisation should work closely with government enterprise support agencies to identify which enterprise and innovation programmes are relevant for the food and bio resources sector.

- Food & Bio Cluster Denmark should engage with larger companies to encourage them to work with smaller and newer firms in order to help solve their innovation problems, especially with respect to sustainability.
- Provide access to infrastructure, in particular testing facilities and help with compliance with food and safety regulation.
- Food & Bio Cluster Denmark should develop an equality, diversity and inclusion working group.

Finland – Public Procurement for Innovation : KEINO

Overview

Public procurement for innovation

Public procurement for innovation (PPI) is a demand-side policy that plays an important role in mission-oriented policies, leveraging public-private co-operation to co-create and shape markets for new sustainable products and services. It is a powerful instrument with the potential both to drive new innovations and precipitate the faster adoption of innovation among public sector users. PPI can boost economic growth by providing innovative companies, in particular start-ups and scale-ups, with the opportunity to obtain first user references.

PPI requires a shift from a purely administrative approach to public procurement to a strategic and needs-driven approach. This involves moving away from the traditional, two-dimensional rationale of focusing almost exclusively on final cost and additional services offered, with rigid definitions for the products or solutions to be provided. Instead, PPI uses more differentiated parameters and criteria that enhance quality-oriented, sustainable and long-term economic, societal and environmental outcomes. Instead of pre-defining the solutions to a given situation, PPI describes the needs or problems to be solved, allowing for a greater range of potential solutions. This is known as functional PPI. This is also a focus for CO-PI, the new unit for public-private innovation in Denmark¹.

The strategic use of public procurement is intended to harness the purchasing power of the public sector to stimulate the development of new products and solutions. Even though PPI is a strategic instrument that can drive growth and bring multiple benefits to public authorities, industries, consumers and society as a whole, its widespread adoption is only taking place slowly and is hampered by a number of challenges that need to be addressed. These include a lack of awareness, knowledge, experience and capabilities related to new technologies and market developments, as well as a lack of incentives and motivation to purchase innovative solutions from new companies rather than purchasing established products from long-standing suppliers.

PPI tenders that only specify problems to be solved will often require innovative solutions. This lends a competitive advantage to start-ups that are based on new knowledge and technologies over less innovative incumbent firms. If PPI is supported by funding for developing new solutions, it can represent a large growth market for start-ups and scale-ups. Such PPI models can be found in countries such as the USA, Canada and Sweden.

KEINO

KEINO was established in 2018, funded by the Ministry of Economic Affairs and Employment for the period 2018-2021. It is a network-based competence centre for sustainable and innovative public procurement in Finland, building on and exploiting expertise in existing public agencies. Public procurement spending in Finland is EUR 47 billion each year. EUR 31 billion of this amount is sourced from competitive markets with the remaining purchases being contracts between public bodies. The innovation procurement programme in 2021 is targeted at 10% of national spend. The government grant programme for preparing

the tender is overseen by Business Finland, and is usually targeted at larger procurements such as IT systems. Typically, funding is provided to cover 50% of the procurement design and innovation costs. The intention is to increase the number of innovative and sustainable procurements in Finland by recognising and actively using public procurement as a management tool, with contracting entities openly disseminating information on their experiences and learning from one another.

The founding members of KEINO responsible for its operation and development are Motiva, the Association of Finnish Local and Regional Authorities, VTT Technical Research Centre of Finland Ltd., the Finnish Funding Agency (Business Finland), the Finnish Environment Institute (SYKE), Hansel Ltd, KL-Kuntahankinnat Ltd and the Finnish Innovation Fund (Sitra). Hansel and KL-Kuntahankinnat have been merged and are currently operating jointly as Hansel Ltd., and Sitra is not any longer involved with KEINO. Core competencies of KEINO include public procurement, business and innovation, sustainable development, technology and innovation procurement, environmental research and assessment methods, municipal and city management, and service domains.

KEINO seeks to increase contracting entities' awareness of strategic procurement management and influence thinking. It aims to assist contracting entities in management tool development and measurement and set up impactful and efficient buyer groups for procurement in the fields of social welfare and health services, construction and energy use, mobility and logistics, and the bio- and circular economy. KEINO also supports the development of procurement competencies through advisory services, events and KEINO-agent activities. Through the KEINO Academy training programme, it also seeks to strengthen international networks and peer-to-peer learning for procurers. KEINO also has regional activities including an innovation broker service and a network of 12 regional change agents. Procurement strategies are designed to encourage environmental awareness and social considerations. Calls for tender reflect those priorities.

An example that illustrates the potential of PPI to trigger the emergence of successful start-ups is the experience of a start-up that won a contract to develop a medical dispensing system for hospitals. Through the resulting programme, the start-up has been growing by 25% per year, and is now the market leader in Finland with large contracts for the major hospitals. The start-up is currently customising its product to target overseas markets.

Issue 1: Legal hurdles to supporting start-ups and scale-ups

While there is a strong consensus within KEINO that PPI is a potential pathway for supporting start-ups and scale-ups, procurement laws are very strict about not favouring any specific type of company. Accordingly, even if regions or cities are eager to make it easy for small companies to enter into public procurements, they sometimes lack the means to do so because of legal issues surrounding neutrality and confidentiality. However, solutions can be developed in a collaborative way by creating links between public procurement and other policy instruments. For example, there is an extensive discussion around test beds, innovation environments or different types of funding modalities that could bring things together more efficiently. To help, advice is regularly given to procurers to split larger tenders into smaller chunks to enable smaller companies to participate. This does occur in certain instances but is not always a feasible option.

Issue 2: Climate-friendly procurement of milk and dairy products - Case City of Helsinki²

An example of PPI in Finland is the City of Helsinki's procurement of the milk, dairy products and plant-based products used by schools and day care centres in the city, Service Centre Helsinki, foundations and the facilities of the Social Services and Health Care Division. The procurement value is approximately EUR 14 million and the procurement procedure is an open one. The procurement aims to reduce emissions and increase responsibility and involves multi-disciplinary co-operation. Procurement criteria steer companies' provision and companies are consulted in an ongoing dialogue.

Issue 3: Using sustainability criteria in competitive bidding for food procurement – Case City of Salo

Every day, the City of Salo serves and home-delivers 14 000 meals in schools, day care centres, hospitals and senior citizens' assisted living facilities. The object of procurement in this example is therefore food products. A competitive bidding process guided the City's food procurement, underpinned by a procurement policy programme for 2016–2019. The objective was to procure sustainably-produced, high-quality food products. A further aim was to enable small local producers to participate in the bidding. The four strategic guidelines were:

- A systematic, economical approach
- Business-friendliness and vitality
- Innovation and experimentation
- Responsibility

These guidelines were implemented by monitoring procurement, increasing market dialogue, adopting new procurement methods and procuring responsibly. All of the guidelines were implemented in the competitive bidding process for food procurement, reflecting a specific programme goal of responsible food procurement. The procurement was implemented in co-operation with catering and procurement service companies. Extensive market dialogue was carried out during the pre-tendering phase. Specifically, small producers' opportunities to participate in the competitive bidding were facilitated. The consultancy Yrityssalo organised a separate event to provide companies with guidance on responding to the public invitation to tender. Sustainability criteria that were used in the evaluation of bids included the promotion of animal welfare and health, food safety, environmental impacts, and social responsibility. Overall, the selection criteria were divided between price and quality, with the former receiving a weighting of 70% and the latter receiving a weighting of 30%.

As a result of the process, all of the unprocessed meat products used by the City of Salo's food service units are now of Finnish origin and the overall degree of Finnish origin of food products has increased. However, local producers did not submit bids, despite the special efforts that were taken to ensure that small producers had the opportunity to participate.

Lessons for Denmark

There is great potential for using public procurement resources to shape and co-create new markets in partnership with the private sector, stimulating the development of new products and solutions provided by start-ups and scale-ups that are socially sustainable and contribute to the green transition of the economy. The rationale for PPI is to address social, sustainability and service challenges where there are no existing products and solutions in the marketplace and there is clear room for productivity improvements. If successful, innovative suppliers obtain a good reference case, demonstrating that they have truly made a difference for their public client, for example by increasing productivity or raising living standards. This helps them to attract further clients. Although Denmark is among the EU's good performers on PPI, it underinvests in PPI when compared to Finland, which ranks first in the EU (European Commission, 2016).

One of the lessons of the Finnish experience is that it took a long time to build support for PPI across the Finnish government. For Denmark, it will be important that all involved parties share a common aim of deploying public procurement as a strategic tool to meet goals, especially those related to solving societal challenges.

KEINO's experience also shows that a competence gap PPI in legal and technical areas will need to be overcome before more complex issues about favouring innovation in the best possible way can be addressed.

KEINO has built procurement strategies that embrace start-ups and scale-ups. KEINO also encourages procurement units to find new ways of implementing procurements, which has fostered an experimental culture.

It should be noted that from 2022, the Danish government, municipalities and regions agreed to strengthen public-private innovation and innovation procurement and established a new joint unit, CO-PI, dedicated to support this purpose. This is expected to benefit SMEs' participation in public procurement. However, Denmark does not have a target for innovation procurement or a target for SME participation. Hence, incentives need to be built into the actions by CO-PI.

Recommendations for Denmark based on the Finnish case

- Promote PPI across government as a strategic way of promoting innovation in food and bio resources.
- Build PPI competences with respect to food and bio resources across government.
- Set targets for the level of innovation procurement and the participation of SMEs.

References

- Danish Veterinary and Food Administration (2021), *Insects — farming and use as feed and food in Denmark and the EU — what's allowed and what is not?* [2]
- European Commission and European Investment Bank (2020), *Financial needs in the agriculture and agri-food sectors in Denmark.* [3]
- Holmbeck, P. (2020), *Best practice in Organic Public Procurement: The case of Denmark*, IFOAM Organics Europe. [1]

Notes

¹ <https://co-pi.dk/>

² The two food procurement examples are good examples of sustainable and green procurement but they are not the most innovative cases of Finnish procurement. Procurement of more innovative solutions can be found e.g. in these cases: (1) [Modern ERP system for waste management](#) (2) [Pre-Commercial Procurement for developing self-driving buses](#) (3) [Digitalization of Field Inspections](#)

6. Conclusions and proposals for Denmark

Conclusions

The analyses in this report shed light on the key challenges that start-ups and scale-ups face in three sector strongholds in Denmark and the lessons that can be drawn from programmes designed to stimulate start-ups and scale-ups in these sectors in other countries.

In Denmark's advanced production sector, start-ups are relatively large in employment and turnover terms. There is also a high share of scale-ups in the business population. However, start-ups and scale-ups face challenges surrounding supply chain entry. Low representation in the national cluster organisation and long development timescales are major issues in this sector stronghold. The cases of Austria's Plattform Industrie 4.0, Canada's Advanced Manufacturing Supercluster, and Sweden's Robotdalen and Automation Region highlight the important role that cluster organisations can play in supporting start-ups and scale-ups in the advanced production sector.

Denmark's energy technology sector has a greater share of start-ups than either the advanced production or food and bio resources sector strongholds. Furthermore, the average revenue of energy technology start-ups is more than four times' higher than the economy-wide average. Moreover, while the number of scale-ups in the energy technology sector is low, those firms that do succeed in scaling up generate significantly higher revenues on average. Start-ups in the energy technology sector come from a wider range of sources than their counterparts in the advanced production sector, with many new firms emanating from universities, outside of the supply chain and from crossovers from other sectors. An example of this would be entrepreneurs in the robotics field moving into the energy technology sector. Extended development timescales and insufficient access to finance are key challenges for start-ups and scale-ups in the sector. The industry structure of the energy technology sector, which is characterised by a small number of very large companies, can also stifle innovation by restricting the role of innovative new businesses. The United States' Small Business Innovation Research programme illustrates how the development and commercialisation of technology can be effectively promoted in the energy technology sector through the provision of grants to competitively selected start-ups. Meanwhile, the three energy clusters and catapult centres in Norway and the United Kingdom's Energy Systems Catapult provide a number of lessons that can be applied in Denmark, such as mapping new technology developments, providing testing and piloting facilities, employing technology managers, and involving start-ups and scale-ups in the design of regulations.

In Denmark's food and bio resources sector, new firms also emanate from a variety of sources. Start-ups and scale-ups in the sector face difficulties navigating the regulatory environment and developing radical innovations. These issues are exacerbated by limited testing and piloting facilities. Foodvalley NL and the Science Foundation Ireland Research Institutes provide a model for how start-ups and scale-ups can be supported in these areas, while Finland's KEINO scheme shows how public procurement for innovation can be an effective tool in the food and bio resources sector.

These sector-specific issues and lessons are reflected in the recommended actions set out in Chapters 3, 4 and 5 of this report. The remainder of this section focuses on a number of cross-cutting issues and policy recommendations that affect the development of start-ups and scale-up in all of the three case study sectors and that may be important in other sectors of the Danish economy.

Cross-sector policy recommendations

1) Develop patient capital

Funding for start-ups and scale-ups is a recurrent problem. A common theme is that there is finance available for software start-ups and scale-ups but far less for deep-tech and hardware firms in the advanced production and energy technology sectors that need larger funding rounds and patient capital, usually for up to a decade.

2) Build collaborations between large firms and start-ups and scale-ups

Large firms in the three case study sector strongholds are not engaging with start-ups and scale-ups to the extent seen in key innovation concentrations in other countries. Policy needs to seek a culture shift in this respect, for example through triggering activities of large firms as first customers for new firms, or through collaboration with large firms in developing incubators and accelerators.

3) Develop public procurement for innovation

The Danish Government, regions and municipalities recently established a new joint unit, CO-PI, which has been formed in order to strengthen public-private innovation and innovation procurement. Rather than focusing on specific public demand, the new unit will be based on market dialogue and focus on developing or adjusting solutions in collaboration with public and private actors. Focus areas are green transition, sustainable construction and technology that improves welfare services.

Public procurement for innovation (PPI) is a key instrument to support start-ups and scale-ups in other countries such as the USA and Finland. There is still a potential in Denmark to develop this area further, in part by learning from other countries' experiences. Actions are recommended to build a vision and strategy for PPI in Denmark, build PPI competences in government, and introduce targets for the participation of start-ups and scale-ups in PPI.

4) Build university-industry collaboration

Knowledge transfers are critical to start-up and scale-up development. Easier co-operation between universities and industry, especially start-ups and scale-ups, could be driven by reform of the IPR systems and the operation of technology transfer offices. More specifically, recommendations in this area are to:

- Address the problems of ownership of intellectual property that is held by the universities, as this is a barrier to commercialisation and working with start-ups and scale-ups. With its professor's privilege concept, Sweden offers a contrasting example in this area.
- Broaden the metrics for evaluation of researchers so that innovation and not just research and teaching are counted.
- Encourage universities to work more strategically with start-ups and scale-ups on innovation, for example by providing more targeted public support for this purpose.
- Complement the public funding system of universities so that facilitating start-ups and scale-ups and not only patents and licences provide earnings for universities. Such reform could make it cheaper for start-ups and scale-ups to exploit patents and licences from universities.
- National policy should encourage and recognise the contribution of university colleges to innovation and entrepreneurship and incentivise closer collaboration with universities and industries in developing talent supply strategies.

5) Provide long-term, freer cluster funding on a competitive bidding basis

The national cluster organisations can play a central role in start-up and scale-up development in the sector strongholds and emerging industries. However, for them to take roles in strategic actions for promoting start-ups and scale-ups they need access to some longer-term and freer public funding in addition to resources that are tied to delivering particular research project outcomes. The strategic actions funded in this way could include:

- Establishment of programmes for promoting start-ups and scale-ups;
- Pro-active work to find promising start-ups and scale-ups and match them to potential partners and resources;
- Facilitating closer co-operation among universities, larger firms and SMEs in the cluster;
- Initiatives to promote university and corporate spin-offs;
- Searching for extra-cluster (international) knowledge sources on behalf of cluster member firms (especially SMEs and start-ups and scale-ups);
- Supporting the international branding of the cluster and the organisations within it (which will particularly help SMEs, start-ups and scale-ups in accessing international markets and collaboration partners);
- Identifying international funding sources for cluster development.

The award of long-term, freer funding to different cluster organisations should be driven by success in proposing strategic actions in a competitive bidding process. Regular evaluation should also be applied to assess the extent to which stated objectives and targets in the bidding proposals are achieved, and continued funding provided only on condition of meeting success criteria. Cluster programmes in Norway and Sweden could be used as inspiration.

Norway has a stepwise cluster programme with three divisions: Arena with 3-5 years funding, Arena Pro with another five years funding, and Global Centre of Expertise (GCE) with an additional ten years of funding. This means that a cluster can get up to 20 years funding, although the more common funding periods is 10 years (as there are only three GCEs). The progression from one level to another depends on an evaluation of the new application and on the performance of the cluster as assessed by external evaluations. Evaluations are focused on whether the clusters are fulfilling the goals that were presented in the original funded application. In Sweden, the clusters are also rewarded through a competitive process and the normal period of funding is ten years. One half of the funding comes from Vinnova, and the other from regional triple-helix stakeholders. This funding period can be extended, as was the case with Robotdalen, which received funding for 16 years. Sweden's cluster programme is also subject to regular external evaluations, which examine whether the clusters are fulfilling the goals of their original funded applications. If not, the funding of the clusters from Vinnova will be terminated.

The aim of such long-term public funding of clusters is that a relatively small contribution (EUR 1 million per annum in Sweden) can enable the cluster member firms and the cluster management organisation to focus on strategic goals going beyond regular research and collaboration projects among cluster firms and between cluster firms and external organisations (e.g. universities). Cluster policy builds on the view of innovation as interactive learning, which implies that better and more collaboration between different actors in an innovation or entrepreneurial ecosystem promotes innovation and competitiveness. Evaluations show that the building of such collaboration takes time and also improves over time. This is a main reason for having long-term funding.

In Norway, the cluster organisations are tasked with identifying strong synergy effects within the cluster or with external organisations, within and/or across value chains and technologies, which will impact the cluster firms' innovative capacity, value added potential and international competitiveness. The cluster organisations are also tasked with contributing to industrial restructuring and new industry path

development. These goals cannot be fully achieved within a three-year funding period. A concrete example of what can be achieved with longer-term, more flexible, results-driven funding, is the success of two of the GCEs, Blue Maritime and Node (both within the maritime industry), in establishing a Centre for Research Driven Innovation in close co-operation with the universities in their regions. This is a ten-year funded project from Research Council Norway. The same rationales are behind the Swedish initiatives to establish regional clusters. The two cluster cases presented in this report, Robotdalen and Automation Region, provide abundant examples of a wide range of cluster support for internal and external co-operations and how they promote increased innovation and competitiveness among the cluster member firms as well as for the respective regions.

Annex A provides further discussion of strengths and weaknesses and potential development areas for the Danish national cluster organisations in the three case study sector stronghold areas.

6) Build linkages between national cluster organisations and regional entrepreneurial ecosystem actors

National cluster organisations have been established to centralise public support to clusters. However, much cluster activity in the sectors is undertaken at regional level, in local concentrations of cluster activity. A key challenge is therefore to organise systemic relations between the national cluster organisations and regional ecosystem actors such as science parks, regional networks and incubators.

7) Promote diversity in the populations of start-up and scale-up entrepreneurs

It is important to increase the diversity of firm founders in the strongholds in order to tap into wider talent, alleviate skill shortages and secure equal opportunities in entrepreneurship. Universities and university colleges can play a key role in promoting diversity in entrepreneurship by building up the entrepreneurial competencies of graduates and supporting them in start-up and scale-up activities, focusing on all groups of the student population. There is also a need for a broader diversity push to encourage social groups including women and immigrants to start and grow companies.

Timescales

Timescales for the recommended activities vary considerably. Instilling changes in the educational system is typically a long-term undertaking, whether it be to persuade more women to enter relevant disciplines, or changing the perceived role of universities or changing what is taught. However, there are quicker policy wins, even within the creation and retention of talent category. These include creating more powerful incentives for start-ups and scale-ups to work with universities and vice versa, finding ways of retaining talent within Denmark and interworking between clusters. Initiatives that “merely require money” can usually be done faster than those involving mindset changes.

In line with this, institutional changes relating to procurement rules and procedures and help with regulatory compliance can be achieved within a couple of years. Increasing the provision of incubators and accelerators and testing and prototyping facilities may take a little longer but can be started fairly quickly. Changes to IPR systems usually have significant lead times because of the plethora of interested parties and the politics of the area.

Policies for the development of patient capital need to be determined, but once, for instance, patient finance is in place, much can be achieved fairly quickly.

Finally, some actions need to be aimed at changing cultures, for example on the priorities, structures, and attitudes of the cluster organisations as well as those of prominent larger firms within the clusters. Attitudes can take longer to turn around.

Annex A. Evaluation of cluster organisations in the three case study sectors

The assessment framework

The interviews with stakeholders in the sector strongholds have provided numerous insights into the current approaches and perspectives towards supporting start-ups and scale-ups in the three case study sector strongholds for this report. Meanwhile, the nine international inspiring policy practice case studies have provided points of reference for Denmark. In this section, the template proposed by (Giest, 2021^[1]) is used to develop a summary of the collaborative and absorptive capacity in the advanced production, energy technology and food and bio resources cluster organisations, thus providing an assessment of their performance on these dimensions.

In Giest's model, collaborative capacity highlights factors such as the purpose of the clusters, the structure of the organisation, the communication strategy and the resources the cluster organisations have at their disposal to fulfil their mission. The absorptive capacity focuses on the intra-cluster and extra-cluster knowledge systems. A well-developed cluster with a competent cluster management organisation can be an important instrument in supporting start-ups and scale-ups, as it contains the key actors and inter-relationships within entrepreneurial ecosystems. According to (Brown and Mason, 2017^[2]), these key actors and inter-relationships are:

- Entrepreneurial actors (support and mentoring services, business incubators, and networking and accelerator programmes).
- Entrepreneurial resource providers (financial providers (e.g. venture capital), business angel networks, linkages to large firms, and linkages to universities and R&D centres).
- Entrepreneurial connectors (start-up communities, business enterprise centres, and investor-investee matching services).
- Entrepreneurial orientation (role models, and social status of entrepreneurship).

The two Swedish clusters presented in the advanced production chapter of this report are good examples of such well-developed clusters with the presence of many of these key actors and inter-relationships present.

Summary of cluster organisation assessment

Table A A.1 summarises the assessment of the three national cluster organisations on different dimensions of collaborative and absorptive capacity.

Table A A.1. Collaborative and absorptive capacity of the MADE, Energy Cluster Denmark and Food & Bio Cluster Denmark

Framework	Basic elements	MADE	Energy Cluster Denmark	Food & Bio Cluster Denmark
Collaborative capacity				
Purpose	Leadership	✓	✓	✓
	Shared vision	✓	✓	✓
	Network membership	Partly	✓	✓
Structure	Formal and informal	✓	✓	✓
	Procedures	✓	✓	✓
	Clear roles	✓	✓	✓
Communications	Information links	✓	✓	✓
	Active communications	✓	✓	✓
Resources	Knowledge and skills	✓	✓	✓
	Financing power	Partly	Partly	Partly
Absorptive capacity				
Intra-cluster knowledge system	Knowledge spillovers	Partly	Partly	✓
	Social relations	✓	✓	✓
Extra-cluster knowledge system	Extra cluster knowledge sources	Partly	Partly	Partly
	Interface between the external linkages and the intra-cluster knowledge system	Partly	Partly	✓

Source: (Giest, 2021^[1])

Collaborative capacity within clusters

Table A.1 shows that the collaborative capacity of the national clusters in the three sector strongholds is good, with the exception of financing power and to an extent the network membership. Providing better collaboration between stakeholders from the private and public sector, and between industry and Danish Universities was one of the main aims of establishing the national cluster organisations. Based on the interviews undertaken, it seems that the cluster organisations have the leadership required to achieve this aim, and also a shared vision of their mission among their stakeholders. The structure of the cluster organisations as well as the communications internally and externally are also satisfactory. Furthermore, the clusters appear to have the necessary knowledge and skills at their disposal. Therefore, as determined by the majority of the dimensions of this criterion, it can be concluded that the initiative of forming national cluster organisations has been a success.

Network membership

The minor reservation with respect to the network membership concerns the way in which the clusters work with SMEs, start-ups and scale-ups. Generally, the cluster organisations are dominated by the large firms in the sector. This is particularly the case with the cluster organisation for the advanced production sector (MADE). MADE is in the process of changing its membership policy, so that SMEs are also encouraged to become members. The three clusters could, however, have a more explicit strategy of using special measures to support start-ups and scale-ups.

The role of large companies as support for start-ups and scale-ups

Large firms could play a strategically important role in supporting start-ups and scale-ups in the different sectors by being the first customer of products developed by start-ups and scale-ups, by establishing corporate funding agencies (see the case of Novo Nordisk) to provide funding for start-ups and scale-ups, and through corporate spin-offs. For this, they need to be motivated. The general impression from the interviews was that it is an important task to facilitate and improve the collaboration between the large firms and start-ups and scale-ups. Motivation could come from more long-term funding for the clusters to ensure ongoing co-operation in joint projects. Dedicated agencies could also be established, such as the Ignite Sweden programme, to achieve this in the future. Good international examples of how this can be done can be found in the two Swedish clusters, which are covered in the advanced production chapter as learning cases.

Funding

According to a majority of the interviewees, the lack of long-term funding inhibits the financing power of the cluster organisations. At present, the clusters receive four-year funding from the public sector to run the ordinary activities of the clusters, while other forms of activities (such as research and development and programmes for start-ups and scale-ups) must be based on project funding. This normally runs for a period of up to three years. This lack of long-term funding, for example over a period of ten years as is the case with Norway and Sweden, to promote a strong cluster and cluster organisation, can limit the development of the innovation capacity of the cluster, especially with respect to supporting start-ups and scale-ups. Longer-term funding, over which the cluster organisations have more discretionary control, would provide the financing power necessary to introduce cluster internal initiatives to support innovative start-ups and scale-ups. This could come through the establishment of programmes for promoting start-ups and scale-ups, inviting new start-ups to enter the cluster, and facilitating closer co-operation with universities, larger firms in the cluster and between SMEs. The latter initiative could also result in university spin-offs arising from the cluster's co-operation with knowledge institutions (Asheim and Moodysson, 2017^[3]) (Njøs and Jakobsen, 2016^[4]).

International evaluations of cluster programmes show that firms in clusters increase their collaboration and innovation activity considerably (Samfunnsøkonomisk analyse AS, 2017^[5]). In addition to co-operation with universities, searching on behalf of cluster member firms (especially SMEs and start-ups and scale-ups) for extra-cluster (international) knowledge sources is important in increasing the innovative capacity of clusters. Another benefit of long-term cluster funding is that it can help to underpin the international branding of the cluster and the organisations within it, which will particularly help SMEs, start-ups and scale-ups in accessing international markets and collaboration partners, and identifying international funding sources.

Absorptive capacity

Intra-cluster knowledge system

Food & Bio Cluster Denmark is, at least in part, a positive exception with respect to the functioning of the intra-cluster knowledge system, as there seems to be a well-developed system of co-operation and knowledge spillovers between the members of the cluster, which involves some large firms, many SMEs and also a significant numbers of start-ups. This appears to be due to the regional pattern of ecosystems in this sector, co-located with universities and research institutions (e.g. Aarhus University and Foulum Research Station). This is specifically the case for the agricultural part of the food and bio resources sector, where Arla Foods is a dominant player. By contrast, the experimental, new food element of the sector

struggles more, as the main focus of Arla Foods and the large meat companies is not on alternative materials for food production.

In Energy Cluster Denmark and MADE, the domination of large companies and the relative lack of focus on SMEs, start-ups and scale-ups results in sub-optimal knowledge spillovers between different categories of firm. In the energy technology and advanced production sectors, start-ups and scale-ups enter the industries through the value chain, where the cluster organisations as such are not involved, since they do not work systematically on establishing links between large companies and start-ups and scale-ups. In the absence of this activity becoming a responsibility for the cluster organisation, other, financially-driven mechanisms would need to be found for knowledge spillover promotion.

Extra-cluster knowledge system

The evaluation of the extra-cluster knowledge system is carried out along two dimensions: extra-cluster knowledge sources and the interface between the external linkages and the intra-cluster knowledge system. There are two important issues that need to be considered when evaluating the efficiency of the extra-cluster knowledge systems:

1. The collaboration with universities and research institutes concerning extra-cluster knowledge sources.
2. The collaboration between regional science parks, incubators and accelerators, and the national clusters concerning the interface between the external linkages and the intra-cluster knowledge system.

Collaboration with universities and research institutes

In general, all three clusters have a close relationship and good collaboration with the Danish universities, which have scientific and research strengths in different areas. Thus, the three clusters work more with some universities than with others, depending on their areas of strength. The typical hardware or deep tech sectors of energy technology and advanced production typically have closer collaboration with the technical universities, such as the Technical University of Denmark (DTU) and Aalborg University, as well as the University of Southern Denmark in the area of robotics, specifically with relation to the Odense robotic cluster. Meanwhile, Food & Bio Cluster Denmark has the closest collaboration with Aarhus University and the University of Copenhagen.

While the food and bio resources sector has a close co-operation with knowledge-providing institutions that specialise in research relevant to the sector, MADE does not see the same value in research co-operation with universities. This is partly due to the very specialised knowledge coming out of university research. This problem partially stems from the publication pressures faced by researchers, which forces them to focus on new contributions to the scientific literature, rather than on areas that might be more useful or relevant to start-ups and scale-ups in the sector. Another factor inhibiting co-operation between MADE and universities is the IPR laws and regulations in Denmark, which were identified by stakeholders as being a barrier to the smooth diffusion of knowledge from university to industry, especially for start-ups and scale-ups. Partly, the significant diffusion problems from research to start-ups and scale-ups are due to universities wanting to make money from patents and licences, resulting in them becoming too expensive for start-ups and scale-ups to exploit. There is a further problem in that university collaborations can quickly become bureaucratic and difficult, leading to start-ups and scale-ups (and others) walking away from such collaborations.

Research has shown a decreasing tendency for collaboration between industry and university in the biotech sector after the new IPR law – modelled after the 1980 American Bayh-Dole Act – was introduced in Denmark in 2000 (Valentin and Jensen, 2007^[6]). One interviewed stakeholder indicated that something could be learned from Sweden, which still operates with professor's privilege, whereby the professor

(inventor) owns the research results and inventions rather than the university. The interviewee also noted that a committee is currently looking into the question of reforming the IPR law in Denmark. In Sweden professor's privilege results in more professors starting their own companies, which is a useful source of start-ups and scale-ups. It also leads to a smoother collaboration between university professors and industry (Wigren-Kristoferson, Gabrielsson and Kitagawa, 2011^[7]). In 2004, Sweden was on course to introducing a similar IPR law to that currently found in Denmark, but halted this partly due to the research results from Denmark referenced above. In fact, when co-operation with Danish universities decreased after the introduction of the IPR law in 2000, collaboration with Swedish Universities, especially Lund University, increased. IPR practices also vary between Danish Universities. The practice adopted by a university is also dependent on the background of the persons running the corresponding technology transfer office. If they have a background in business, the co-operation is more pragmatic than if the technology transfer office (TTO) is run by people with a background in law.

Several interviewees commented that there is a tendency for funding to be too heavily focused on R&D, without enough emphasis on innovation i.e. bringing an invention to the market. In hardware and deep tech, engineering and manufacturing are part of the innovation process. This impacts the funding needed for start-ups in the hardware and deep tech sectors, as the commercialisation process is much longer and more costly. This means that start-ups need significantly larger amounts of patient capital for them to be successful than is the case for, as an example, software start-ups. Finance needs to match lead times.

*Interface between the external linkages and the intra-cluster knowledge system:
Collaboration between regional science parks and incubators and the national clusters*

A final question of interest is what has gone missing by establishing the national cluster organisations. Several interviews emphasised that spatial proximity between stakeholders is especially important to support the development of start-ups and scale-ups, as entrepreneurship is a localised phenomenon (Brown and Mason, 2017^[2]). This spatial proximity is found at the regional level but is lost at the national level. An often-mentioned example of a successful regional cluster is Odense Robotics, where a close spatial, organisational, and social proximity between industry, university, municipalities, entrepreneurs and investors helped to turn Denmark into one of the major producers of robotics globally. This does not mean that the national cluster organisations should be abolished. Rather, there should be a drive towards forming systematic channels for co-operation between the national clusters and regional clusters and entrepreneurial ecosystems in order to promote innovation, start-ups and scale-ups.

There is a considerable number of regional ecosystems in Denmark, especially in connection with universities, which usually have incubators, accelerators and science parks related to their respective research strongholds. These regional ecosystems should be able to benefit from a closer, more systematic and long-term collaboration with the national cluster organisations as part of sectoral innovation systems including national and regional levels, in order to maximise the synergy effects of the total ecosystem for start-ups and scale-ups in Denmark.

References

- Asheim, B. and J. Moodysson (2017), "Innovation policy for economic resilience: The case of Sweden", *Lund University*. [3]
- Brown, R. and C. Mason (2017), "Looking inside the spiky bits: a critical review and conceptualisation of entrepreneurial ecosystems", *Small Business Economics*, Vol. 49/1, <https://doi.org/10.1007/s11187-017-9865-7>. [2]

- Giest, S. (2021), *The capacity to innovate: Cluster policy and management in the biotechnology sector*. [1]
- Njøs, R. and S. Jakobsen (2016), "Cluster policy and regional development: Scale, scope and renewal", *Regional Studies, Regional Science*, Vol. 3/1, <https://doi.org/10.1080/21681376.2015.1138094>. [4]
- Samfunnsøkonomisk analyse AS (2017), *Evaluation of Norwegian Innovation Clusters*. [5]
- Valentin, F. and R. Jensen (2007), "Effects on academia-industry collaboration of extending university property rights", *Journal of Technology Transfer*, Vol. 32/3, <https://doi.org/10.1007/s10961-006-9015-x>. [6]
- Wigren-Kristoferson, C., J. Gabrielsson and F. Kitagawa (2011), "Mind the gap and bridge the gap: Research excellence and diffusion of academic knowledge in Sweden", *Science and Public Policy*, Vol. 38/6, <https://doi.org/10.3152/030234211X12960315267859>. [7]

OECD Studies on SMEs and Entrepreneurship

Promoting Start-Ups and Scale-Ups in Denmark's Sector Strongholds and Emerging Industries

Start-ups and scale-ups often make outsized contributions to innovation and job creation. However, while entrepreneurial ecosystems in countries and regions are increasingly studied, less is known about differences by sector. What role do start-ups and scale-ups play in the development of different future growth sectors? What problems and bottlenecks does government policy need to address? To what extent do the start-up and scale-up contributions and obstacles vary by sector, and what is in common across sectors? This report examines the entrepreneurial ecosystems of three of Denmark's sector strongholds, sectors where future growth is likely to be generated - advanced production, energy technology and food and bio resources. A focus on Denmark includes the scale and nature of start-ups and scale-ups in different sectors, the bottlenecks, the current policies and how they can be refined. In addition, nine international policy experiences are presented as inspiring practices for Denmark and other countries - covering Austria, Canada, Finland, Ireland, the Netherlands, Norway, Sweden, the United Kingdom, and the United States. Recommendations are offered for Denmark across areas such as entrepreneurial finance, networks, public procurement, and cluster management organisations, covering both cross-sector and sector-specific recommendations.



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