



Nordic Council  
of Ministers



# NORDIC TEST AND DEMONSTRATION FACILITIES

A MAPPING  
OF TEST AND  
DEMONSTRATION  
FACILITIES IN  
THE NORDIC REGION



# **Nordic test and demonstration facilities**

A mapping of test and demonstration facilities in the Nordic region

*Leif Henrik Jakobsen, Benita Kidmose Rytz, Stig Yding Sørensen, Göran Hallin, Pär Lindquist, Janne Antikainen, Valtteri Laasonen and Anandasivakumar Ekambaram*

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# Executive summary

In the Nordic countries, manufacturing plays a vital socio-economic role by contributing to employment and the economy at large. The key prerequisites are a high productivity and a strong competitive edge. One of the ways to obtain and maintain a competitive edge is if (small and medium-sized) companies apply new knowledge and new technologies. However, a key barrier for Nordic manufacturing companies that we have identified is access to test and demonstration facilities.

To support the use of new technologies by companies, easy access to testing of new products and technologies is a decisive factor for the companies to gain knowledge of and inspiration for the use of the new technologies in their current business.

The project therefore sets out to present a mapping of test and demonstration facilities in the Nordic countries. In addition to the mapping, we have identified ten good practice examples of such facilities. Moreover, we have identified political initiatives in the Nordic countries, including specific strategies for setting up and structuring test and demonstration facilities as well as covering possible evaluations of the demand for and quality of the facilities.

The *long-term objective* of the mapping is to make it easy for Nordic companies to gain an overview of relevant suppliers of testing and demonstration facilities. To fulfil this objective, the intention is to offer suppliers of test and demonstration facilities an opportunity to render their testing and demonstration facilities visible to customers and business partners that are developing new products or production processes.

The *specific purpose* of the project is:

- *To map Nordic test and demonstration facilities.* Through a survey, we have gathered data to characterise and describe the test and demonstration facilities;
- *To design a proposal for an interactive product* (a website or an online portal) through which (potential) users can gain access to information about Nordic test and demonstration facilities;
- *To describe political strategies and action plans in the Nordic countries* aimed at developing an infrastructure for test and demonstration facilities, and, if information is available, such as evaluations, review the benefits and impact of the strategies and action plans;
- To present ten illustrative best practice cases of test and demonstration facilities where experiences and lessons learned can inspire others with ambitions to develop test and demonstration facilities.

The *target group* of this mapping exercise is first the companies lacking this overview. Second, the mapping, the good practice cases and the description of political strategies are all relevant for policy makers and managers of test and demonstration facilities seeking to improve the framework conditions for companies.

The *methodology* for the study has been as follows:

- Mapping Nordic test and demonstration facilities based on a survey;
- Designing a proposal for an interactive product (a website) based on desk research;
- Describing political strategies and action plans in the Nordic countries based on desk research and interviews with policy experts;
- Presenting ten illustrative best practice cases of test and demonstration facilities based on desk research and interviews with managers of test and demonstration facilities.

The *mapping of the test and demonstration facilities in the Nordic countries* has shown that the innovation infrastructure for test and development is well developed in the Nordic countries. In total, we have received responses from 384 test and demonstration facilities in the Nordic countries with facilities relevant to this mapping. The technological focus is largely on climate, water and energy technology, biotechnology, nanotechnology, information and communications technology and robot technology, with variations among the countries. The services offered in relation to the test and demonstration facilities are primarily consultancy in close connection with testing and demonstration activities, consultancy and assistance for project-based development – innovation or incubation trials and business development, and consultancy concerning product approval, standardisation, certification, etc.

To build a *website/an interactive platform* for Nordic test and demonstration facilities, it is crucial that the national authorities and possibly industrial organisations including the Nordic Council of Ministers and the official committees firmly back the initiative. Nordic funds could be assigned to the creation of the platform. As part of the platform, it could be considered to encourage Nordic test and development facilities to collaborate, for instance, with inspiration from the Danish RoboTT-NET case. Clearly it is relatively difficult to make companies (test and demonstration facilities) provide information on these open platforms, unless there is a clear incentive to do so. This can, for instance, be seen in the current mapping, where it has taken a great deal of follow-up to persuade the companies to participate.

The *good practice cases* of test and demonstration facilities are characterised by a high degree of collaboration with the (local) surrounding eco-system and other partners offering test and demonstration facilities. Collaboration is an important parameter for success when it comes to creating added value for companies. In most of the cases, collaboration in some form, either national or international, is present, but Nordic collaboration seems to be rare. Along these lines, the network and eco-system in which the facilities operate are also deemed an important success factor. Other success

factors include access to expert staff who can assist companies with tests and demonstrations and give advice on further steps. Along these lines, access to state-of-the-art technological infrastructure as well as access to an extensive network within research are also highlighted as key success factors. Ability to combine different research areas/areas of expertise has also been highlighted as a key success factor in the cases. For instance, ability to join different fields of research and industrial sectors is considered an important success factor.

The facilities established in the good practice cases are primarily established through a market-driven focus. The market – not governmental programmes and policies – determines the supply of test and demonstration facilities. However, in some instances many of the good practice facilities can offer companies (particularly SMEs) access to state-of-the-art test and demonstration facilities, often at a lower price than the market price. This is possible because the investment in and use of the facilities are based on innovation programmes (such as H2020) or through public-private partnerships. In addition, many of the RTOs are subject to partial public funding, which carries a part of the economic risk in terms of investments.

In all the Nordic countries except Iceland, there are *national strategies* where the creation of test and demonstration facilities in relation to the research infrastructure is prioritised and funding allocated. However, as mentioned above, when it comes to innovation infrastructure, the creation of test and demonstration facilities is more indirect, for instance through funding of facilities in RTOs (where many test and demonstration facilities are placed) or innovation schemes supporting the industry to purchase innovation services including test and demonstration services. Consequently, test and demonstration facilities relating to innovation are largely based on a bottom-up approach (or a market-based business model) where the market demand is decisive for the establishment of test and demonstration facilities. This also means that the strategic decisions about investments in test and demonstration facilities are primarily made by private or semi-private (RTOs) actors in terms of technological focus, markets and clients. This means that the focus areas for the test and demonstration facilities do not necessarily follow the political focus areas.

In some of the Nordic countries there seems to be an interest in creating specific (regional) innovation policies that also have an impact on creation of test and demonstration facilities, for instance in relation to clusters or politically prioritised areas such as green energy.

Regardless of the choice of profile, a Nordic focus could be an advantage as the platform visualises a larger and a more specialised market of test and demonstration facilities. However, it is of the utmost importance that such Nordic initiatives receive backing from national authorities, including the Nordic Council of Ministers and the official committees. The challenging task for the Nordic Council of Ministers will be to get the Nordic countries on-board the vision for a Nordic market for test and demonstration facilities and initiate supporting innovation policy initiatives.

In conclusion, the Nordic test and demonstration facilities seem to be used by and are relevant for Nordic companies. The economic setup makes the focus of the facilities largely market driven. However, we have seen test and demonstration facilities that

have been developed to meet the express demand from industry sectors or groups of companies. This is positive for the companies, but in relation to national (or Nordic) competitiveness, it could be advantageous to connect the innovation infrastructure more closely to the national strategies, as it could encourage the test and demonstration facilities to make a faster introduction of new technologies and/or to link new technologies to the main societal challenges.

# Introduction

The project about mapping of Nordic test and demonstration facilities was initiated as part of a joint Nordic project aimed at enhancing the level of automation and digitisation in the Nordic Countries. The project is funded by the Nordic Council of Ministers.

The purpose of the assignment has been to present a survey of the test and demonstration facilities across the Nordic countries. For more SMEs to use new technologies, they need to be better able to test their new products or new technologies. By being able to do so, they can gain knowledge and inspiration as to how the technology can be used in their businesses. Nevertheless, they also need to know where such facilities are located and what they can offer. Therefore, we have identified ten good practice examples of Nordic test and demonstration facilities in addition to the mapping.

Moreover, political initiatives in the Nordic countries have been identified, including specific strategies for setting up and structuring test and demonstration facilities, also covering possible evaluations of, for instance, the demand for and quality of the facilities.

The Danish Business Authority has the overall responsibility for the project on behalf of the Nordic Council of Ministers. In collaboration with MDI – Consultancy for Regional Development (Finland), SINTEF (Norway) and Kontigo (Sweden), the Danish Technological Institute (DTI) has carried out the mapping of test and demonstration facilities in the Nordic countries.



# Background

In the Nordic countries, manufacturing plays a vital socio-economic role by contributing to employment and the economy at large. Key prerequisites are a high productivity and a strong competitive edge.

However, over the past decades, employment in the manufacturing sector has decreased. Reasons include a decrease in competitiveness – not least for mass-produced goods, but outsourcing is also an explanatory factor.

This is reflected in increased off-shoring of manufacturing from the Nordic countries to low-income countries. However, the tendency of increased off-shoring seems to be decreasing, but the global division of labour is still increasing. Some of the driving forces behind this development are the emergence of new technologies and new production methods, such as increased digitisation and automation, including the use of artificial intelligence and new advanced materials (also referred to as KETs).<sup>1</sup> As a result, companies often apply new business models, for example with an increased degree of interaction between production and service (“servitisation”).

These driving forces – or trends – force companies to reassess what to produce and how and where the manufacturing should be placed to be cost-effective. These changes and, not least, the speed with which the digital transformation and automation takes place are pushing the process of re-industrialisation (also known as Industry 4.0)<sup>2</sup> also in the Nordic countries.<sup>3</sup>

This re-industrialisation means that the companies will have the opportunity to absorb new knowledge in different ways and to apply new technology and new production methods and processes.

The array of technologies is very broad and very complex at the same time. Developers and suppliers of new knowledge and technology (such as RTOs)<sup>4</sup> are increasingly becoming more specialised in line with the companies’ use of and demand for knowledge. In recent years, Danish companies have increasingly purchased R&D services – including services related to test and demonstration. An indication of an increasing and more specialised demand is that approx. three-fourths of the total purchase of R&D services takes place abroad, according to analyses carried out by DTI for the Agency for Research and Innovation (Styrelsen for Forskning og Innovation, 2015).

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<sup>1</sup> KETs: Key Enabling Technologies include nanotechnology, advanced materials, advanced manufacturing and processing (production technology) and biotechnology; <https://ec.europa.eu/programmes/horizon2020/en/area/key-enabling-technologies#Article>

<sup>2</sup> See (Schwab, 2016)

<sup>3</sup> <http://em.dk/nyheder/2015/15-12-07-nordisk-samarbejde-styrker-avanceret-produktion>

<sup>4</sup> A Danish example of RTOs is \*Godkendt Teknologisk Service (GTS) or in English Advanced Technology Groups. <https://en.gts-net.dk/>

The joint Nordic project “Produktion i Norden” has been launched to strengthen the proliferation of digitisation and automation in Nordic manufacturing companies to the benefit of the competitiveness in the Nordic companies and the Nordic countries’ economic development. The project has identified a number of barriers to increased digitisation and automation. One of these barriers is access to test and demonstration facilities (Iris Group, 2015). This is particularly true for small and medium-sized companies that face difficulties with gaining access to testing their new products or testing new technologies and thus gaining knowledge on - and inspiration for – the use of new technologies.

Companies – and especially SMEs – can obtain better access to test and demonstration facilities in several ways. One way is to create a better overview of the relevant test and demonstration facilities and thereby increase the SMEs’ awareness and knowledge of these facilities.

A better overview, and thus a better knowledge of the facilities, can provide the industry with better access and increased use of test and demonstration facilities. The facilities may even gain an opportunity to enlarge their market to the rest of the Nordic market. For policy makers and managers of test and demonstration facilities, it may be the information needed as a starting point for increased Nordic cooperation. It may also provide the necessary information for the test and demonstration facilities to be able to provide specialised facilities that other organisations do not offer.

Increased use of test and demonstration facilities can also be encouraged by other means, for instance financial incentive structures such as business and innovation programmes.



# 1. Objective of the project

Currently, an overview of testing and demonstration facilities in all the Nordic countries does not exist. However, some institutions have established websites or long lists that present their own test and demonstration facilities or test and demonstration facilities within specific business or technological areas (see Section 2.2).

The long-term objective of the mapping is to make it easy for Nordic companies to gain an overview of relevant suppliers of testing and demonstration facilities. To fulfil this objective, the intention is to offer suppliers of such facilities an opportunity to render their testing and demonstration facilities visible to (Nordic) customers and business partners developing new products or production processes.

The specific purpose of the project is:

- *To map Nordic test and demonstration facilities.* Through a survey, we have gathered data to characterise and describe the facilities;
- *To design a proposal for an interactive product* (an online portal) through which (potential) users can gain access to information about Nordic test and demonstration facilities;
- *To describe political strategies and action plans in the Nordic countries* aimed at developing an infrastructure of test and demonstration facilities, and, if information is available, such as evaluations, review the benefits and impact of the strategies and action plans;
- *To present ten illustrative best practice cases of test and demonstration facilities* where experiences and lessons learned can inspire others with ambitions to develop test and demonstration facilities.

This mapping report addresses two target groups. First, the target group of this report on mapping of test and demonstration facilities is mainly actors with a strategic or political interest to whom the report, hopefully, can be of inspiration. A second target group is (potential) suppliers and users of test and demonstration facilities. A possible interactive product presenting the test and demonstration facilities across the Nordic region could be of great value to them.

## 1.1 Applied methodology

Reflecting the purpose of the project, the project is based on four activities:

- Mapping Nordic test and demonstration facilities based on a survey;
- Designing a proposal for an interactive product based on desk research;
- Describing political strategies and action plans in the Nordic countries based on desk research and interviews with policy experts;
- Presenting ten illustrative best practice cases of test and demonstration facilities based on desk research and interviews with managers of test and demonstration facilities.

Below, we give a short presentation of the methodology we have used for gathering data, which includes the survey, desk research and interviews. The criteria for selecting the cases are presented in Chapter 4.

### 1.1.1 Survey

The survey consists of the following methodological elements:

- Target group and technological focus
- Identification of respondents in the target group
- Questionnaire
- Carrying out the survey.

We present the elements in the following.

#### Target group and technological focus

In line with the purpose of the mapping, the target group represents organisations, i.e., private companies, RTOs, universities and other knowledge institutions that offer test and demonstration facilities and related services aimed at supporting innovation or innovative processes.

The main focus is innovation. However, within innovation the scope of the survey (the mapping) is not defined by any further delimitation as the survey includes all types of technologies. In addition, the users/customers can be all types of private companies or public organisations. Consequently, the target group must be found in the innovation infrastructure while organisations that *only* operate within the research infrastructure with research questions or research projects are not included in the target group.

#### Identification of respondents in the target group

We have used NACE, EU's industrial statistical classification system, to identify the individual organisations within the target group. We present the industrial sectors selected for the survey in Table 1.

**Table 1: Industrial sectors selected for the survey**

	Denmark	Finland	Iceland	Norway	Sweden
Description Sector text in English and Danish	NACE	SIC	NACE	NACE	SNI BRANCHE
Consulting engineering activities within production and machinery technique (Rådgivende ingeniørvirksomhed inden for produktions- og maskinteknik)	711,220	N/A	711,220	711,220	711,220
Testing and control activities in the field of food hygiene (Kontrol af levnedsmidler)	712,010	N/A	712,010	712,010	712,010
Technical testing and control (Teknisk afprøvning og kontrol)	712,020	7120	712,020	712,020	712,020
Other measuring and technical analysis (Anden måling og teknisk analyse)	712,090	N/A	712,090	712,090	712,090
Research and experimental development on biotechnology (Forskning og eksperimentel udvikling indenfor bioteknologi)	721,100	7,211	721,100	721,100	721,100
Other research and experimental development on natural sciences and engineering (Anden forskning og eksperimentel udvikling inden for naturvidenskab og teknik)	721,900	7,219	721,900	721,900	721,900
Technical and vocational secondary education (Tekniske skoler og fagskoler)	853,200	8,532	853,200	853,200	853,200
Post-secondary non-tertiary education (Videregående uddannelser ikke på universitetsniveau)	854,100	N/A	854,100	854,100	854,100
Tertiary education (Videregående uddannelser på universitetsniveau)	854,200	8,542	854,200	854,200	854,200

Source: Danish Technological Institute and Statistics Denmark (Danmarks Statistik, 2007).

Initially, we selected all 7,822 organisations within these NACE codes.<sup>5, 6</sup> However, a data wash was carried out to exclude:

- Organisations with unsolicited advertising protection
- Branch offices
- Irrelevant organisations, such as motor vehicle inspection branch offices, non-technical organisations, etc.
- Organisations characterised by few employees. Therefore, we excluded organisations within the size category “fewest employees”.

As the survey was carried out as an e-survey, we needed the e-mail addresses of all the organisations. We already had the e-mail addresses of some organisations, and for those we did not, we tried to identify their e-mail addresses by visiting relevant websites.

<sup>5</sup> Data from Experian.

<sup>6</sup> By applying this procedure for selecting respondents for the surveys, we have excluded the use of RTOs list of test and demonstration facilities.

## The questionnaire

The questionnaire was designed to gather information, including:

- to characterise the test and demonstration facilities by the technology in focus, additional services offered, industrial focus as well as a short description of the individual test and demonstration facilities; and
- on the size (number of employees at the test and demonstration facility), number of users or customers, and the business model.

The introductory part of the questionnaire includes control questions to make sure that the organisations run test and demonstration facilities aimed at supporting innovation.

In addition, an organisation might run more than one test and demonstration facility. The survey is designed to handle such situations as an organisation could fill in a questionnaire for each test and demonstration facility in their organisation.

The outcome of the first part is presented in this report, and it constitutes the information to be included on a possible interactive product/website. The second part of the questionnaire will only form part of a mapping report where the answers will become part of statistical analyses and overviews.

## Carrying out the survey

The survey was carried out as an e-survey. The e-survey was launched in Denmark at the beginning of May 2017 and in the other Nordic countries at the beginning of June 2017.

In total, 4,473 e-mails were sent out (see Table 2). To increase the number of respondents, we sent reminders to the non-responding organisations, and after the deadline for responding, we carried out an individual follow up at organisations with 50+ employees.

**Table 2: Statistical data about the survey**

	Number of questionnaires sent out (e-mails)	Total number of respondents	Respondents not included in the mapping/analysis as the respondents do not have any test and demonstration facilities or the respondents do not have any valid information	Incomplete information	Respondents with information about test and demonstration facilities	Number of responses used in the analysis
Denmark	745	365	180	43	142	185
Finland	376	24	12	3	9	12
Iceland	47	12	6	2	4	6
Norway	778	103	54	13	36	49
Sweden	2,527	243	111	34	98	132
Total	4,473	747	363	95	289	384

Note: No organisations from Greenland or the Faroe Island have responded.

Source: Danish Technological Institute.

Out of the 747 respondents, 363 organisations did not pass the control questions. Consequently, we received information from 384 test and demonstration facilities, which formed the basis of the report's statistical analysis. Complete information is available from 289 test demonstration facilities (see Table 2).

Thus, the survey maps test and demonstration facilities interested in participating in the survey and being part of the planned website of Nordic test and demonstration facilities. The number of facilities participating in the survey is relatively high, meaning that the overall picture of the Nordic test and demonstration facilities is quite representative.

However, we have, as a required precondition, applied a methodological approach aimed at including all types of test and demonstration facilities and as many as possible. Consequently, we have paid special attention to organisations, such as RTOs, with many and often specialised test and demonstration facilities, other than a special follow-up on organisations with 50+ employees not responding to the survey.

### **1.1.2** *Desk research*

Desk research, in the form of a review of literature, documents, websites, etc., has provided input to the national overviews of political strategies and action plans in the Nordic countries as well as for preparing the ten illustrative best practice cases.

### **1.1.3** *Expert interviews*

Expert interviews have also provided input to the national overviews of political strategies and action plans in the Nordic countries as well as for preparing the ten illustrative good practice cases. In this respect, we have interviewed policy experts from ministries, agencies and organisations along with managers representing the selected test and demonstration facilities.

The interviews were carried out as semi-structured interviews.

## **1.2** *Overview of the report*

In the following, we present the definition of test and demonstration facilities as well as recent trends (Chapter 2). In Chapter 3, we present and summarise the policies and strategies for test and demonstration facilities in the Nordic countries. The full review of the strategies can be found in Annex 3. Chapter 4 presents the experiences and lessons learned from the ten Nordic good practice cases on test and demonstration facilities. The full cases are presented in Annex 2. In Chapter 5, we carry out the actual mapping of the Nordic test and demonstration facilities based on the survey results. Finally, Chapter 6 shows the design proposal for the (potential) website, and Chapter 7 makes conclusions.



## 2. Test and demonstration facilities

This section presents a definition of test and demonstration facilities viewing the facilities from an innovation perspective. Furthermore, different mapping initiatives have been carried out in recent years, and we give an overview of these mappings.

### 2.1 Definition of test and demonstration facilities

We define test and demonstration facilities as physical facilities associated with innovation activities or initiatives encouraging innovation. As the physical facilities are linked to organisations supporting innovation and innovative activities, the definition must be related not only to the physical facilities but also to the “innovation infrastructure”. Moreover, the “innovation infrastructure” embeds facilities at a higher “technology readiness level” than the “research infrastructure”.

The concept “innovation infrastructure” is a relatively new concept, which can be construed in several ways. By initially employing a literature review, a characteristic (definition) of how we understand “innovation infrastructure” can be set up (Teknologisk Institut, 2015).

The report’s definition of innovation infrastructure is a further development of what lies in the concept “research infrastructure”. The concept “research infrastructure” is part of the basic facilities that must be present to carry out excellent techno-science research. The innovation infrastructure must therefore be understood as based on the role it plays in the research-innovation process with the changes in the development processes that take place in company-based R&D-projects ranging from R&D, product development, development of production processes and last, but not least, sales. On this background, the innovation infrastructure can be defined as follows (see Table 3).

**Table 3: Characteristics of the research and innovation infrastructure**

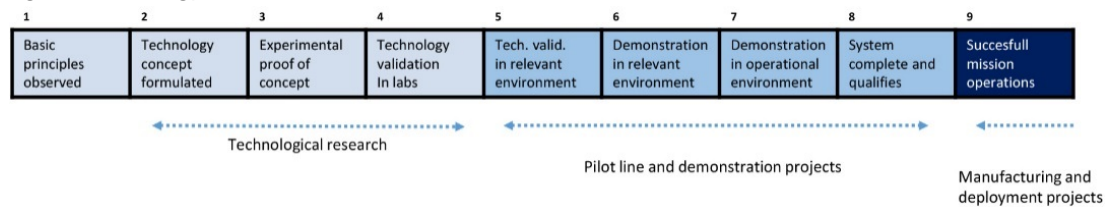
Characteristics	Research infrastructure	Innovation infrastructure
Physical	Laboratories, apparatus, data registers, collections, libraries	Laboratories, apparatus, test facilities, testing, simulation, certification, demonstration, high-tech pilot production, Living Labs
Driver	Scientific breakthroughs and acknowledgement based on new research (publications)	Technological innovation and industrial use
Output	Scientific acknowledgements, results as basis for further research	Innovation and industrial use and approval of products, etc.
Competences and know-how	Techno-science perspective	Techno-commercial (user-oriented research + commercial expertise)
Relation to industry	10 years from market	1-5 years from market
Business model	Primarily public founded	Commercial – necessary critical mass – and an international market
Importance to society	Future-proof of research and contribute to the development and growth of society: Educate masters and PhD's Hold on to/attract world-class-researchers Spin-off & new enterprises Clusters	Future-proof of industry's innovation and contribute to the development and growth of society through business clusters, spin-off & new companies, company growth and workplaces.

Source: Teknologisk Institut, 2015.

When test and demonstration facilities are linked to innovation or the concept “innovation infrastructure”, the expected outcome and impact as well as the applied business model become part of the definition.

The Technology Readiness Level (TRL) is also assumed to make a fundamental difference between the research and innovation infrastructure. In general, test and demonstration activities related to innovation will take place between the technology readiness level 3-4 and higher levels (see Figure 1), while the lower levels are characterised as research.

**Figure 1: Technology Readiness Levels**



Source: European Commission, 2011.



## 2.2 Mapping test and demonstration facilities - recent trends

Recently, examples of mapping of test and demonstration facilities have been seen both in relation to research infrastructure and innovation infrastructure, and, in some cases, the mapping even has a techno-policy focus or agenda.

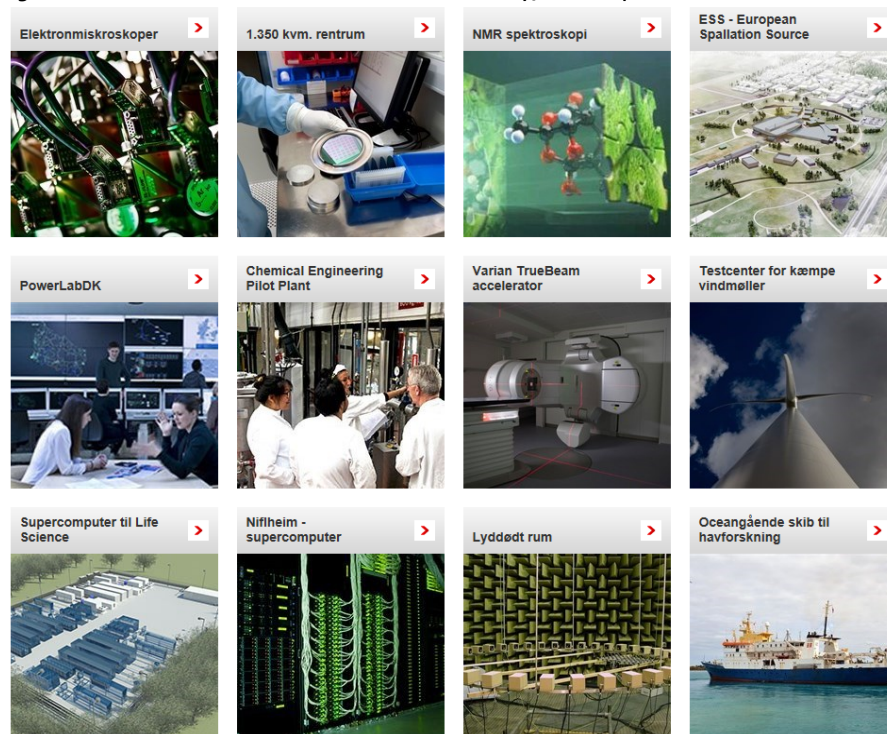
### 2.2.1 Research infrastructure

The research infrastructure is a crucial part of the research policy as important facilities to meet the needs of Europe's research communities across all scientific areas. Since 2002, the European Strategy Forum on Research Infrastructures (ESFRI) identifies research infrastructures (European Strategy Forum on Research Infrastructures, 2016), and the results are presented in interactive maps showing the location and technical domains of the research infrastructures.<sup>7</sup>

The EU Member States have also presented national roadmaps of their research infrastructures (see Chapter 3).

It is also seen that individual universities present their test and demonstration (research) facilities, some of which are presented in their report, ranging from fundamental research to applied research (see Figure 2).

Figure 2: Research facilities at Danish Technical University, an example



Source: <http://www.dtu.dk/Forskning/Forskningsfaciliteter>

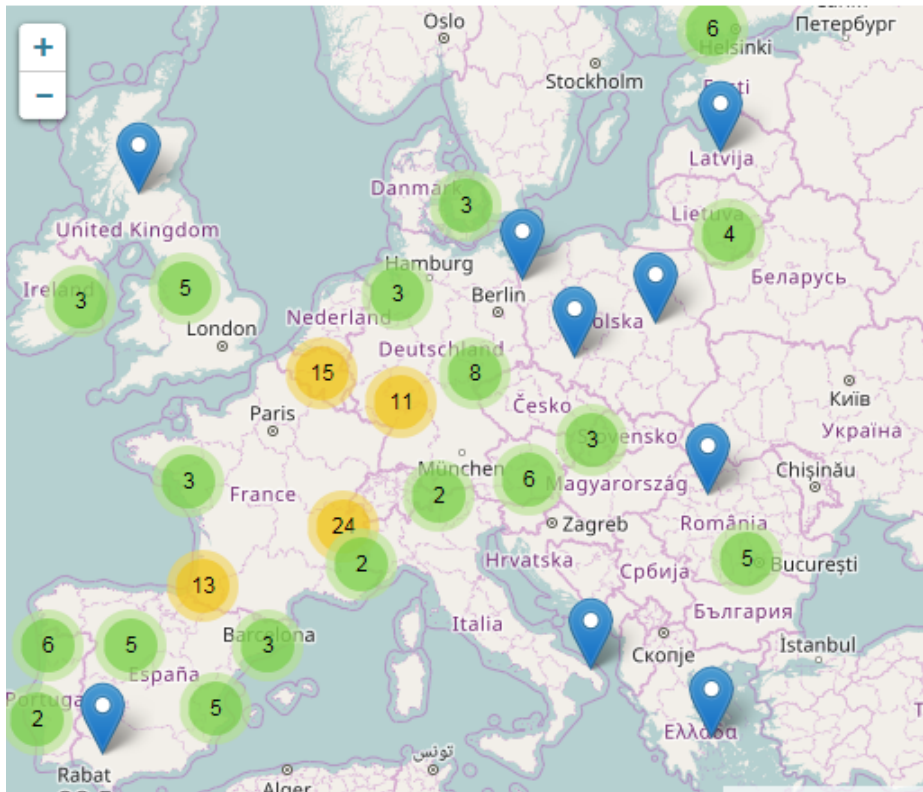
<sup>7</sup> <http://www.esfri.eu/maps-ris>

### 2.2.2 Innovation infrastructure

In recent years, the EU has highlighted technological challenges due to new technological developments. At the same time, the EU emphasises the value of giving industry, especially SMEs, access to close-to-market research and innovation.

KETs are a long list of new and challenging technologies, where access to technology centres and test and demonstration facilities can help the industry to innovate. Technology centres can be identified on a map and additional information be found by clicking on the map. However, the mapping is probably not complete (see Figure 3).

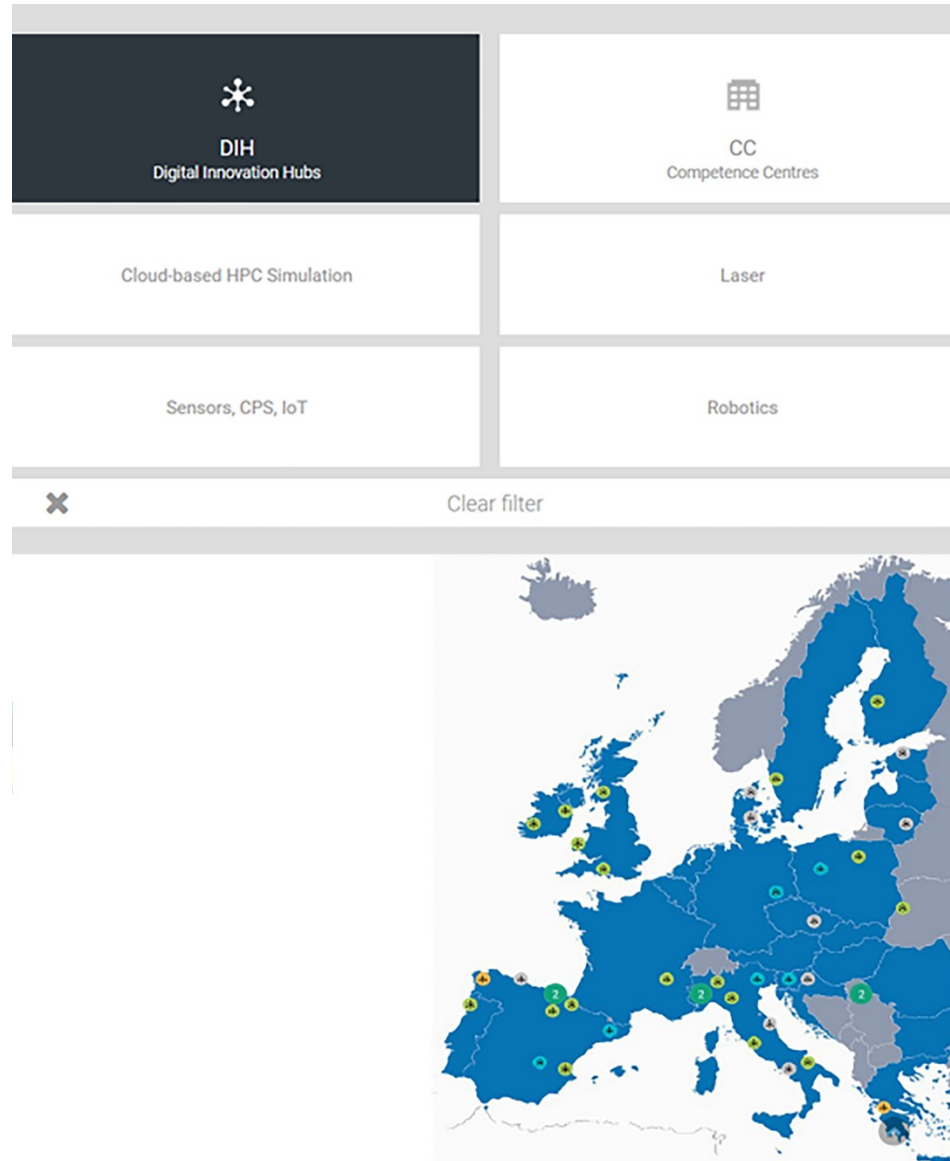
Figure 3: Mapping of Key Enabling Technologies (KETs) Technology Centres



Source: <https://ec.europa.eu/growth/tools-databases/kets-tools/kets-tc/map>

The EU has applied a similar approach to the implementation of the “Digitising Europe Industrial Strategy” as facilities, i.e., digital innovation hubs, can provide the industry with access to competences needed to digitise their products and services (see Figure 4).

Figure 4: I4MS (ICT Innovation for Manufacturing SMEs) to promote adoption of ICT technologies



Source: [http://i4ms.eu/regional\\_hubs/map.php](http://i4ms.eu/regional_hubs/map.php)

At national level, we have found mappings of test facilities with different types of focus.

First, German industry has access to a website providing information on test facilities focusing on digitalisation of the production (see Figure 5).

Figure 5: German website on test facilities related digitisation – Industry 4.0



Source: <http://www.plattform-i40.de/I40/Navigation/Karte/SiteGlobals/Forms/Formulare/karte-testbeds-formular.html;jsessionid=14ACD30955301E7837F655C9D5E59567?oneOfTheseWords=Suchbegriff+eingeben>

Second, the mapping of test facilities can have a specific technical-industrial focus as seen in the wind power industry, where Megawind, the Danish Wind Power Association, not only presents a list of especially Danish test and demonstration facilities but also some international test facilities.<sup>8</sup>

Third, test and demonstration facilities associated with the national networks of RTOs have also been listed in mapping studies, e.g., in Finland (TEKES, 2017) and Sweden (VINNOVA, 2015), (RISE, 2017).<sup>9</sup>

Summing up, in recent years, mapping of test and demonstration facilities is a common activity that applies a technological approach, while others present test and demonstration facilities within specific organisational setups. Whether these websites or lists of test and demonstration facilities are of any practical value to industry or encourage innovation seems uncertain, as we have not found any evaluations of the subject.

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<sup>8</sup> [https://megavind.windpower.org/megavind/test\\_\\_\\_demonstration\\_facilities/dynamic\\_list\\_of\\_global\\_test\\_facilities.html](https://megavind.windpower.org/megavind/test___demonstration_facilities/dynamic_list_of_global_test_facilities.html)

<sup>9</sup> <https://www.ri.se/erbjudanden/test-och-demonstrationsanlaggningar>

## 3. Policies and strategies for test and demonstration facilities

In this chapter, we examine policy measures with the objective to encourage the development of test and demonstration facilities in the Nordic countries. Focus will be on national and regional strategies with the aim of establishing and structuring test and demonstration facilities to the benefit of business-based innovation. Since test and demonstration facilities are elements not only in relation to the national innovation infrastructure, but also to the research infrastructure, the perspective in this chapter will be unfolded to include policies in relation to both innovation and research infrastructure. Furthermore, if information or evaluations are available, we have examined the demand for test and demonstration facilities among companies. Annex 3 makes an in-depth presentation of the strategies in each of the countries.

### 3.1 An overall Nordic observation

In all the Nordic countries except Iceland, there are *national strategies* where the creation of test and demonstration facilities in relation to the research infrastructure is prioritised and funding allocated. However, when it comes to innovation infrastructure, the creation of test and demonstration facilities is more indirect, for instance, through funding of facilities in RTOs (where many test and demonstration facilities are placed) or innovation schemes supporting the industry to purchase innovation services including test and demonstration service. Consequently, test and demonstration facilities relating to innovation are largely based on a bottom-up approach (or a market-based business model) where the market demand is decisive for the establishment of test and demonstration facilities. However, RTOs typically have access to some general funding which can reduce the risk when investing in test and demonstration facilities.

In some of the Nordic countries, particularly in Finland and Sweden, there seems to be an interest in creating specific (regional) innovation policies that also have an impact on creation of test and demonstration facilities, for instance in relation to clusters or politically prioritised areas such as green energy.

We sum up the national strategies related to test and demonstration facilities in the following. They illustrate the above-mentioned main observations as well as the differences between the Nordic countries.

### 3.2 Strategic initiatives

With regard to research infrastructure, Sweden has both specific government bills and national strategies such as the *Nationella strategin för hållbar tillväxt och attraktionskraft (NShtak)*. In the Swedish NShtak, one focus area for priorities with resources from the European Regional Development Fund (ERDF) is to develop strong research and innovation environments including investments in research infrastructure, test and demonstration sites. However, the specific actions taken to ensure that test and demonstration facilities are created are not evident from the strategy. Sweden also has three specific policies on Smart Industry, the maritime industry, and the national strategy for sustainable growth. Similar challenges with identifying the specific road maps for test and demonstration facilities are evident in the specific policies. For instance, this applies to the Smart Industry Strategy in Sweden, where one of the strategic routes is to create Test Bed Sweden. Test Bed Sweden focuses on emphasising new forms of promoting innovation in relation to Swedish manufacturing, involving test and demonstration sites, living labs, innovative public procurement, etc. However, the actions to be taken to make this a reality (the road map for creating Test Bed Sweden) are not clearly laid out, and there is limited evidence as to the efficiency of these strategies, e.g. Test Bed Sweden.

Finland has its strategy and roadmap for research infrastructures 2014–2020 alongside specific innovation strategies such as the regional “6cities strategy” aimed at supporting companies to develop smart city-related products and services. Thus, in Finland, test and demonstration facilities for the innovation infrastructure are primarily in the form of lab tests and product testing, commissioned studies as well as joint development of innovations in collaboration with the research organisation. The use is most commonly financed by one-time payments from companies or as a part of a joint RDI project (for instance a H2020 project). Thus, funding does not come from national budgets but rather as a “bottom-up approach”.

This approach compares with the Danish model of test and demonstration facilities being considered an integral part of both the research and innovation infrastructure, but where the research infrastructure is funded in the national budgets, and the innovation infrastructure is laid out to the specific actors. In Denmark, these actors are primarily the Advanced Technology Groups.<sup>10</sup>

The bottom-up approach is also prevalent in Iceland. As mentioned above, Iceland is one of the few countries where there is no national strategy as such for test and demonstration facilities. The Science and Technology Policy Council’s policy paper from 2017 on science, technological development and innovation<sup>11</sup> includes an action on the creation of a research and innovation roadmap and policy, which also includes a recommendation on creating a strategy and roadmap for access to test and demonstration facilities. Instead, the establishment and use of test and demonstration

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<sup>10</sup> GTS institutes; <https://en.gts-net.dk/>

<sup>11</sup> Mennta- og menningarmálaráðuneyti (2017): Stefna og aðgerðaáætlun Vísinda- og tækniráðs 2017–2019

facilities is handled by the two Icelandic organisations Matís and Innovation Center Iceland and is regulated by market supply and demand.

In Norway, test and demonstration facilities are primarily supported through the Norwegian Catapult scheme. In the 2017 national budget, SIVA (which is a public enterprise owned by the Norwegian Ministry of Trade, Industry and Fisheries and a part of the public funding agencies for innovation) received NOK 50m to start the Norwegian Catapult scheme to support national facilities for testing, demonstration, simulation and visualisation aimed at SMEs. The Norwegian Catapult scheme will support the establishment and development of centres (facilities) for testing, simulation and visualisation. This will contribute to faster, less expensive and better innovation processes, which are crucial for the companies' competitiveness, and thus become the prerequisite for value creation (new employment opportunities, etc.) in Norway. Thus, Norwegian SMEs, in particular, will have better access to test and demonstration facilities and at a lower cost than market conditions.

### 3.3 Implementing the test and demonstration strategies

In Finland, the two programmes SHOK and INKA have supported test and demonstration platforms and public-private partnerships (PPP's). Although both programmes have recently been discontinued and new PPP instruments are being formulated, the Finnish government still has the establishment of test and demonstration facilities as a key priority, although in a different format. Instead, focus in Finland is on pre-commercial procurement of innovation (for instance through Tekes' Smart procurement programme), which has triggered the establishment of many recent test and demonstration facilities. A recent OECD review of Finnish research and innovation policies<sup>12</sup> also highlights that Finland needs a new science, technology and innovation vision to regain growth, and that this vision should entail giving increased support to SMEs ranging from innovation grants to the promotion of innovation linkages with large firms, and access to test sites, demonstration facilities and research infrastructure. Important instruments and funding for test and demonstration facilities are EU structural funds and national funding (including innovation vouchers).<sup>13</sup> They are administrated and allocated by regional councils and Centres for Economic development, Transport and the Environment (ELY Centres) and Tekes.

In the Swedish strategies, there appears to be a shared focus on innovation and testing and demonstration as an important aspect of innovation. Moreover, there appears to be a common focus on the importance of opening up testing and demonstration towards (a solution to) social challenges and a collaborative approach involving "problem owners" (such as national, regional and local authorities), academia and industry.

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<sup>12</sup> OECD (2017). OECD Reviews of Innovation Policy: Finland 2017, OECD Publishing, Paris.  
<http://dx.doi.org/10.1787/9789264276369-en>

<sup>13</sup> <https://www.tekes.fi/en/funding/SME/innovation-voucher/>

It is more difficult to see how the Swedish strategies influence real innovation processes. Government bills have a specific budget attached to them, but other national strategies normally do not budget for resources directly allocated to the objectives of the strategies. Instead it is hoped that government agencies will initiate and readdress some of the funding that has already been allocated to meet the priorities stressed in the national strategies. Hence, many strategies seem to focus on the same issues and target areas such as innovation, testing and demonstration. However, this does not necessarily mean that resources are allocated to these focus areas or that the funding resources are large enough to cover all aspects of the strategies related to test and demonstration facilities.

In Denmark, test and demonstration facilities are mostly addressed indirectly in the innovation infrastructure. Denmark has three key areas under which test and demonstration facilities are funded, i.e., the Advanced Technology Groups (GTS institutes), cluster and innovation networks and innovation environments.

Across the Nordic countries, there are also initiatives to support the establishment of test and demonstration facilities. For instance, Nordic Innovation has a NOK 25 m call for proposals for innovative Nordic solutions together with Tekes, Vinnova, Innovation Norway and Rannis. Focus is exclusively on health and welfare, and test beds and living labs are an integral part of the call.<sup>14</sup>

Consequently, the Nordic countries (except Iceland) all have a structure where test and demonstration facilities in relation to the research infrastructure are prioritised and funding allocated. For the innovation infrastructure, the creation of test and demonstration facilities is often more indirect, for instance through funding of facilities in RTOs.

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<sup>14</sup> <http://www.nordicinnovation.org/news/towards-a-nordic-ecosystem-for-health-innovation/>



## 4. Nordic good practice cases

We have made 10 case studies to shed light on good practice examples of test and demonstration facilities in the Nordic countries.

The cases were primarily selected because they were either very successful ventures (meaning that they create a great deal of added value for companies) and/or because they have an interesting and relevant setup that can serve as inspiration to policy makers and managers of test and demonstration facilities.

### 4.1 Selection layer 1: How successful are the facilities

The cases represent a mix of facilities that have:

- successfully assisted firms in developing and introducing new products to the market and/or in developing and introducing new production processes, irrespectively of which technology the facilities focus on
- helped generate a positive economic impact for the involved firms (e.g., turnover, export, employment, etc.).

In addition to the these overall criteria, we have used the following selection criteria:

### 4.2 Selection layer 2: Key services offered and market orientation

We selected test and demonstration facilities aimed at offering technical service related to introducing new technologies in either product and/or production processes. However, the cases represent a mix of different test and/or demonstration facilities as well as additional services.

Consequently, the cases represent different types of technologies, and often new technologies are in focus with the aim of encouraging innovation and development, typically based on a commercial business model.

The tests and demonstrations may be offered by a single service provider or by a group of service providers. Altogether, the services offered may also be characterised

as a “technology platform”<sup>15</sup> or as Living Labs,<sup>16</sup> indicating that the service is not a stand-alone service but part of a broader ecosystem.

We have also attempted to present a mix of facilities operating nationally and internationally. The services on offer may be specialised, and, consequently, the national market may be too small to develop a financially sustainable service. In other cases, the national market will be sufficient.

We have not prioritised simple test facilities or control/quality assurance facilities as cases.

### 4.3 Selection layer 3: Basic selection criteria

We also applied some basic criteria, such as:

- The facilities’ services are aimed at manufacturing companies (they can be aimed at other sectors too);
- We needed to ensure a balance between facilities assisting SMEs and LSEs (so that we did not end up with 10 cases depicting facilities that only assist LSEs, for instance).

Finally, we needed a balanced selection of cases between the Nordic countries.

### 4.4 Overview of cases

The cases were divided among the four Nordic countries Denmark, Finland, Norway and Sweden. In Iceland, test and demonstration facilities have little focus, and no good practice examples have been identified.

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<sup>15</sup> The concept “technology platform” is inspired by the European discussion on technology platforms. However, the European definition of technology platform is much broader. By using the concept here, we stress that the test and demonstration facilities have to be associated with new technologies and be part of a larger ecosystem.

<https://www.innovationpolicyplatform.org/content/technology-platforms-and-fora>

<sup>16</sup> Living labs are test/demonstration facilities situated in real-world contexts, not constructed laboratory settings. [https://www.ltu.se/cms\\_fs/1.101555!/file/LivingLabsMethodologyBook\\_internet.pdf](https://www.ltu.se/cms_fs/1.101555!/file/LivingLabsMethodologyBook_internet.pdf)

**Table 4: Selected cases**

Country	Name	Organisation	Technological focus
Denmark	RoboTT-NET	Danish Technological Institute, Robotcenter International RTO collaboration	Robot technology
	LORC Nacelle Testing	Lindo Offshore Renewables Center (LORC) in collaboration with Force Technology	Offshore wind mile technology
Finland	VTT Bioruukki	VTT	Focus on bioeconomy - bio- and circular economy businesses
	Oulu 5G Test Network	VTT, University of Oulu	A full-scale, deployable 5G network, providing a real life living laboratory for application and service testing with real life network-level performance
	Smart Machines and Manufacturing Competence Centre (SMACC)	Tampere University of Technology, VTT	Digitisation/reindustrialisation (Industry 4.0)
Norway	Stadt Towing Tank	Stadt Towing Tank AS	Maritime sector
	SINTEF Raufoss Manufacturing AS	SINTEF	Two test facilities Lightweight materials and automated production Advanced production of goods in a high-cost country Several laboratories
Sweden	ElectriCity	Joint venture between the City of Gothenburg, the Volvo Group, Region Västra Götaland, Chalmers University	Public transport - new solutions for sustainable commuting
	Sport tech research center	Mid Sweden University	Sports engineering and product development.
	Ligno city	Innventia research institute	Paper & Pulp industry with focus on industrial processes

#### 4.5 Experiences and lessons learned from the cases

The following section provides input on the lessons learned from the cases and could serve as inspiration for policy-makers and managers in the field of test and demonstration facilities. The examples are not representative, but they demonstrate key success factors of test and demonstration facilities in the Nordic countries.

*Collaboration* is an important parameter for success, when it comes to creating added value for companies. In most of the cases, collaboration in some form, either national or international, is present. In the ROBOTT-NET case, the collaboration is between four RTOs in Europe, whereas in other instances, such as the ElectriCity case, collaboration is at national level between universities, the private industry and the

public sector, or in the SMACC case, between an RTO and two universities. In the case of ROBOT-NET, the four partners all have a good network and can assist companies in the best way possible. This collaboration increases the value for the company needing help, as it can connect with and get input from the RTO with the most specific knowledge related to the problem of the company in question. The value proposition must be clear to the partners and the collaboration agreements must be well defined.

Also for LORC in Denmark, the public-private partnership and a common ambition from all partners have been the driving force behind the success of the facility.

A key success factor for facilities such as LignoCity and ElectriCity is the strong cooperation between actors from academia, business/industry and the public sector. For instance, since large-scale testing within the public transport sectors is often intimately connected with city and traffic planning issues (ranging from how citizens use the public space to how to provide buses with ElectriCity at a sufficient scale, etc.), close cooperation between university-industry-government is an important success factor.

For SMACC, the success of the facility is closely related to the collaboration between the VTT Technical Research Centre of Finland and the two universities in Tampere, which has ensured broad contacts to enterprises in the manufacturing sector as well as research-based competences, which have added value to the companies.

Among the other success factors is *access to expert staff* who can assist companies with tests and demonstrations and advise them on the next steps they should take. For instance, the staff's competences have been very valuable to Finnish VTT Bioruukki because of the accessibility of accurate and new research information. Clients have especially used the opportunity to develop new processing methods together with VTT Bioruukki's experts and in test labs. Each company also has its own key account manager.

For SMACC, the service model enabling the facility to offer equipment, facilities and software from the RTO VTT and the two universities from Tampere, TUT and TUAS, may be one of the key factors of success, because by doing so they can offer a wide range of different services to the companies. In addition, by collaborating with universities, they can activate students who can offer their knowledge and gain valuable experience and maybe a future job with one of the customers.

The same can be said of Sintef Raufoss Manufacturing, which can assist the companies with prototype development and pilot production, engineering workshop services and small series production, product testing and analyses, as well as material characterisation.

Along these lines, *access to state-of-the-art technological infrastructure* and access to an extensive network within research are also highlighted as key success factors. This is the case for LignoCity, where research stakeholders, such as the University of Karlstad, the Innventia Research Institute, provide frontage technological knowledge apart from test and demonstration facilities. Moreover, regional and local authorities provide a variety of business support, which is listed as an additional important success factor.

Also in the case of the Sports Tech Research Centre, links to Mid Sweden University and access to top-class research within the field of technologies as well as health and

sports are considered strong contributing factors to the centre being one of the leading test facilities within its specialty.

The network and eco-system in which the facilities operate are also deemed to be an important success factor. LignoCity is based in a strong industrial area, as the region of Värmland (and the Municipality of Kristinehamn) has a long historical tradition of wood based-industry and are considered a frontrunner in bio-based economy in Sweden.

Regarding ROBOT-NET, it has proved beneficial that the RTOs are located in a local cluster of excellence. For instance, DTI Robotics is situated in Odense, which is the robotics cluster of Denmark. This way, DTI has thorough knowledge of and is instantly connected with system integrators, the University of Southern Denmark, etc. DTI can then easily put the company in touch with these actors to solve a problem, provide additional advice, etc. This increases the value of the test and demonstration for the company in question.

Likewise, the Stadt Towing Tank benefits from being part of the Norwegian maritime cluster and has good access to companies in need of a state-of-the-art test facility.

*Ability to combine different research areas/areas of expertise* is also highlighted as a key success factor in the cases. For instance, the ability to join different fields of research and industrial sectors – ranging from testing and developing electric hybrid technologies, designing buses and enhancing the user experience in areas such as indoor climate, noise reduction in the buses, to city planning and behaviour – is considered an important factor, making ElectriCity an attractive test and demonstration site.

Typically, the test and demonstration facilities established in the good practice cases are primarily established through a market-driven focus, even though it would be right to emphasise that many facilities are *operating on a semi-market based business model*. The semi-market based business model originates from the market – not governmental programmes and policies – and determines the supply of test and demonstration facilities. However, many of the good practice facilities can offer companies (particularly SMEs) access to state-of-the-art testing and demonstration facilities at a lower price than the market price as well as access to new and/or to technical specialised facilities. This is possible because the investment in and use of the facilities are based on innovation programmes (such as H2o2o) or through public-private partnerships. However, in some cases, the use of test and demonstration facilities is an integrated part of a research and innovation programme where the programme finances the use of the facilities and not the industry.



## 5. Mapping of Nordic test and demonstration facilities

In this Chapter, we present the results of the survey of Nordic test and demonstration facilities. The survey gives a statistical profile of the test and demonstration facilities illustrating some noticeable features and operating characteristics. Overall, this indicates significant profiles and differences between the Nordic countries.

### 5.1 Overall characteristics of the services offered

To become part of the mapping of test and demonstration facilities, the facilities had to respond positively to at least one of the four questions in Table 5. The Nordic test and demonstration facilities are generally characterised by:

- offering services assisting companies to innovate, e.g., develop or test new materials, new products or new production processes
- doing tests that not only correspond to existing standards or norms, but can go beyond
- basing their services on physical testing facilities and/or demonstration facilities.

These general characteristics of test and demonstration facilities can be seen in all the Nordic countries.

**Table 5: General characteristics of the research and innovation infrastructure**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Do you offer services concerning testing and demonstration that can help companies to develop or test new materials, new products or new production processes?	98%	92%	83%	88%	92%	94%
Are your services based on one or more physical testing facilities and/or demonstration facilities?	98%	92%	100%	88%	83%	91%
Do you offer testing and demonstration services that go beyond a mere check according to a standard or a norm?	96%	83%	67%	73%	86%	89%
Do you have virtual test and demonstration facilities?	NA	17%	17%	22%	33%	29%

Note: The question "Do you have virtual test and demonstration facilities?" did not apply in Denmark. N-values; see Table 2.

Source: Danish Technological Institute.

In the light of increasing digitisation, large companies have established digital or virtual facilities to develop and monitor their production that are also used for testing. Consequently, we might expect to find similar facilities among test and demonstration facilities operating as an open source for the industry. Moreover, virtual test and demonstration facilities have made their entry, even though such facilities are not widespread.<sup>17</sup>

## 5.2 Services offered

The services offered by the test and demonstration facilities can be divided into two main groups of services. The first group of services is at the core of doing tests and demonstrations, while the second group of services can be characterised as a supplementary service to pure testing and demonstrations.

Regarding the service at the core of doing tests and demonstrations, the Nordic test and demonstration facilities are primarily targeted at testing products, and slightly more oriented towards new products than testing or checking products that are already in the market (see Table 6).

Testing and demonstrations that are closer to the market are less common. Half of the Nordic test and demonstration facilities offers testing of new production technology or production processes. Furthermore, when it comes to demonstration plants including, for instance, living labs or pilot production, about one third of the test and demonstration facilities offers such services.

Some test and demonstration facilities also do some manufacturing. However, such services are not very common and are probably limited to small-scale or micro-production.

Between the Nordic countries, some differences can also be identified. In this instance, we can observe that the Norwegian test and demonstration facilities appear to be less oriented towards production processes and the final use.

**Table 6: Which types of testing and demonstration services do you offer to other companies? Multiple answers are possible**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Testing or checking products that are already on the market	74%	83%	50%	76%	63%	70%
Testing or trying out new products including prototypes	84%	83%	67%	67%	78%	79%
Testing of new production technology or production processes	50%	58%	67%	29%	49%	48%
Demonstration plants including, e.g., living labs	31%	50%	17%	16%	30%	29%
Pilot production with a view to scaling up to full production	37%	58%	50%	31%	32%	35%
Actual production	12%	17%	33%	16%	20%	16%
Other	13%	8%	0%	14%	20%	15%

Note: N-values; see Table 2.

Source: Danish Technological Institute.

<sup>17</sup> <https://www.dti.dk/virtual-production/34276>



When it comes to supplementary services, the facilities offer different types of consultancy services (see Table 7). These consultancy services are mainly found in close connection with testing and demonstration activities or are related to project-based development, probably with a focus on product development.

It is also very common to assist with product approval, standardisation, certification, etc. However, only few facilities offer any kind of service that could be construed as official documentation in terms of product approval or certification. Even fewer facilities assist with IPR-related issues.

An overall observation is that the facilities mainly offer supplementary services relating to product development and rarely have a wider perspective, such as consulting in connection with product systems.

**Table 7: Do you offer other services in connection with testing and demonstrations to companies?  
Multiple answers are possible**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Consultancy in close connection with testing and demonstration activities	86%	91%	33%	83%	83%	84%
Consultancy and assistance for project-based development – innovation or incubation trials and business development	71%	55%	33%	57%	53%	62%
Consultancy concerning product approval, standardisation, certification, etc.	54%	73%	50%	38%	43%	48%
Providing contacts to other consultants, advisers, producers, etc.	49%	27%	17%	21%	38%	40%
Marketing, including the users bringing their own customers to attend testing and demonstration activities in support of the users' own sales and marketing efforts	37%	36%	17%	19%	24%	30%
Product approval	34%	27%	0%	15%	27%	28%
Consultancy concerning product systems, e.g., flexible or digital production systems	33%	64%	17%	9%	22%	27%
Certification	27%	18%	17%	17%	18%	22%
Consultancy concerning patenting and licensing	12%	45%	17%	13%	11%	13%
Access to external financing, e.g., loans, equity	2%	9%	0%	9%	1%	3%
Access to loans or other types of financing	1%	18%	0%	4%	1%	2%
Don't know	1%	0%	0%	0%	2%	1%
No	2%	9%	50%	6%	5%	5%
Others	3%	0%	0%	2%	6%	4%

Note: N-values; see Table 2.

Source: Danish Technological Institute.

### 5.3 Indication of market focus

The market can be viewed from a technical and an industrial perspective. Technologically, all the test and demonstration facilities represent a broad technological range, which is also indicated by the different inputs under the category “others”. However, new technologies or technological challenges are also setting the technological agenda as technological challenges regarding climate and energy are a main area together with technologies related to KETs where the facilities offer their services.

The technological focus indicates that the facilities are dedicated to new technology trends, and, in line with the services offered, an intent to address innovative problems linked to product development.

**Table 8: Technologies that are part of your testing and demonstration environment. Multiple answers are possible**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Climate, water and energy technology	38%	64%	17%	21%	35%	35%
Other advanced materials (- than listed elsewhere in the table)	37%	36%	0%	13%	24%	29%
Biotechnology, bioenergy	26%	55%	50%	23%	18%	24%
Nanotechnology, surfaces and microtechnology	26%	27%	0%	15%	16%	21%
Information and communication technology, including specialised software, systems solutions	19%	45%	0%	6%	21%	19%
Robot technology, mechanics, etc.	23%	45%	17%	4%	15%	18%
Photonics, e.g., intelligent meters and sensors, Smart Grid	18%	27%	0%	9%	16%	16%
Micro- and nanoelectronics, electrochemistry, printed electronics	15%	9%	0%	4%	11%	12%
Aero- and hydrodynamics	15%	9%	17%	2%	8%	11%
Others	30%	18%	33%	45%	40%	35%
Don't know	4%	0%	0%	11%	5%	5%

Note: N-values; see Table 2.

Source: Danish Technological Institute.

From a customer perspective, the facilities service industry within a very broad range of industrial sectors (see Table 9). However, Energy and climate, Water, Bio and environmental solutions and Circular economy are the main sectors together with Industrial manufacturing and are thus in line with the main technology areas in focus (see Table 9).

Moreover, the facilities target a long list of “traditional” industrial sectors with a tendency to focus on sectors where the individual Nordic countries are internationally competitive, such as:

- Denmark within Energy (wind power) or Agriculture
- Maritime shipping including offshore in Norway and Denmark
- Information and communication technology, including tele infrastructure in Finland
- Forestry in Finland and Sweden.

Due to the number of replies, the national sector profiles are subject to reservations.

**Table 9: Which market or business areas are your testing and demonstration facilities primarily directed at? Multiple answers are possible**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Energy and climate	47%	27%	0%	34%	43%	42%
Industrial manufacturing, including machine manufacture and production methods, as for example digitisation and automation	42%	45%	17%	19%	32%	35%
Water, bio and environmental solutions, circular economy	37%	45%	33%	26%	26%	32%
Agriculture, fishery, food stuffs	40%	27%	67%	23%	15%	29%
Health and welfare, including pharmaceutical industry (pharma), medical devices, sports, treatment systems, e-health, etc.	34%	36%	33%	30%	20%	29%
Construction	23%	36%	0%	21%	22%	22%
Maritime shipping including offshore	26%	0%	17%	28%	10%	20%
Consumer goods	19%	27%	50%	6%	17%	17%
Onshore transportation, including means of transport and physical infrastructure	18%	0%	0%	9%	18%	16%
Mining and quarrying	15%	9%	0%	9%	11%	12%
Information and communication technology, including tele infrastructure	9%	27%	0%	15%	13%	12%
Forestry	7%	18%	0%	4%	14%	9%
Others	8%	9%	0%	15%	15%	11%
No specific markets	2%	9%	0%	2%	2%	2%
Don't know	0%	0%	0%	0%	1%	0%

Note: N-values; see Table 2.

Source: Danish Technological Institute.

## 5.4 Indication of the business model and economic activities

The Nordic test and demonstration facilities predominantly offer their services on market conditions as the users pay full market price for their services (see Table 10).

However, the Nordic countries have implemented initiatives or programmes that indirectly support the use of test and demonstration facilities (see Chapter 3). The financial support is often provided as a part of a technology programme (R&D or innovation programmes) or as a grant, such as vouchers, to purchase tests. Consequently, the users have access to test and demonstration facilities at a reduced cost under these conditions, but the test and demonstration facilities will typically charge the users the market prices. However, due to differences in the design of the R&D/innovation policy among the Nordic countries, we observe significant differences between the Nordic countries when it comes to having access to test and demonstration facilities at reduced prices. In Finland, the users have the most favourable conditions (See Table 10). These policy initiatives appear to have a significant impact on the market conditions for the Nordic test and demonstration facilities, even though there is no indication of the financial benefits of these policy initiatives.

**Table 10: How much do companies pay for access to your testing and demonstration facilities or consultancy? Please give several answers if there are several possibilities**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Full payment – market price	88%	90%	100%	55%	83%	83%
Reduced price, as public support or programme funding pays part of the costs	37%	60%	60%	32%	22%	32%
The companies may gain access to public support which they can spend on purchasing our services	27%	50%	60%	34%	15%	25%
Free for users and customers	11%	10%	0%	11%	11%	11%
Don't know	1%	0%	0%	5%	7%	4%
Others	7%	0%	0%	13%	7%	7%

Note: N-values; see Table 2.

Source: Danish Technological Institute.

In line with the facilities operating on market conditions, users from other countries wishing to make use of the testing and demonstration facilities are typically offered the same conditions as domestic users.

We have not carried out a detailed review as to whether financial support from the national R&D/innovation programmes can be used in other countries and the possible impact of such schemes. However, national R&D/innovation programmes are typically designed in such a way that financial support (grants) can only be used in the domestic market and not for purchasing tests and demonstration facility services abroad. Consequently, the users may not have exactly the same economic conditions when

importing test and demonstration facility services or the test and demonstration facilities may be economically challenged when exporting their services.

The facilities can be part of a science park, business incubator, industrial park associated with the testing and demonstration environment, but the users are typically not required to be part of these establishments.

On average, the facilities service below 100 users per year, with Norway at the lower end (see Table 11). However, we observe a significant variation in the number of users. For example, in Denmark, eight facilities each have more than 500 users, and one has more than 4,000 users. In Sweden, we observe a similar picture where just three facilities have more than 500 users of which one has 5000 users.

**Table 11: Average number of users per testing and demonstration facility in 2016. Approximate numbers**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Number of companies	85	76	53	32	97	81

Note: N-values; see Table 2.

Source: Danish Technological Institute.

Due to the limited number of users and since the facilities mainly operate under commercial conditions, the average number of employees is also relatively low as each facility typically has fewer than 20 employees (see Table 12).

**Table 12: Average number of full-time employees per testing and demonstration facility in 2016**

	Denmark	Finland	Iceland	Norway	Sweden	Total
Full-time employees	16	15	16	9	25	18

Note: N-values; see Table 2.

Source: Danish Technological Institute.

The low number of users and employees is potentially an indication of technologically specialised services. Keeping the review of the policy strategy on test and demonstration in mind, we have observed that test and demonstration facilities within the innovation infrastructure are mainly based on market conditions and that the decision to invest in new facilities is a decision primarily made by the individual organisations hosting the facilities. A challenge must be to balance the required investments in facilities matching the latest technological developments and demand and the expected turnover.

Thus, the Nordic test and demonstration facilities offer services within a broad range of technologies, which also include front-end technologies or technological solutions to societal challenges. The facilities mainly offer services connected to innovation and hereby have the industries as their clients. In general, the facilities apply a business model based on ordinary market conditions, which, on the other hand, may make them interested in becoming part of a website presenting test and demonstration facilities to potential users.



## 6. Design proposal for an interactive presentation of data

In the following, we present the draft guiding principles for an interactive product that can help users to identify relevant test and demonstration facilities in the Nordic countries. The project has generated a large amount of data from the providers of test and demonstration facilities in the Nordic countries. The objective of the interactive presentation of data is to give users, predominantly private enterprises, access to the information in an easy and direct way.

### 6.1 Underlying data for an interactive product

The information from the e-survey includes data to identify or classify the test and demonstration facilities as well as qualitative data describing the facilities, which will be made available in the interactive product. From the e-survey, the description of the facilities is available in at least one Nordic language as well as in English – if the test and demonstration facility has provided the information. Table 13 presents the core information.

For each test and demonstration facility, the information comprises contact information and a short introduction to the facility. The introduction was collected in the e-survey and consists of a text field of up to 4,000 characters.

Examples of text fields [some may be much shorter/longer]:

Danish Technological Institute; The Energy Efficiency Laboratory can assist with various types of testing of professional and commercial refrigerators and freezer appliances, electrical and electronic household and office equipment as well as vaccine coolers, e.g. testing of performance, efficiency, and energy consumption as well as accredited testing according to international standards. The tests are carried out in controlled climate conditions at temperatures ranging from -20 °C to 50 °C and a relative humidity up to 100%. The tests are also carried out according to all relevant European standards. Further, the laboratory also carries out custom-designed tests and focuses on the development, optimisation and demonstration of products and new technology as well as the use of natural and synthetic refrigerants.

The contact information fields are divided into:

- Website
- Name of contact person
- Company name
- Street and number

- Postcode
- City
- Country
- E-mail
- Telephone

Furthermore, there are typologies for the types of tests, additional advice, technologies and markets. The typologies are important filters for an easy identification of a relevant test and demonstration facility. The filters are binary fields.

The data are stored electronically and can be retrieved in a CSV, XLS, MS ACCESS or SPSS format. Each record represents a test and demonstration facility. A company with multiple facilities is represented with each of its test and demonstration facilities.

**Table 13: Overview of data available for an interactive product**

Information	Question
Name	What is the name of your testing and demonstration facilities?
Types of test	Testing or checking products that are already on the market
	Testing or trying out new products including prototypes
	Testing of new production technology or production processes
	Demonstration plants including , e.g., living labs
	Pilot production with a view to scaling up to full production
	Actual production
Additional advice	Consultancy in close connection with testing and demonstration activities
	Consultancy and assistance for project-based development – innovation or incubation trials and business development
	Consultancy concerning product systems, e.g., flexible or digital production systems
	Consultancy concerning product approval, standardisation, certification, etc.
	Consultancy concerning patenting and licensing
	Product approval
	Certification
	Marketing, including the users bringing their own customers to attend testing and demonstration activities in support of the users' own sales and marketing efforts
	Providing contacts to other consultants, advisers, producers, etc.
	Access to loans or other types of financing
Access to external financing, e.g., loans, equity	
Technology	Nanotechnology, surfaces and microtechnology
	Micro- and nanoelectronics, electrochemistry, printed electronics
	Other advanced materials



Information	Question
	Photonics, e.g., intelligent meters and sensors, Smart Grid
	Biotechnology, bioenergy
	Aero- and hydrodynamics
	Robot technology, mechanics, etc.
	Information and communication technology, including specialised software, systems solutions
	Climate, water and energy technology
Market	Agriculture, fishery, food stuffs
	Forestry
	Mining and quarrying
	Construction
	Energy and climate
	Water, bio and environmental solutions, circular economy
	Industrial manufacturing, including machine manufacture and production methods, as for example digitisation and automation
	Information and communication technology, including tele infrastructure
	Health and welfare, including pharmaceutical industry (pharma), medical devices, sports, treatment systems, e-health, etc.
	Onshore transportation, including means of transport and physical infrastructure
	Maritime shipping including offshore
	Consumer goods
Presentation	A short text of presentation
Contact information	Address and contact person

Source: Danish Technological Institute.

## 6.2 Design proposal for an interactive product

### 6.2.1 Digital Interactivity

Digital interactivity in this context means that a digital tool is used to access and manipulate data. That can take place on many digital platforms, and in its raw form it could be just an Excel spreadsheet with all the information in one place. Here, data could be filtered, sorted and selected, but Excel would be insufficient in terms of accessibility and distribution. Furthermore, it would be difficult for the test and demonstration companies to update the information.

Thus, our proposal is to create a website. The internet is ideal for this type of information.

- *Easy-to-use.* There is no need to install databases or software on user machines. Users will be familiar with using websites;
- *Covers all types of information about the test and demonstration facilities.* The website can contain searchable data, filter data and can also present the data tables, the case stories, FAQs and information about test and demonstration facilities;
- *Maintaining.* The website can be created to allow test and demonstration facilities to update the information;
- *Availability.* The website can be optimised for search engines, and advertising such as google AdWords may also be added;
- *Advertising platform.* The website will be a portal for companies searching for test and demonstration facilities in the Nordic countries;
- *Multinational.* The website can present data in the Nordic language<sup>18</sup> of the test and demonstration facility and in English. This could facilitate more cross-border cooperation and business-to-business cooperation.

For this proposal, we have been inspired by the German website Industrie 4.0,<sup>19, 20</sup> which uses geographical information, tags and searchable lists to give an overview of test and demonstration facilities in Germany. The German website is open and anyone can find information on relevant test and demonstration facilities.

We propose a similar website for the Nordic test and demonstration facilities. The interactive element means that it is relatively easy to identify a test and demonstration facility with a few mouse clicks using a map and with full text search or through a menu system.

Figure 6: Landkarte Testzentrum Industrie 4.0 [Map of test facilities for industry 4.0]



Source: <https://goo.gl/Ees9qG>

<sup>18</sup> Danish, Finnish, Norwegian and Swedish.

<sup>19</sup> <https://goo.gl/Ees9qG>

<sup>20</sup> See also KETs facilities; <https://ec.europa.eu/growth/tools-databases/kets-tools/kets-tc/map>

### 6.2.2 *Proposal for platform for internet site*

We propose that the website be developed in the content management system (CMS) Joomla. Joomla is one of the most common CMS systems in the world and is behind millions of websites. Joomla enables developers to create websites and powerful online applications. Many aspects, including its ease-of-use and extensibility, have made Joomla the most popular website software available. Joomla is an open source solution and is available free of charge.

The website should have at least three entry points: Front end, back end for users (the test and demonstration facilities) and a back end for administrators.

The *front end* for visitors should have at least the following features:

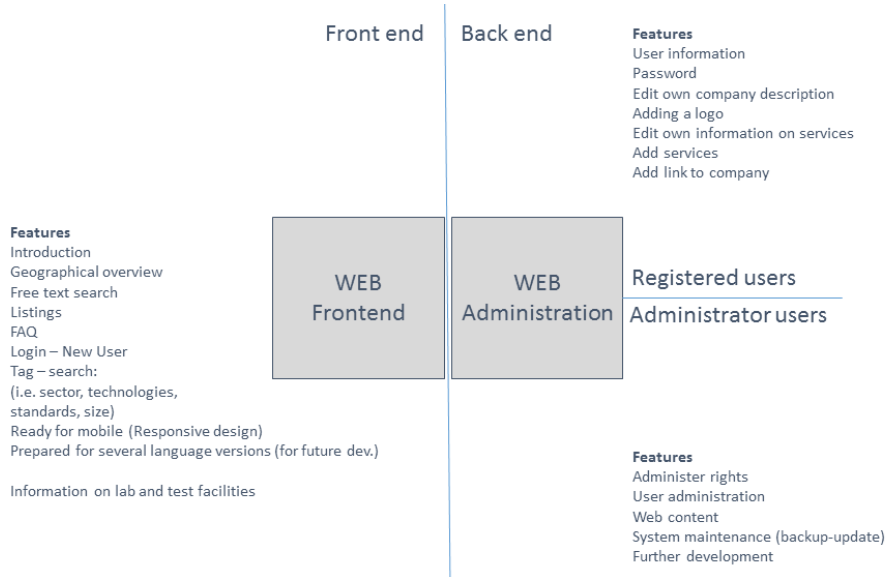
- An easy-to-navigate menu system
- An introduction to the site (About us)
- An online help system (FAQ)
- Access to qualitative content: case stories, reports from the project
- Geographical overview (facilities on a map, filtering according to tags, etc.)
- Search (free text search)
- Filtering by key words or tags
- Presentation of the individual test and demonstration facilities
- Login to backend for test and demonstration facilities
- Language selection. The system should be able to use all Nordic languages<sup>21</sup> as well as English. Other system languages may be considered. The content from the test and demonstration facilities will be in a Nordic language, i.e., Danish, Finnish, Norwegian or Swedish and in many cases English as well.

The internet design must be responsive to being used on all platforms from computers, smart pads and smartphones. The layout should be efficient and professional with direct access to search facilities. There may be pictures, but the focus will be on functionality.

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<sup>21</sup> Danish, Finnish, Norwegian and Swedish.

Figure 7: Website overview



Source: Danish Technological Institute.

The *back-end* is a password protected area with access to test and demonstration facilities. In the back-end area, users of test and demonstration facilities can edit, add or delete their own profile information. The profile information is all information (categories, contact information, description).

The facilities may have new features or technologies to offer, they may want to change their presentation, or they may wish to add a logo-file. Only registered users are allowed to use the system. A user cannot edit other user profiles and has no access to the administrator files.

The users may need help, and in the back-end there will be a section on help with FAQs and simple guides.

Contact information has been gathered with the survey. All interviewees will receive a username and password information by e-mail. New users can apply, but a system administrator will have to grant access rights before access is allowed. We will e-mail an invitation to companies that have not answered the e-survey, but which seem to be relevant for the website. The content and forms for users must be provided in Danish, Swedish, Norwegian, Finnish, Icelandic as well as English. German, Faroese and Greenlandic are suggested as optional.

It is important that the back-end is easy and self-explanatory to use to reduce the resources needed for servicing the users.

In the *administrator section* system developers and administrators can administer all content, perform system maintenance (such as a back-up, unless a webhost with backup is chosen). Further development of the system is handled from the administrator section.

On delivery of the final sites, all rights to the website, including the URL, etc., will be handed over to the Danish Business Authority.

We propose that the website primarily be developed using standard software and extensions for Joomla. Some customisation to complete the site will be necessary. A solution with software that is not open source or needs further customisation and programming will be considerably more expensive.

The administrator section can be used in the Nordic languages and English according to the preferences of the individual user.

**Table 14: Proposed software tools: Joomla, My Maps Location and Tableau**

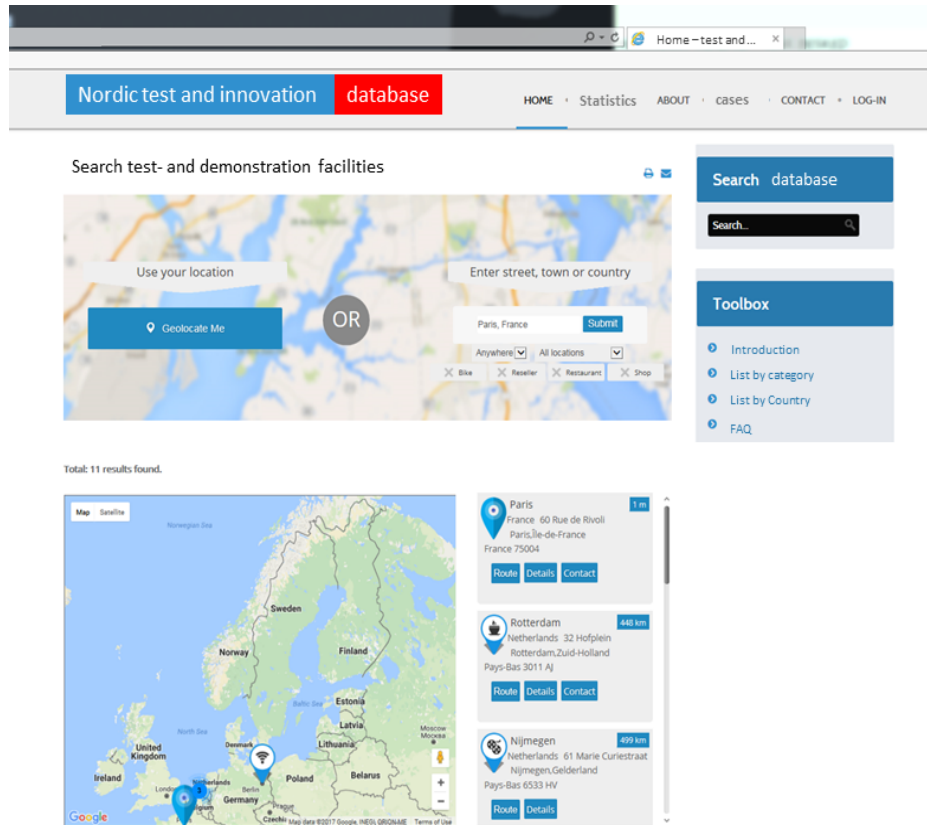
Joomla	MY MAPS LOCATION
<p>Joomla is an award-winning content management system (CMS), which enables you to build websites and powerful online applications. Many aspects, including its ease-of-use and extensibility, have made Joomla the most popular website software available. Joomla is an open source solution that is freely available to everyone.</p> <p><a href="https://www.joomla.org/">https://www.joomla.org/</a></p>	<p>An example for the map feature is "My Maps Location" extension for Joomla.</p> <p>The main features:            Search for locations you have created            Auto geolocation            Map source can be Google Maps, Bing maps or Mapbox            Add map design            Get information from Google places            Import/Export/Sync locations from .csv file            Frontend location submission            A lot of 3rd party extension integrations</p> <p>An alternative could be J-BusinessDirectory. The final selection of extension should be based on what needs less adaption to fulfil requirements.</p> <p><a href="https://www.joomunited.com/">https://www.joomunited.com/</a></p>

Source: Danish Technological Institute. Note more extensions will be necessary.

### 6.3 Dummy- example of the proposed website

Below we show three dummy screen dumps for the proposed website. The first illustrates what a geographically based search could look like.

Figure 8: Dummy front page



Source: Danish Technological Institute. The map graphics are a copy + paste from the demo presentation <https://www.demo-joomunited.com/my-maps-location/location-search>. The demo map has no locations in the Nordic countries.

### 6.4 Marketing of the Nordic test and innovation database

It will be necessary to develop a marketing plan to promote the Nordic test and innovation database. The plan must be directed at target groups, i.e., industries and test and demonstration facilities. For industries, Google AdWords or advertising are possibilities. For test and demonstration facilities direct e-mail to contact persons and other relevant companies is a cost-efficient way to promote the site once it goes public.

## 6.5 Recommendations and next steps

The set-up for this platform is that it is voluntary for companies to provide the necessary information. In addition, international experience shows that many organisations have similar and quite detailed platforms, although they often have a more specific focus based on own interests.

Thus, when building a platform for Nordic test and demonstration facilities, it is crucial that the initiative be thoroughly backed by national authorities and possibly industrial organisations. It is also clear that it is relatively difficult to get companies to provide information for these open platforms, unless there is a clear incentive to do so. This can be seen in the current mapping, where it has taken a great deal of follow-up to persuade companies to participate.

One solution for making the incentives to participate clearer to the companies could be to initiate a clearer profile for the platform (such as a focus on Industry 4.0, KETs, green energy, etc.). This would make it clearer to the companies who the potential users of their services are and give the companies an opportunity to create a stronger profile in the market. Regardless of the choice of profile, a Nordic focus could be an advantage as the platform visualises a larger and a more specialised market of test and demonstration facilities.

As mentioned above, it is of utmost importance that the initiative receives the backing of national authorities, including the Nordic Council of Ministers and the official committees. The challenging task for the Nordic Council of Ministers will be to get the Nordic countries on-board the vision for a Nordic market for test and demonstration facilities and initiate supporting innovation policy initiatives.

Nordic funds could be assigned to the creation of the platform. As part of the platform it could be considered to encourage Nordic test and development facilities to collaborate with inspiration from the Danish RoboTT-NET case for instance.

An innovation programme could be run in parallel with support companies in search of test and demonstration facilities to further their innovation endeavours. However, this should only be seen as a supporting instrument and not as an instrument decisive for the success of the platform.





## 7. Conclusions and recommendations

The mapping of test and demonstration facilities in the Nordic countries has shown that the innovation infrastructure for test and development is well developed in the Nordic countries. We have received responses from 384 test and demonstration facilities in the Nordic countries with facilities relevant to this mapping. The technological focus is largely on climate, water and energy technology, biotechnology, nanotechnology, information and communications technology, and robot technology, with variations among the Nordic countries. The services offered in relation to the test and demonstration facilities are primarily consultancy in close connection with testing and demonstration activities, consultancy and assistance for project-based development – innovation or incubation trials and business development, and consultancy concerning product approval, standardisation, certification, etc.

The good practice test and demonstration facilities are characterised by a high degree of collaboration with the surrounding eco-system and other partners offering test and demonstration facilities. Collaboration is an important parameter for success in relation to creating added value for companies. In most of the cases, collaboration in some form, either national or international, is present. Along these lines, the network and eco-system in which the facilities operate are also deemed to be an important success factor. Other success factors include access to expert staff, who can assist companies with tests and demonstrations and give advice on further steps to the companies. Along these lines, access to state-of-the-art technological infrastructure and access to an extensive network within research are also highlighted as key success factors. The ability to combine different research areas/areas of expertise has also been highlighted as a key success factor in the cases. For instance, the ability to join different fields of research and industrial sectors is considered an important success factor.

The facilities in the good practice cases have primarily been established with a market-driven focus. The market – not governmental programmes and policies – determines the supply of test and demonstration facilities. Having said that, many of the good practice facilities can in some instances offer companies (particularly SMEs) access to state-of-the-art test and demonstration facilities, often at a lower price than the market price. This is possible because the investment in and use of the facilities are based on innovation programmes (such as H2020) or through public-private partnerships. In addition, many of the RTOs are subject to part public funding, which carries a part of the economic risk in terms of investments.

All the Nordic countries except Iceland have national strategies where the creation of test and demonstration facilities in relation to the research infrastructure is prioritised and funding allocated. However, as mentioned above, when it comes to the

innovation infrastructure, the creation of test and demonstration facilities is observed more indirectly, for instance through funding of facilities in RTOs (where many test and demonstration facilities are placed) or innovation schemes supporting the industry in purchasing innovation services including test and demonstration services. Consequently, test and demonstration facilities related to innovation are largely based on a bottom-up approach (or a market-based business model) where the market demand is decisive for the establishment of test and demonstration facilities. This also means that strategic decisions about investments in test and demonstration facilities are primarily made by private or semi-private (e.g. RTOs) actors in terms of technological focus, markets and clients. This means that the focus areas for the facilities do not necessarily follow the political focus areas or strategies, e.g., technological problems related to societal challenges or challenges related to employing new emerging technologies. However, test and demonstration facilities will typically focus on new emerging technologies as these technologies will also generate a demand for technological services including test and demonstration facilities, but it does not imply a match between political strategies and business strategies for test and demonstration facilities.

However, in some of the Nordic countries there seems to be an interest in creating specific (regional) innovation policies. This also has an impact on creation of test and demonstration facilities, for instance in relation to clusters or politically prioritised areas such as green energy.

In conclusion, the Nordic test and demonstration facilities appear to be used by and are relevant for the companies. The economic setup makes the focus of test and demonstration facilities largely market driven. This is positive for the companies, but in relation to the national (or Nordic) competitiveness, it could be advantageous to connect the innovation infrastructure more closely to the national strategies.

To increase the visibility of the Nordic test and demonstration facilities and thereby make it easier for companies to gain access to these, thus increasing the Nordic competitiveness, we have the following recommendations:

## 7.1 Increase visibility through a website

The website should primarily be used to make it easier for companies searching for test and demonstration facilities to obtain access to the information on test and demonstration facilities in an easy and direct way. The website should have the following features:

- *Easy-to-use.* There is no need to install databases or software on user machines. Users will be familiar with using websites;
- *Covers all types of information about the test and demonstration facilities.* The website can contain searchable data, filter data and can also present the data tables, the case stories, FAQs and information about the test and demonstration facilities;

- *Maintenance.* The website can be created to allow test and demonstration facilities to update the information;
- *Availability.* The website can be optimised for search engines, and advertising such as google AdWords may be added;
- *Advertising platform.* The website will be a portal for companies searching for test and demonstration facilities in the Nordic countries;
- *Multinational.* The website can present data in the Nordic language<sup>22</sup> of the test and demonstration facility and in English. This could facilitate more cross-border cooperation and business between companies.

## 7.2 Test and demonstration facilities could have an active and dedicated role in national strategies for innovation

The test and demonstration facilities could be tied to the national strategies to a larger extent, and a number of initiatives could be undertaken in parallel with the increased visibility of the Nordic test and demonstration facilities. For instance, a number of technology-focused websites could be created to make it easier for companies with a specific profile (for instance green economy) to identify relevant test and demonstration facilities. This could be further supported with innovation programmes that help the companies (SMEs in particular) all the way to the market.

Along these lines, it could be considered as a Nordic (EU) initiative to establish test and demonstration programmes that encourage (further) technological specialisation and at the same time increase the size of the market for the test and demonstration facilities. Business models and collaboration models should then be developed for these programmes, with inspiration from the good practice cases, where collaboration is of utmost importance for the success of these.

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<sup>22</sup> Danish, Finnish, Norwegian and Swedish.



# Sammenfatning

De nordiske lande har en række fælles udfordringer med hensyn til at fastholde og tiltrække arbejdspladser inden for fremstillingsindustrien. Mange arbejdspladser i fremstillingsindustrien er i de sidste 20 år tabt eller udflyttet til lavindkomstlande, blandt andet begrundet i et relativt højt omkostningsniveau i de nordiske lande. Skal denne udvikling vendes, kræver det en revitalisering af særligt små og mellemstore produktionsvirksomheders konkurrenceevne, og her spiller en mere innovativ anvendelse af digitalisering og automatisering en nøglerolle for virksomhederne. I den forbindelse er det væsentligt, at virksomhederne har adgang til at teste og afprøve nye produkter og ny teknologi, for herigennem at få inspiration til, hvordan nye teknologier kan anvendes til fx at udvikle nye produkter, services og forretningsmodeller. Denne rapport præsenterer en kortlægning af test- og demonstrationsfaciliteter i de nordiske lande, herunder et overblik over fokusområder og ydelser. Derudover indeholder rapporten ti case-beskrivelser af udvalgte test- og demonstrationsfaciliteter samt en beskrivelse af politiske initiativer på området i de enkelte nordiske lande.



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## Annex 2: Case studies

Annex 2 presents ten illustrative best practice cases of test and demonstration facilities whose experiences and lessons learned can inspire others with ambitions to develop test and demonstration facilities

The cases have been prepared based on desk research and interviews with managers from the test and demonstration facilities.

**Table 1: Selected cases**

Country	Name	Organisation	Technological focus
Denmark	RoboTT-NET	Danish Technological Institute, Robotcenter International RTO collaboration	Robot technology
	LORC Nacelle Testing	Lindo Offshore Renewables Center (LORC) in collaboration with Force Technology	Offshore windmill technology
Finland	VTT Bioruukki	VTT	Focus on bioeconomy - bio- and circular economy businesses
	Oulu 5G Test Network	VTT, University of Oulu	A full-scale, deployable 5G network, providing a real life living laboratory for application and service testing with real life network-level performance
	Smart Machines and Manufacturing Competence Centre (SMACC)	Tampere University of Technology, VTT	Digitisation/reindustrialisation (Industry 4.0)
Norway	Stadt Towing Tank	Stadt Towing Tank AS	Maritime sector
	SINTEF Raufoss Manufacturing AS	SINTEF	Two test facilities Lightweight materials and automated production Advanced production of goods in a high-cost country Several laboratories
Sweden	ElectriCity	Joint venture between the City of Gothenburg, the Volvo Group, Region Västra Götaland, Chalmers University	Public transport – new solutions for sustainable commuting
	Sport tech research center	Mid Sweden University	Sports engineering and product development
	Ligno city	Innventia, research institute	Paper & pulp industry with focus on industrial processes

We have used an overall similar structure to present the cases, even though the cases represent as many similarities as differences. The overall applied structure includes the following elements:

- Introduction or presentations
- Organisation – target group and business model
- Technological focus – services offered
- Lessons learned or success factors

## Annex 2a: Denmark

Figure 9: RoboTT-NET



### Case: RoboTT-NET

#### *Introduction*

Based on collaboration between four European RTOs, ROBOTT-NET provides access to state-of-the art competence centres within robotics supplying test and demonstration facilities for companies.

Collaboration is a cornerstone in ROBOTT-NET. The collaboration between the four RTOs increases the value of the facilities for the company, as it can connect with and receive input from the RTO with the most specific knowledge related to the problem of the company in question. The use of the test and demonstration facilities and associated advice is free of charge under the ROBOTT-NET voucher programme, which, particularly for a start-up or an SME, is highly valuable as price might be a barrier for these companies.

The location of each of the RTOs in a *local cluster of excellence* means that the RTOs have thorough knowledge of and are instantly connected with system integrators, universities, etc., and can then easily put the company in touch with these actors to solve a problem, provide additional advice, etc. This increases the value of test and demonstration for the company in question by providing a one-stop-shop.

### **Organisation – target group and business model**

ROBOTT-NET is a European robotics network operated by four RTOs in Denmark, Germany, Spain and the UK. The four RTOs in ROBOTT-NET help companies of all sizes to bring their ideas to market and to optimise their production. They do so through a voucher system. Companies needing to test a new technology or an existing technology in a new market can apply for these vouchers. The vouchers offer services such as consulting/advice, test of the product and a roadmap for the next steps for the company. Test and demonstration are the core of these vouchers and the main reason for companies to apply for the vouchers. This means that the test and demonstration facilities are a very important element of creating a roadmap for the companies to help them move from their current situation to a new solution or a new market.

ROBOTT-NET exists to help make the best ideas in industrial robotics a reality to the benefit of technology developers and European manufacturing.

ROBOTT-NET's mission is to collect and share the latest knowledge about robot technology that can improve production, bring new ideas to market and ensure economic competitiveness. In this particular project, the four RTOs set out to reach that mission by offering free consulting and use of test and demonstration facilities to European companies that develop or deploy robot technology in industrial production.

ROBOTT-Net's raison d'être is thus to help transform the best industrial robot ideas into real products. What is unique about the consortium is that the RTOs are interlinked, which provides benefits to the companies. For example, a Danish company can contact Danish Technological Institute (DTI) with an idea or prototype that needs to be tested, and if it creates more value for the company to collaborate with other members of the consortium, the company is linked to another RTO. Thus, the consortium seeks to create as high value as possible for the companies.

### **Who are the RTOs behind?**

As mentioned above four RTOs operate ROBOTT-NET, i.e., DTI from Denmark, Fraunhofer from Germany, Technalia from Spain and the Manufacturing Technology Centre from UK. All of them have test and demonstration facilities that companies can use under the ROBOTT-NET voucher programme.

*DTI (Denmark):* DTI has two robot innovation halls that function as living labs, providing the base for technical development and testing of innovative technologies for agile manufacturing, health, and agriculture and service sectors.

*Fraunhofer (Germany):* The Fraunhofer Institute for Manufacturing Engineering and Automation IPA was established 40 years ago. The department "Robots and Assistive Systems" focuses on the development of robot systems and automation solutions for industry and the services sector.

*Technalia (Spain):* Technalia Research and Innovation's Robotics Group within the Advanced Manufacturing Business Unit focuses on three business areas, i.e.,

1) prototyping and control of robots, 2) professional service automation, 3) modern automation, such as sensor-based guiding and collaborative robotics.

*The Manufacturing Technology Centre (UK):* The Manufacturing Technology Centre (MTC) develops and proves innovative manufacturing processes and technologies on an industrial scale in an agile, low-risk environment in partnership with industry, academia and other industries. The MTC's areas of expertise include intelligent automation, advanced tooling and fixturing, high integrity manufacturing, and net shape and additive manufacturing.

#### **Target group and costs associated with the test and demonstration facilities**

ROBOTT-NET targets technology developers, start-ups, SMEs and established manufacturers as well as academics and investors. In short, *anyone with a concrete idea, challenge or development project related to industrial robotics* can apply to the programme. The programme is *free of charge* for the participants. However, not all projects that apply are accepted into the programme.

#### ***Technological focus – services offered***

64 selected projects will receive a ROBOTT-NET voucher. This voucher is the backbone of the programme. It entitles users to approx. 400 hours of free consulting with robotics experts from all over Europe. By the end of the voucher programme, applicants will have developed a plan detailing the technical innovation needed (path-to-product or automation design) and the business case for product maturation or robot automation. Among other things, this is done by using the test and demonstration facilities at the premises of the four RTOs.

Throughout the process, ROBOTT-NET will hold Open Lab events in Denmark, Germany, Spain and UK. These events will promote state-of-the-art industrial and professional service robot technologies to robot developers, investors, end-users and others to help participants develop their network. This supports the test and demonstrations that companies undertake in the voucher programme.

In addition, all partners will *run general courses for industry management and technicians*. One of the important aims in ROBOTT-NET is to strengthen the technology transfer between the participating research and technology organisations (RTOs) and the European manufacturing industry. The courses set out to achieve this technology transfer. Some of the major topics that will be treated in these courses include:

- What can robotic automation offer and where are the limits?
- How can companies obtain the right automation solution?
- How can staff be used effectively alongside automation?
- How can robotics be used strategically?

Finally, *eight of the original 64 projects will be selected for further development assistance*. For these eight projects, ROBOTT-NET will team each project with a real-world case and the technology will be implemented in a pilot.

### *Lessons learned or success factors*

*What is ROBOTT-NET's value proposition and what can be learned from the case?* One of the main success factors in ROBOTT-NET is the *collaboration between the four RTOs*. The four partners all have a good network and can assist the companies in the best way possible. This collaboration increases the value for the company as it can connect with and get input from the RTO with the most specific knowledge related to the problem of the company in question. To ensure optimal value for the company, the partners in ROBOTT-NET focus on match-making between the RTOs and the companies. Only this way can it be ensured that the right knowledge from the right RTO flows to the company. In this regard, a formalised partnership and well-defined collaboration agreements between the RTOs across Europe are extremely important. Otherwise, there is the risk of the different entities competing instead of collaborating, which does not create the optimal benefit for the companies. Questions that need to be addressed before entering a partnership include:

- Which services are relevant to offer beyond national borders?
- What is the price/cost model for different services and what is the incentive?
- Terms of delivery of services such as IPR, responsibility, support, etc.

Along the same lines, it is important that there is an incentive for collaboration between the partners, in this case the RTOs. If the incentive for all partners is unclear, the collaboration will not function optimally. In this respect, it is important that all partners are RTOs and therefore understand the balance between serving a commercial market and carrying out R&D&I activities. The partners understand each other and complement each other at the same time.

Another main success factor is that the use of the test and demonstration facilities and associated advice are *available to the company*, once the company in question has been approved for the voucher programme. Particularly for a start-up or an SME, this can contribute to creating new products and/or services or open up new markets for the companies as their ideas and products have been tested before venturing into the markets.

Lastly, it has proved beneficial if the RTOs are situated in a *local cluster of excellence*. For instance, DTI Robotics is situated in Odense, which is the robotics cluster of Denmark. This way, DTI has thorough knowledge of and is instantly connected with system integrators, the University of Southern Denmark, etc. DTI can then easily put the company in touch with these actors to solve a problem, provide additional advice, etc. This increases the value of the test and demonstration for the company in question.

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## Case: Lindoe Offshore Renewables Center (LORC)

### Introduction

In 2009, the Lindoe Offshore Renewables Center (LORC) was established on what was left from the former Lindoe Shipyard situated in the northern part of Funen. Initially, LORC was established with the ambition to maintain or secure local workplaces and support the transformation into a greener economy. The then Danish Prime Minister, Poul Nyrup Rasmussen, was the driving force behind the establishment of LORC and helped to form a board of directors of powerful private and public partners who supported his ambition.

Without any capital, LORC was established as a non-profit commercial foundation.

### Organisation – target group and business model

After a couple of years, when LORC had been running small projects, it was decided to focus on test and validation in relation to the offshore renewable energy sector based on demand from the sector.

*The business model emerged:* Major co-funding from the public programme “Green Labs DK” has been decisive not only for keeping the technology in focus but also for the business model:

- Financial support could only be given to SMEs. Consequently, LORC had to be a small independent firm;
- A precondition for obtaining public funding was co-funding from private partners, which was provided by A.P. Møller-Mærsk, DONG and the Southern Denmark University.<sup>23</sup> Later, the Danish Growth Fund and Denmark’s Export Credit Agency (EKF) also provided public funding;
- Remaining a small independent company, LORC had to turn to bank loans to raise sufficient capital for investments. However, the bank demanded a turnover guarantee that would enable LORC to pay back the loan within a short period. Consequently, some users of the test facilities had to commit to purchasing test services for a definite amount within 30 months.

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<sup>23</sup> A.P.Møller – Mærsk A/S, DONG Energy A/S, Siemens Wind Power A/S, University of Southern Denmark; Vattenfall Vindkraft A/S, Vestas Wind Systems A/S, Wave Star A/S.

The same funding/investment model has been applied for the subsequent test facilities. In total, LORC has invested DKK 380m in test facilities, and the last two years the net turnover has been approx. DKK 40m. LORC has approx. 15 employees.

From the very beginning, LORC has been a commercial test and demonstration facility challenged to obtain a constantly high utilisation ratio combined with limited opportunities to operate financially. Consequently, LORC cannot enter R&D-projects as a partner, but their clients can use the test facilities for R&D purposes on market conditions.

Today, LORC's first test facilities are debt free

LORC's business model is also based on a long-term commitment from its clients, which goes hand in hand with the clients' (the windmill industry) very long-term R&D-programmes. The benefit for LORC is that their test facilities are typically booked several years ahead. The business relations can be characterised as tight and long-lasting while clients would have difficulties gaining access to other test facilities in Denmark or internationally. Changing to other test facilities is risky and costly. However, to be selected as a preferred test facility requires facilities with state-of-the-art technology and highly skilled service staff.

### *Technological focus – services offered*

LORC focuses on the offshore renewable energy sector and aims to support innovation by offering state-of-the-art facilities within test and validation. Until now, the windmill industry has been the main client group, but the ambition is to broaden the target group.

Activities span from manufacturing technologies and testing of structures and components to full-scale testing of wind turbine generators.<sup>24</sup> Today, LORC offers the following test facilities:<sup>25</sup>

- Lindoe Nacelle Testing including:
  - A function test facility to verify the performance and robustness of the nacelles' electrical systems as well as grid compliance, established in 2014;
  - A function test facility to verify the performance and robustness of the nacelles' electrical systems as well as grid compliance, established in 2016.
- The Lindoe Component & Structure Test Center for mechanical testing operates a strong floor for static and fatigue testing of large-scale structures and a climatic chamber to expose systems, components and structures to varying climatic conditions such as low and high temperatures, varying humidity and corrosive environments;
- The Lindoe Welding Technology Center develops and industrialises the laser-hybrid welding process for the offshore energy sector.

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<sup>24</sup> <http://www.lorc.dk/about>

<sup>25</sup> <http://www.lorc.dk/about>



In a strategic alliance with FORCE Technology, a leading Danish RTO, LORC operates the Component & Structure test Center as well as the Welding Technology Center. These centres have a more generic technological approach and are relevant to many industries. Consequently, the synergies between the four tests facilities are, so far, rather limited.

Overall, LORC has turned out to be one of several test and demonstration facilities in Denmark that support the technological development in the windmill industry (wind power industry) which, all together, underpins Denmark as an international research and industrial wind hub. The industry recognises the value of access to test and demonstration facilities.

### *Lessons learned or success factors*

In short, LORC stresses the following factors as being decisive when establishing the test facilities:

- public-private partnership and a common ambition;
- commitment from the industry and presale to ensure a turnover;
- a dedicated investment strategy; and
- LORC as guide and enabler for designing and implementing test activities.

*International challenges:* For the time being, the international competition is weak due to few international competitors, i.e., two in Europe, one in Germany, one in the UK, and one in the USA. Furthermore, they are all, like LORC, in a build-up phase, but increasing competition is foreseen, not only influenced by technology but also funding and tax regimes for operating test and demonstration facilities.

However, increasing collaboration among these international test and demonstration facilities may also be an option. The collaboration must be on market conditions, responding to market demand. It should also be acknowledged that international competition is about being an international wind hub.

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# Annex 2b: Finland

## Case: VTT Bioruukki

### Introduction

The VTT Bioruukki pilot centre is a test and demonstration facility that functions under the VTT Technical Research Centre of Finland Ltd. The expertise, equipment and facilities of the research centre can be utilised to develop companies' production and processing methods within bio- and circular economy. Information from research can be quickly converted into practice. Companies can test new methods before starting a demo plant or even full production reducing the risk when making new investments.

### *Organisation – target group and business model*

VTT Bioruukki provides an innovation and demonstration platform for bio and circular economy businesses. The idea is to provide a platform for R&D relating to forest and agricultural biomass usage as well as processes for waste and side streams from the manufacturing industry and communities. The facility is operated by VTT *Technical Research Centre of Finland Ltd*, and it combines VTT's expertise in treating chemicals, energy and biomass.

The VTT Bioruukki pilot centre supports business opportunities in low carbon energy solutions, efficient biomass refining, new biomass-based products and textile fibre technologies as well as recycling concepts and waste utilisation and sustainable chemicals. The entire R&D volumes of VTT's bio and circular economy are available through VTT Bioruukki with a turnover of EUR 60m/year and nearly 500 man-years.

*Characteristics of target group and use of facilities:* VTT Bioruukki serves the process and product development activities of companies as well as VTT projects and its research partners. The main funding comes from VTT, various R&D projects and the state of Finland (as part of the government's spearhead project financing). The platform has been developed in close cooperation with other platforms and test and demonstration facilities such as Luke (Natural Resources Institute Finland).

The services provided by VTT Bioruukki are chargeable and the customers can also enter into a leasing contract on hiring expertise or equipment according to their requirements, timetable and need for flexible pricing. However, VTT's services can also be funded by public organisations such as TEKES or the EU. The estimated annual turnover of VTT Bioruukki's services for businesses amounts to EUR 5m.

VTT typically owns the facilities, and customers pay rent for using the equipment. However, the use of the equipment and facility issues can be organised flexibly, as companies or research partners can bring their own equipment into the premises during projects. In addition, VTT can also lease space, research infrastructure, equipment, and

operational assistance to start-up companies. The use or collaboration is mainly based on research and customer projects, but long-term partnerships also exist. Partnerships with companies or research institutes often aim to develop new process concepts and process equipment technologies. The customers can enter a leasing contract for hiring expertise or equipment according to their own needs, timetable and flexible pricing. Another form of partnership may be that companies outsource piloting to VTT, and thus these customers take care of piloting and scale-up activities by using VTT Bioruukki's equipment and VTT's know-how. The main advantage for companies is that using the test facilities will accelerate commercialisation of new products and processes.

More test and pilot facilities are under construction. VTT Bioruukki will have a test facility related to energy storage and biomass processing and a centre for green chemistry. The entire pilot plant is expected to be finished in 2019-2020. The aim is to achieve international visibility, increase Finnish know-how and encourage exports through innovation and product development. For instance, Siemens and VTT have agreed on digital fibre cooperation to develop digital forest industry. The cooperation includes development of ecosystems for digital forest industry and development of new kinds of forest industry processes, technology solutions and the modernisation of the VTT Bioruukki pilot centre.

### *Technological focus – services offered*

*Characteristics of the company's value offerings:* For the customers, opportunities to test new technology before starting full-scale production or making big investments have been particularly valuable. The expertise of VTT Bioruukki's staff has also been valuable because of the accessibility to accurate and new research information. Clients have especially used the opportunity to develop new processing methods together with VTT Bioruukki's experts and in test labs. Each company also has its own key account manager, which ensures that one person is not dealing with competing clients. VTT Bioruukki is working hard at developing its test and demonstration facilities in international collaborations, which can also lead to a situation where customers will be able to hire expertise and equipment from abroad in the future.

The main services are thermochemical conversion where new and sustainable technologies are created to produce bio-based chemicals and low carbon energy. Thermochemical conversion includes fast pyrolysis-conversion of biomass to bio-fuel, gasification of biomass and waste, CFD (Computational Fluid Dynamics) modelling and catalyst R&D for syngas cleaning and upgrading.

- *Sustainable chemistry*, which includes the design and production of chemical products, processes and materials solutions based on environmentally friendly and economically viable technologies. It includes chemical pilots in reactors and labs, pilot environment for plastic processing, the development, usage and recycling of green solvents, development of smart materials, processing of

polysaccharides and the development of industrially viable chemical synthesis technologies;

- *Biomass processing*, which includes the services of biomass processing concept development, development of nanocellulose production chains and cellulose dissolution techniques;
- *Simulation and modelling*, where VTT Bioruukki can quickly and efficiently provide information on various process industry needs for investment decision-making, process development and problem-solving. The services include CFS modelling, process modelling, and techno-economic feasibility of new concepts, lab- and pilot- scale experimental work and process development for industrial demonstration support.

### *Lessons learned or success factors*

The success of VTT Bioruukki is based on a customer or user approach, where the users have to hire the expertise of VTT's staff and its equipment, and the users have been able to formulate their leasing contracts according to their needs.

In some cases, the users have even wanted to be co-owners of the equipment, but this is not possible yet. VTT Bioruukki is facing some challenges as the users consider their services to be quite expensive, even though public funding is available in some cases. Looking forward, VTT Bioruukki seems to be aiming at:

- developing PPP's for funding and ownership
- making its research facilities and equipment even more accessible to SMEs
- developing VTT Bioruukki's marketing skills in order to develop the facilities of VTT Bioruukki into commercial products.

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## Case: Oulu 5G Test Network

### *Introduction*

The Centre for Wireless Communications (CWC) at the University of Oulu and the VTT Technical Research Centre of Finland and industrial partners have created the 5G Test Network to develop critical new technologies and test performance of novel technologies in a realistic environment. The idea is to provide two network sites:

- A restricted network, where companies can test the functionality of their technologies, tools, and applications in a controlled environment.
- A public network, where solutions such as those for large-scale deployment of user devices can be verified.

### *Organisation – target group and business model*

The 5G Test Network environment is a joint project between industry, researchers and the Finnish State. The consortium is represented by large global players in the telecommunications industry, SMEs, network operators, authorities, universities and research institutes.

5GTN is part of the 5thGear programme funded by Tekes (the Finnish Funding Agency for Innovation) and EU structural funds. 5GTN also collaborates with the HILLA programme, which is a new major programme focusing on accelerating research to business and ICT to new industries through smart specialisation. Funding for the test and demonstration facility is provided by several partners (companies and public institutions).

### *Characteristics of target group and use of facilities*

5GTN's services are offered to companies wishing to test their technologies, tools, and applications in a controlled environment. The project's main partners are Anite, Bittium, Eltel, Exfo, Haltian, Indalگو, Mediatek, Nokia, Sarokal, Oamk, Business Oulu, PehuTec, Pulse Electronics, the Finnish Communications Regulatory Authority and Yle (Finnish Broadcasting Company). Parts of the network are offered as open test environments to third parties.

### *Technological focus – services offered*

Information related to collaboration with businesses is limited in 5GTN because it is in an early-stage development phase and confidentiality agreements. However, 5GTN offers companies a realistic 5G network environment where they can test their applications, services, algorithms, technologies and systems. Sharing early evaluation results with partners will help to iron out shortcomings and strengthen the technology for a successful commercial launch of 5G systems. The participating companies have also experienced networking as a very important aspect of the platform. The idea of the

5G test network is to test entirely new business models and create an open test environment for companies to try out radical new concepts and in doing so challenge the current carrier led business models.

The 5G Test Network is a facility for R&D and testing in a realistic 5G network environment coordinated by VTT and University of Oulu. It will form a dynamic and heterogeneous platform for developing and testing new applications, services, algorithms, technologies, and systems. The 5G Test Network consists of two network sites:

1. Using VTT's restricted network, companies can test the functionality of their technologies, tools, and applications in a controlled environment;
2. Using the public network at University of Oulu, solutions such as those for the large-scale deployment of user devices, can be verified in a living lab condition.

The research is concentrated in three areas, i.e., air interface, network management and testing technologies.

Services include support and consultancy for all 5G-related R&D, a research platform for studying and exploring 5G, possibility to test partners' applications and tools over a live 5G network, including demanding IoT solutions, new business opportunities and business development assessments for new operator business models and opportunities for long term co-operation between the actors of the wireless communications ecosystem.

#### *Lessons learned or success factors*

The platform has focused on business cooperation, but the activities of the main partners in the use and development of the platform have varied. More passive partners have mainly focused on monitoring the development of 5G technology, while more active partners have used the platform to develop their hardware and software. In the future, the platform will focus more on non-telecommunications companies that could benefit from the use of faster wireless communications (e.g., healthcare). In addition to the main partners, the platform's services will become increasingly popular with so-called "third parties". Many of the companies are from the Oulu region, but the platform is also marketed to other Finnish and foreign companies.

Businesses hope to gain access to the platform as soon as possible, but organising the operation efficiently and with agility on a new platform has been difficult. SMEs would also need coaching concerning the business opportunities of the new enabling technology. Finding a balance between basic research promoting technology and developing new applications based on the existing technologies has been somewhat challenging but aims at:

- developing day-to-day operations and operating models to keep the test and demonstration facilities running;
- developing a marketing strategy for the platform's operations abroad.

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## Case: SMACC

### Introduction

The Smart Machines and Manufacturing Competence Centre (SMACC) is a platform combining the facilities, equipment and know-how of different actors including research institutes and companies. It aims to make research facilities and equipment accessible to SMEs. The research alliance of VTT Technical Research Centre of Finland and Tampere University of Technology is combined with contacts to enterprises, which makes networking and the usage of new information and technology much easier. The SMACC platform makes research facilities and equipment accessible to SMEs. SMACC's customers have been particularly pleased with the various ready-made-concepts where the expertise of researchers and students can be used.

### Organisation – target group and business model

SMACC is a competence centre and an alliance of VTT Technical Research Centre of Finland and Tampere University of Technology (TUT). The union of VTT and TUT enables the combination of extensive research-based competence and contacts to enterprises in the manufacturing sector. It employs roughly 20 persons and indirectly over 200 persons. The operations are financed mainly by projects and the combined research portfolio is worth EUR 40m yearly. SMACC is an active scientific actor conducting yearly several national and international research programmes and projects.

*Characteristics of target group and use of facilities:* SMACC provides services, including test and demonstration facilities to SMEs that are mainly in the field of manufacturing, ICT and machinery. It also includes students in its research and development activity. SMEs pay for the services provided by SMACC, but it is possible to finance the services either partly or fully by an innovation coupon or other financial services from Tekes.

### Technological focus – services offered

SMACC's services include advanced digital manufacturing, digital services, design and modelling, digital quality management and asset management as well as additive



manufacturing (3D printing), robotics and automation. Additional services include SMACC-Think Tank (workshops), SMACC-Flywheel (products and an agile production development programme), SMACC-Productivity Leap (for enhancing productivity), SMACC-Hacks (hackathon-type workshops that provide a meeting place for companies, students, researchers and professionals), SMACC-Acuta (clinic for solutions to practical problems) and SMACC-Labs. The laboratories are research facilities, equipment and laboratories of VTT, TUT, and Tampere University of Applied Sciences, which SMACC makes available to SMEs. Typical SMACC laboratory services include prototype creation, demonstration sessions and laboratory piloting in conjunction with production renewals. The equipment that SMACC can provide ranges from 3D printers and scanners to laser and vinyl cutters, industrial robots, cameras, atomisation equipment, etc. Examples of facilities are test rooms and chambers, clean rooms, arctic testing room (down to -40°C), aerosol generators, deep sea and aircraft system testing facilities, computing room with various software and virtual reality.

SMACC's broad experience with digitisation, smart machines and smart manufacturing has given value to SMEs in modernising their business models, service concepts and manufacturing, design and modelling systems. SMEs have utilised the SMACC-Think Tank services in particular, where the companies have brainstormed with SMACC professionals in workshops on SME business models. The workshops have provided a deeper understanding of the digital businesses and of what SMEs can already do, the opportunities provided by digitisation and how SMEs can further develop their operations by highlighting development needs and defining further measures. The SMACC networks with various enterprises have helped customers to create new contacts and cooperation. The opportunity to use the latest research information and students' knowledge and new thinking has also proved to be valuable for customers. The "hackathons", which have been organised together with students and researchers, have found solutions to customers' practical issues and new information about materials and production methods to be further utilised in their manufacturing.

The benefits of companies include faster product development process and utilising the capabilities of SMACC Labs. Fast testing, for example, in the 3D printing area, gives agile information on where development efforts are needed.

Collaboration with businesses is currently based on research projects and of course through direct business services. In the future, the aim is also to integrate businesses' open/semi-open research and development environments with SMACC Labs.

### *Lessons learned or success factors*

SMACC's success is based on the cooperation between VTT, TUT and TAMK, which provides broad contacts to enterprises in the manufacturing sector and research-based competences. The service model, enabling SMACC to offer equipment, facilities, software and expertise from VTT, TUT and TUAS, may be one of the key factors to success, since by doing so they can offer a wide range of different services. By collaborating with universities, they can activate students who can offer their knowledge and gain valuable experience and maybe also a future job with one of the customers.

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# Annex 2c: Norway

## Case: Stadt Towing Tank

### Introduction

Stadt Towing Tank AS is a hydrodynamic testing centre that was built in 2009. The facility is located in Måløy in Norway. Several new solutions have been implemented with regard to conducting tests so that the tests can be performed in an effective and efficient way. The facility has a towing tank with a trolley and wave generator. It also has equipment to make complete model-attempts on vessels, such as tow, propulsion, waves, etc. The facility has tools and equipment as well as competences to test most of ship and marine installations.

### *Organisation – target group and business model*

The organisation was started due to a need for easy-access marine testing facilities, fast response time and lower cost levels. Stadt Towing Tank was established and financed by Brothers AS, Ulstein Group ASA, and Rolls-Royce Marine AS with support from the policy instrument *Innovation Norway*. The support from Innovation Norway has helped to develop the facility (equipment, etc.). Grants from the local county was obtained in connection with parking space.

*Strategic direction.* The aim of Stadt Towing Tank is that it will be an attractive/preferred test and development facility for the marine and maritime sector, and it will be an approved research and development (R&D) environment in the long term. This aim provides a strategic direction for the organisation.

*Organisational structure:* Stadt Towing Tank is organised as a private company (AS) with the following ownership structure:

- Royce Marine AS 5.26%
- Brothers: AS 72.63%
- Ulstein Group ASA: 7.11%
- Rolls Vegard Åstebøl Larsen: 15%

The operation of the organisation is financed by customer projects. Stadt Towing Tank depends on paid assignments to finance its operations. The utilisation of the facility is mainly for commercial purposes where the customers pay for tests and analyses. The customers pay 100% for the services. However, it is possible for the customers to make use of national policy instruments/funding agencies such as *Innovation Norway*, the *Research Council of Norway* or *Tax Financing Scheme* ("SkatteFUNN") to cover some of the expenses.

In recent years, significant development work has been carried out by the organisation itself. The work has been supported by policy instruments/funding agencies in Norway called *Innovation Norway* and the *Research Council of Norway* through the *Tax Financing Scheme*.

Moreover, Stadt Towing Tank is deeply connected with the maritime cluster in Norway, and is a member of *Blue Maritime Cluster (GCE Marine)*, *Maritime Forening Sogn og Fjordane*, and *Nordfjord Vekst*. The substantial benefit that Stadt Towing Tank obtains from this membership is that it is acquainted with companies that constitute a very dynamic business environment in Måløy where new ideas and products are being developed. The ideas and products are mainly related to marine/maritime, ships, equipment, rope, fish farming, and renewable energy. The membership can be considered as a strategy for developing knowledge, and being a part of a larger community by sharing knowledge and experience.

For its clients, Stadt Towing Tank is cheaper and easier to use than other similar facilities. It has recently invested in new equipment that offers more opportunities for testing, or acquiring expertise that can be useful in the future. Stadt Towing Tank aims to become an approved R&D environment in future. To achieve this aim, it will apply to become a Norwegian Catapult centre. This will give Stadt Towing Tank opportunities to engage in long-term R&D projects and increase its customer base.

#### *Technological focus – services offered*

Stadt Towing Tank offers complete services in the area of 3D-Cad, model production, and testing and analyses. In addition, the organisation provides advice on designing hull-lines as well as numerical analyses and simulations. Stadt Towing Tank has also been involved in full-scale test projects to deliver instrumentation and logging systems, i.e., software development in combination with sensor systems.

Thus, the services offered by the Stadt Towing Tank not only include providing equipment for testing, but also conducting numerical analyses, offering consultancy, giving advice on product improvements, taking part in the earlier stage of the production process/project as advisors. On rare occasions, Stadt Towing Tank has worked with a few of its customers to produce full-scale products.

Stadt Towing Tank has been involved in collaborative efforts with other organisations that have test facilities. It has built a marine lab for the *Norwegian University of Science and Technology (NTNU)* in Ålesund. It provides support to students in connection with their projects. It also collaborates with *SINTEF Ocean* in connection with propeller models. Furthermore, initiatives are being taken to establish new collaborations.

An example of a project that Stadt Towing Tank has been involved in and contributed to is the development of next generation ships/vessels.

The shipping company *Nordic Wildfish* wants to renew its fleet/vessels by thinking far into the future to get the best solution. Based on experience with its current fleet and the newly remodelled and modernised trawler "Mtr Molnes", the company has made plans for the next generation of vessels. The goal is 20–30% lower energy consumption on the vessel and the on-board technology with the least use of resources. The company has obtained support from the *Research Council of Norway* and established collaboration with ship designers *Seacon, Finnøy Gear and Propeller* and the *Norwegian University of Science and Technology (NTNU)*. A first version has already been designed and was model-tested at Stadt Towing Tank in 2015, and the tests contributed to the development of next generation of vessels.

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Source: Teknisk Ukeblad (2016).

### *Lessons learned or success factors*

Below follows a description of the major factors that have contributed to the successful existence and operation of Stadt Towing Tank:

- *The nature of owners.* Tolerant owners who see the value of the work being done, and the skills that are being built;
- *Location.* The facility is becoming increasingly important to local marine/maritime companies and it may indicate that they have an advantage in being located near a state-of-the-art test facility. This applies to both ship designers and marine/maritime industry equipment manufacturers. The facility is located in the middle of the marine/maritime hot-spot in Norway. Many local and national customers come back with new projects
- *Dedicated employees:*
- *Internal competence building and skill acquisition* over time.

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## **Case: SINTEF Raufoss Manufacturing**

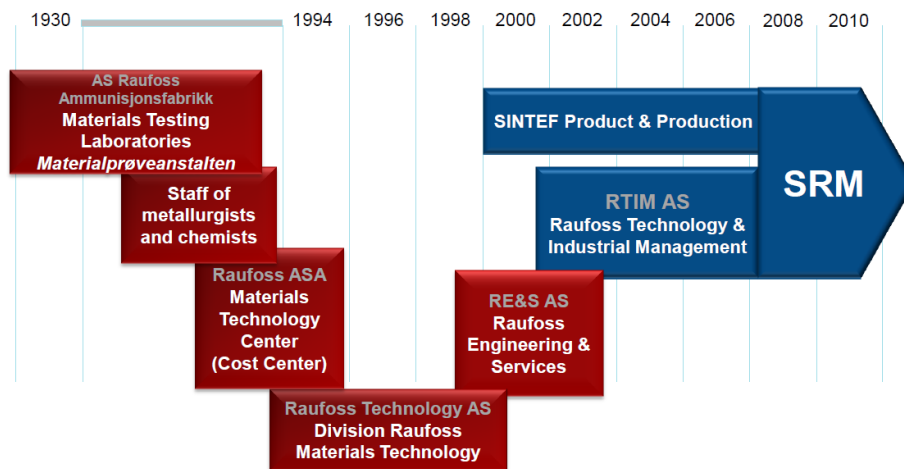
### *Introduction*

SINTEF Raufoss Manufacturing (SRM) is an R&D company that focuses on developing a competitive product manufacturing industry in Norway. SRM provides specialist

expertise in automated production, product and production development, lean, value chain management and material technology, as well as laboratory and engineering workshop services. It offers industry research at a high international level as well as knowledge transfer and advice both to industry and public service organisations. SRM is a part of SINTEF, the largest independent research organisation in Scandinavia. It is located at Raufoss, Trondheim, Ålesund, Stavanger and Kongsvinger and has 90 employees.

Organisation – target group and business model. The history of SRM is summarised in Figure A below:

Figure 10: The History of SRM



*Strategic direction.* SRM's ambition is to create sustainable and effective solutions that provide competitive advantages for both product and service industries in Norway. Its vision and mission are:

- *Vision:* A competence centre for a sustainable manufacturing industry;
- *Mission:* SRM offers research, development and related services to the manufacturing industry based on synergy between experience and theory.

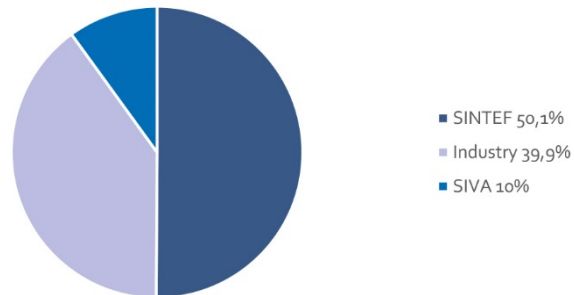
*Large-scale initiatives.* SRM has the project management role in NCE Raufoss (Norwegian Centre of Expertise, Raufoss) and SFI Manufacturing centres. These are two large, long-term initiatives that require high scientific quality and collaboration between research and business communities:

- NCE Raufoss is a national competence centre for lightweight materials and automated production. It is a cluster consisting of 17 companies as well as a network called "TotAl-gruppen", which has 41 member companies;
- SFI Manufacturing is an interdisciplinary research centre focusing on increased competitiveness for the Norwegian industry. The major focus areas are multi-

material products and production processes, robust and flexible automation, and sustainable and innovative organisations. The centre has fourteen industrial partners.

*Organisational structure:* SRM is owned by SINTEF, the industry and SIVA, the state enterprise that facilitates the development of new industry in Norway. The industry partners are Benteler Automotive, Hexagon Composites ASA, Hydro Aluminium AS, Kongsberg Automotive AS, Nammo Raufoss AS and Raufoss Technology AS (see Figure 11).

Figure 11: Ownership structure of SRM



#### *Technological focus – services offered*

SRM's test and demonstration facilities (laboratories and engineering workshop) are situated in Trondheim and Raufoss in Norway.

The facilities in Trondheim are primarily used for R&D projects in which SRM is involved. Concepts and research results of a technological nature are tested and demonstrated at the facilities in Trondheim, where the facilities primarily address production development and production systems development. The R&D projects that SRM is involved in are industry directed (addressing knowledge and technology development, and innovation in the industry). The R&D projects include companies that want to develop an idea, test it and make a prototype. The facilities in Raufoss are used to achieve this objective. Guidance given to idea development and testing during this process can be seen as a form of consultancy. Once the test is done (or the prototype is made), the company involved in the project will industrialise the output (for example, the prototype) using an industrialising company (system integrator). In some cases, SRM is requested to be part of the industrialising process as a competence assistant. Even though the facilities are used primarily for R&D projects, a limited amount of testing is done by the companies that want to test their own products.

Several companies – especially those who are located around Raufoss – utilise the SRM facilities in Raufoss to test, develop and demonstrate their products. The facilities primarily address material technology, production technology, and product and product development technology. Several material and engineering workshop laboratories are also a part of SRM in Raufoss. One example of companies that utilise the facilities in Raufoss is Benteler, a company producing primarily aluminium

components to the automotive industry. Benteler makes use of SRM's test and demonstration facilities to test vision-based robotics to identify specific materials and select them to move them to a designated place. The testing and the knowledge gained through the testing contribute to implementing (and industrialising) the solution more effectively at Benteler.

SRM also initiates and participates in R&D projects. These projects belong to various schemes such as the Knowledge-Building Project for Industry (KPN), User-driven Research-based Innovation (BIA), and Centres for Research-based Innovation (SFI). As mentioned above, these R&D projects include industrial partners who can use the projects to develop, test and/or demonstrate solutions that they will use later.

Participating in several R&D projects through these schemes, having large initiatives such as SFI Manufacturing, providing test and demonstration facilities and consultancy contribute to ensuring the existence and operation of SRM over time. The knowledge and skills acquired and developed through participating in research projects and working with the industry will strengthen SRM's knowledge base. This will in turn improve the possibilities for SRM to participate in/initiate new R&D projects, obtain more consulting assignments, increase its industrial collaboration, be attractive for more users/customers for its test and demonstration facilities, and retain the existing customer base. SRM's customer base ensures a fixed amount of assignments/orders related to test and demonstration.

The companies that use SRM's facilities can test the equipment that they want to test and obtain guidance and consultancy.

SRM provides several services to its customers at its facilities, including:

- Flexible automation focusing on assembly, robot control systems, and cybernetics (a concrete example is the testing of vision-based robotics in connection with Benteler as mentioned above);
- Mechanical testing focusing on tensile, compression, fatigue, impact hardness (a concrete example is testing/stretching material firmness);
- Product testing focusing on fatigue, impact, stress, strain, and environment related to the product;
- Process development focusing on hybrid manufacturing, metal forming, heat treatment, machining, and injection moulding of plastics;
- Metallography focusing on light microscopy and electron microscopy.

### *Lessons learned or success factors*

The following are the major factors that have contributed to the successful existence and operation of SRM:

- *The knowledge base.* As mentioned above, the knowledge and skills, which are acquired and developed through participating in research projects and working



with the industry, continuously strengthen the knowledge base of SRM. The new knowledge can enhance SRM's services to its customers;

- *Location.* SRM is located in Raufoss Industrial Park with around 40 different companies and approx. 3,000 employees. The companies produce high technology products for their customers all around the world. The industrial park is, through its 100 years of innovative history, internationally well-known as a supplier of diversified and advanced mechanical products. This indicates that there is a need for testing and demonstrating new solutions in the industrial park;
- *Close contact.* The location also helps SRM to be in close contact with the companies and the industry;
- *Long-term relationships.* SRM's long term relationships with its customers and collaborative partners are also a success factor. A good reputation and trust developed through the long-term relationships contribute to ensuring the continuing success of SRM and its test and demonstration facilities.

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# Annex 2d: Sweden

## Case: ElectriCity

### Introduction

ElectriCity was established in the region of Gothenburg in 2013. It is a collaboration between industry, the private/public sector and academia. The purpose is to create a platform to develop, test and demonstrate new solutions for sustainable commuting. The demonstration arena is thus primarily for projects that in some way contribute to a more attractive and sustainable public transport system. The focus is on electrifying public transport in cities to decrease noise and improve air quality, while also reducing energy consumption and climate impact.

The central test and demonstration area is the electric bus operations with route 55 that runs between Chalmers University's different campuses. The demonstration takes place here because Chalmers University is involved in research related to a sustainable public transport system. Examples of Chalmers' current research projects linked to ElectriCity are the perspective of the passengers, driver and residents in the area as well as the functionality of indoor bus stops. Evaluations show that the bus route has higher energy efficiency, lower climate impact, emissions and air pollution and receives higher passenger ratings than conventional bus traffic.

ElectriCity has received international and media attention. Around 100 delegates and 5,500 participants from around the world have visited Gothenburg to learn more about ElectriCity. The collaboration has been promoted by Volvo Ocean Race, COP21 and Mipim. An example of an activity is the ElectriCity Challenge in 2015, which included 48 participating teams displaying innovations for a more sustainable bus system.

ElectriCity's area of expertise is primarily within electric public transport, electric engines and IT in the public transport system. It also focuses on how technology co-plays and affects the surrounding environment regarding noise, air quality, energy consumption, city planning and influences people's behaviour and experiences.

Within the scope of the demonstration "facility" there are three electric demonstration buses together with hybrid buses that run through the city landscape of Gothenburg. The route stretches 7.6 km and consists of 16 bus stops, with one indoor bus stop and two charging stations. Around 100,000 passengers use the bus route every month. The premises are also used for educational purposes. The management centre can be used for traffic planning and monitoring of traffic. The daily operations of the buses are a part of the ordinary bus traffic plan. In addition, there is an innovation platform, i.e., a virtual platform for communication and testing. It is synchronised with the route traffic and enables data and information sharing. The arena is a way to create cooperation between different sectors and areas, i.e., the private sector, public sector and university/academia, and it coordinates technological advancement with urban

planning. It creates an opportunity for actors to circulate information to the public through study trips.

### ***Organisation – target group and business model***

ElectriCity is supported by various actors such as the Swedish Energy Agency and Västra Götalandsregionen (VGR) with a focus on sustainable transport. The partners of ElectriCity are the Volvo Group, the City of Gothenburg, Västra Götalandsregionen and Chalmers. Volvo is responsible for the development of the electrified vehicles and transport solutions used in the partnership. Västra Götalandsregionen participates in its role as a public transport provider in the region, and the project ElectriCity supports the region's vision of the "good life". Furthermore, the VGR is the owner of Västtrafik and the electric buses' route 55 will be part of the public transport system. They also develop innovative bus stops and provide technical support and IT-services for the bus route.

Gothenburg City participates in its strategy of attracting skills and investment to the region and for urban development. Chalmers is responsible for coordinating research linked to ElectriCity. Ericsson is responsible for IT and communications technology. The Swedish Energy Department supports the development of the 100% electric buses.

Other collaborators are Johanneberg Science Park, which focuses on issues that cross different research and policy areas, such as construction, transport and community planning. Lindholmen Science Park contributes with networks and research and development (R&D) within ElectriCity. Business Region Gothenburg markets ElectriCity towards external actors with the goal of facilitating business and investments. Other participants include Keolis, Älvstranden Development, Akademiska Hus, and Chalmersfastigheter.

### ***Characteristics of the target audience and use of facilities***

The demonstration arena is for actors and projects that somehow contribute to a sustainable and attractive public transport system. Those who test their products should normally be connected to a partner in ElectriCity. The product or service should be new or be used in a new way within the public transport system. The product or service being tested should also be scalable. The demonstration arena mainly targets actors that are connected to academia/research. Organisations interested in performing tests at the arena are themselves responsible for financing the testing, e.g., through project financing or self-financing.

In addition, there should normally be cooperation with one of the EC partners. To include InterCity in a project application, at least one of the ElectriCity-partners must support the project and the project idea. The Swedish Energy Department and VGR, which are both ElectriCity-partners, finance various projects/collaborative initiatives based on their regular programmes and funding-tools.

### *Technological focus – services offered*

ElectriCity mainly offers testing and demonstration of products and services connected to sustainable mobility and public transport. The demonstration arena offers the possibility to test new sustainable solutions, traffic command systems, security, IT in public transport, energy supply and storage. In addition, research projects are conducted from a user perspective of public transport. A few requirements must be met to use the demonstration arena and its facilities. The demonstration project/test needs to be designed together with one or several of the ElectriCity's partners and should thus be anchored within ElectriCity. The product/service being tested must also be monitorable and scalable.

In gathering different actors spanning from industry, publicly procured public transport as well as academia, there is the opportunity to test solutions in the city with "regular" passengers and within the current public transport system. In 2017, Västtrafik and Volvo Group won the UITP Award in the category Operational and technical excellence for route 55 with the motivation that they have successfully integrated a modern and forward-looking bus-based mobility solution with innovative technology in the public transport system in Gothenburg. The three-year test project with route 55 has led to further attempts to connect the energy storage from buildings with the electricity supply from public transport, which is carried out in collaboration with the Volvo Group, Gothenburg Energy, Riksbyggen and Johannesburg Science Park. An ongoing research project is an indoor bus stop that researchers at Chalmers currently use to study in-door climate. Akademiska Hus is using the results in the planning and development of new buildings and districts in Gothenburg. There are also examples of existing technologies that are applied in new application areas such as touch screens at bus stops.

### *Lessons learned or success factors*

A key success factor for ElectriCity is the strong cooperation between actors from academia, business/industry, and the public sector. Since large-scale testing within the public transport sectors is often intimately connected with city and traffic planning issues (ranging from how citizens use the public space to how to provide buses with ElectriCity in sufficient scale, etc.) close cooperation between different sectors (i.e., Triple Helix or university-industry-government) is one important success factor. The City of Gothenburg's strong commitment is extremely important as well.

Connected to this, and another key factor for success, is ElectriCity's ability to attract major stakeholders from all three "Helixes" (university, industry and government), where actors such as Volvo, Chalmers and the city of Gothenburg collaborate today. This creates a critical mass of knowledge and offers an attractive environment for large-scale testing and demonstration of new technologies and solutions as well as academic research.

Moreover, the ability to join different fields of research and industrial sectors – ranging from testing and developing electric hybrid technologies, designing buses and enhancing the user experience in areas such as indoor climate, noise reduction in the

buses, to city planning and behaviour, is considered to be an important factor making ElectriCity an attractive test and demonstration site.

ElectriCity has also been working strategically on building a brand within its field. This has probably been a contributing factor to attracting funding from the national and regional levels, which in turn has increased ElectriCity's possibilities to work with a long-term plan.

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## **Case: LignoCity**

### *Introduction*

The purpose of LignoCity is to bring together technical development, research and commercialisation of lignin-based products. Lignin is a by-product from pulp mass production and is believed to have great potential as a raw material in the conversion to a bio-based economy. Lignin can be used in fuel production and manufacturing of lightweight materials. Within the test bed there are cutting-edge competences in connection with process industry and lignin. LignoCity focuses on large-scale product and process development in the lignin area as well as evaluation of black liquor/lignin products. Lignin from pulp production as well as other sources, e.g., from ethanol and sugar production, can be processed at the plant. The plant has a production capacity of up to 8,000 tons of lignin per year, which enables large-scale product and process development. In addition to the plant itself, the environment provides competence and networking opportunities. Actors associated with LignoCity are Innventia, Nordic Paper, Paper Province, Karlstad University, Kristinehamn Municipality, Akzo Nobel Bygglim AB, the Region of Värmland, Biokol Sverige AB, Ligno Boost Demo AB, Blatraden AB, BTG Instruments AB, Bionic Group of Companies, Ren Fuel K2B AB, SunCOal Industries GmbH, Swerea, UMV COating Systems AB, Valmet Power AB, Volvo Cars.

Figure 12: Structure of LignoCity Testbed



Source: [www.innventia.com](http://www.innventia.com)

### Organisation – target group and business model

The LignoCity project has been granted support from Vinnova (the Swedish government agency that administers state funding for research and development) for the period 2016–17. The project also receives financial support from the Municipality of Kristinehamn where LignoCity is located. The plant is a further development of the RISE Bioeconomy’s (formerly Innventia) demonstration plant in Bäckhammar. It is operated in collaboration with Innventia, Nordic Paper and Paper Province. Innventia established the demonstration plant in 2006 to demonstrate the LignoBoost process developed in collaboration with Chalmers University. Since 2008, the technology is owned by Valmet and has been installed at pulp mills in Finland and the United States.

### Characteristics of the target audience and use of facilities

The target group consists of actors that want to develop a business based on lignin. At the plant, customer orders are carried out for those customers that want to develop or evaluate their black liquor or lignin products. The facility is accessible to both small and large companies and various actors from R&D. At this point, most of the actors are associated with the forest industry.

### *Technological focus – services offered*

LignoCity offers an open test bed that is one-of-a-kind in terms of producing tailor-made quantities of lignin in sufficiently large quantities for shaking. LignoCity offers the opportunity to develop ideas into commercial concepts and is cutting-edge in terms of refinement. LignoCity's activities can be summarised in five different offers that extend from idea and skill acquisition to scaling up and establishing:

- *Go Explore*: to disseminate and obtain knowledge through lectures and workshops;
- *Go Develop*: idea development. Hypothesis trial and the creation of demonstrators;
- *Go Real*: implementation through support to set up and challenge the business. Create a beta product/service;
- *Go Business*: up-scaling and support for marketing.
- *Personal Network Enabler*: a "door-opener guide" and cooperation in LignoCity's network.

Several full-scale trials have been carried out at the facility. For example, lignin fuel has been used in long-term trials to replace coal at the Fortum Combined Cycle Heat and Power Plant (CHP) in Stockholm. Another example are full-scale trials in a lime kiln in Sweden where replacement of fossil fuel was evaluated.

### *Lessons learned or success factors*

A recent study (Kontigo; 2017) concludes that LignoCity's attractiveness to companies stems from a combination of technological infrastructure linked with access to a raw material, which is considered to have a strong future potential, and a long tradition of "know-how" within the processing industry.

According to stakeholders and companies working at LignoCity interviewed for the study, LignoCity has a highly attractive offer at the moment. The interviewed business emphasises the ability to use state-of-the-art technological infrastructure and gain access to an extensive network within research (such as University of Karlstad, Innventia Research institute and VINNOVA) as well as regional and local authorities providing a variety of business support as important success factors for LignoCity. For the Municipality of Kristinehamn, LignoCity is an important institution that will help boost the innovation capacity of the local industry, increase the attractiveness of the city to business and industries and therefore create more jobs and increase tax income.

Key success factors for LignoCity can be summarised as follows:

- Offers access to technological infrastructure;
- Based on a triple helix collaboration with stakeholders from industry, academia, and the public sector;



- Based on a strong industrial base. The region of Värmland (and the Municipality of Kristinehamn) has a long historical tradition of wood based-industry and is currently considered to be a frontrunner in the field of bio-based economy in Sweden.

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## Case: Sports Tech Research Centre

### Introduction

The Sports Tech Research Centre (STRC) is a research centre connected to MittUniversitet. The centre conducts multidisciplinary research focusing on technology equipment for sports and outdoor activities as well as medical equipment for people with disabilities. STRC has special focus on the connection between humans and equipment, biotechnology, optimisation of equipment, additive manufacturing (3D-printing) with applications in medicine and industry.

### Organisation – target group and business model

STRC’s activities can be divided into five main areas:

- *R&D centre* – a national and international R&D centre with many networks and a significant presence of international visiting researchers;

- *Test centre* in performance and public health. Partnership with the Swedish Olympic Committee, among others;
- *Training centre* for elite and winter sports, and various public health projects;
- *Student laboratory* with links to a range of degrees and courses at Mid Sweden University;
- *VINNOVA* – the Peak Innovation (PI) initiative focusing on prototypes and product development, as well as a range of service concepts in sports technology and performance technology.

The centre uses developed measurement methods and concepts where different methods are combined, and analyses are performed in the different laboratories. The centre can manufacture advanced prototypes, conduct sector-specific testing and verify products in a real-life environment with a focus on functionality.

The tests performed are in accordance with prevailing ISO standards, but they are not accredited. There are several facilities and laboratories for testing and demonstration, with several of them considered to be unique in an international perspective. There is, for instance, a wind tunnel with one of the largest treadmills in the world.

This provides for an opportunity to test products (clothing, equipment, etc.) in conditions that closely resemble the environments they are made for. Other types of tests are material testing, such as water and wind resistance and tolerance, 3D-printing and applied mechanics, where there is access to, e.g., a medical freezer and vibration measurement.

For additive manufacturing purposes, the equipment consists of different printers (Arcam A2, uPrint SE Plus, Objet Eden 260V). The wind tunnel's treadmill can be used in several parallel tests for skiing, running and cycling, etc. It also has equipment that can test inclination regarding different weather conditions. The laboratory for material testing can carry out several types of tests.

#### **Characteristics of the target audience and use of facilities**

The research centre's target groups are both companies, hospitals, and students. The research is conducted in close collaboration with a wide range of industries, from hospitals and leading outdoor companies to companies in the engineering sector. There is also close cooperation with the engineering programmes in mechanical engineering at the graduate and civil engineer level. For instance, students can work in different laboratories, often in connection with industry and outdoor companies linked to their master theses.

#### ***Technological focus – services offered***

The centre develops its own methods and concepts. It has advanced equipment that is considered cutting-edge equipment in many cases. STRC offers several different opportunities for testing materials and products in a realistic environment customised to the product's final usage environment. Finally, they offer testing in a wind tunnel,

additive manufacturing and applied mechanics focusing on sports, healthcare and aids. It is also possible to perform tests related to utilisation, such as how much energy a skier saves by going behind another skier. The centre offers qualified contract education and conducts commissioned research.

Companies can gain access to STRC's laboratory and employees for their own material and product development.

Examples of tests performed in the laboratory are sliding properties on cross-country skis, resistance in roller skis, measurement of skis (pressure distribution), methods for snow storing, insulation properties of shoes, gloves, socks and mechanical effects on instrumented brain. There are also on-going projects for method and product development linked to treatment of skeletal cancer.

### *Lessons learned or success factors*

Today the Swedish Winter Sports Research Centre is one of Sweden's leading environments for sports-based research. The links to Mid Sweden University as well as access to top-class research within the field of technologies as well as health and sports are considered a strong contributing factor to this. This is because research within the Sports Tech Research Centre requires collaboration with expertise in fields such as electronics, computer science, sports science, sport psychology and medicine. Other national and international research groups are part of this collaboration.

The Swedish Winter Sports Research Centre offers an attractive environment in the form of unique laboratories, successful research groups, skilled staff, and close cooperation with external parties (public, private and the sports world), as well as a good international reputation. This is an important reason for its value creation towards companies.

A contribution to its attractiveness is the centre's ability to offer customised measurement methods and concepts combining different methods as well as performing analyses in different laboratories. This way the centre can produce advanced prototypes, implement industry-specific testing, and verify in a real-life environment, focusing on functionality.

Sports Tech Research Centre has a comprehensive network of business partners and stakeholders in business such as Peak Innovation, which represents a network of about 40 regional and about 200 national companies.

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# Annex 3: Policies and strategies for test and demonstration

We have reviewed policies and strategies aimed at encouraging the overall infrastructure for test and demonstration facilities in all the Nordic countries. Furthermore, we have reviewed initiatives, such as programmes and instruments, which directly or indirectly support investment in test and demonstration facilities and/or the use of test and demonstration facilities. Moreover, if the national policies and strategies have been evaluated, it is possible to include indications of the demand for and the quality of the test and demonstration facilities.

We have applied a common approach to reviewing the national test and demonstration facilities. This is also reflected in the presentation of the national policies and strategies for test and demonstration:

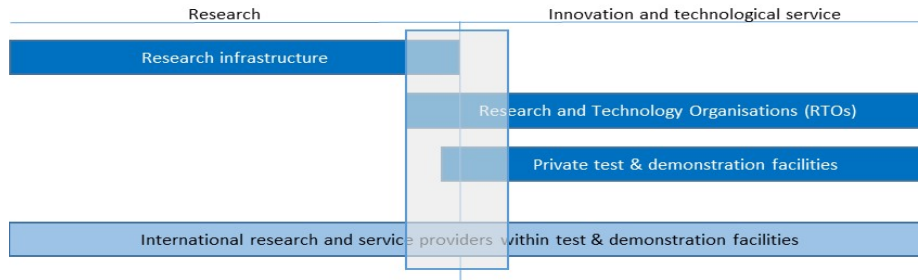
- National policies and strategies for test and demonstration facilities:
  - Research infrastructure
  - Innovation infrastructure
- Programme and instruments aimed at the development of test and demonstration facilities;
- Evaluation of policies and strategies – or a matter-of-fact observation.

## Denmark

### *National policies and strategies for test and demonstration facilities*

In general, Danish innovation policy takes a systemic approach where the ecosystem and the involvement of different actors come into focus (Danmarks Forsknings- og innovationspolitiske råd (DFiR), 2017). However, commercialisation of research and innovative ideas based on a linear approach also have a conceptual impact on Danish innovation policy. Therefore, it is emphasised that research is critical not only in terms of technological development but also for innovation in general, and that the innovation infrastructure is vital for supporting innovation processes (see Figure 13).

**Figure 13: Research and innovation infrastructure – service providers of test and demonstration facilities**



Source: Teknologisk Institut, 2015.

The Danish government publishes an annual political statement on research and innovation policy in which test and demonstration facilities are considered an integrated part of both the research and innovation infrastructure (Regeringen, 2015) (Regeringen, 2016).

The Danish research policy has developed in line with the European strategy of developing the research infrastructure with test and demonstration facilities mainly to be used for research purposes as well as innovation.

In relation to innovation policies and strategies, there is no overall strategy for test and demonstration facilities as the strategy to develop test and demonstration facilities is mainly based on a bottom-up approach. For instance, Danish research and technology organisations<sup>26</sup> can decide to establish test and demonstration facilities based on an assessment of the needs and demands of Danish industry. However, within some technological areas, such as energy and the environment, we have seen a more top-down approach, where targeted programmes have co-financed the establishment of often large-scale test and demonstration facilities.

### **Research infrastructure**

The overall argument for the research policy to address the research infrastructure as an important issue is that the number of technological developments are not only increasing, they are also characterised by increasing complexity. Research, and experimental research in particular, becomes costlier as advanced laboratories, apparatus and test facilities are a precondition. Furthermore, this complexity calls for increasing internationalisation of research both in terms of becoming a world leader – with a positive impact on business and society – and collaboration and common investments in test facilities (large science facilities).

In 2015, the Danish Minister for Higher Education and Science presented a vision and a strategy for the Danish research infrastructure (Uddannelses- og

<sup>26</sup> In Denmark, we have in total seven independent Research and Technology Organisations approved by the Minister for Higher Education and Science and organised in the network 'Godkendt Teknologisk Service' (GTS), Advanced Technology Group. <https://en.gts-net.dk/>

Forskningsministeriet, 2015). The vision is to create the best conditions for carrying out research and innovation in Europe and, in 2020, be at the international forefront regarding research infrastructure. In the years to come, the strategic actions will target both a national and an international dimension.

The national orientation of the strategy is to encourage investments in new research infrastructure. Internationally, the strategy will support Danish researchers' participation, collaboration in and benefit from international research infrastructure. The ambition is also to attract (investments in) research infrastructure to Denmark.

In 2015, the total public investment in research infrastructure came to DKK 787m out of which CERN, ESA and ESS account for almost three quarters of the total investment, emphasising the importance of participating in international collaboration through the European Strategy Forum on Research Infrastructures (ESFRI), (Uddannelses- og Forskningsministeriet, 2015). Furthermore, the Danish strategy has prioritised 22 national proposals for investing in research infrastructure from 2015 to 2020, when the expected investment is DKK 1.6b. The ambition is that 15 of these investments will be accomplished with an expected total co-funding by the Danish government of DKK 420m.<sup>27</sup>

### *Innovation infrastructure*

Test and demonstration facilities are an element in the Danish innovation infrastructure. However, test and demonstration facilities are mostly only indirectly addressed in the political statement on research and innovation policy, while the main focus areas are (Regeringen, 2015):<sup>28, 29</sup>

- *Advanced Technology Group (Godkendt Teknologisk Service (GTS))*,<sup>30</sup> which provides technological service to Danish industry covering a broad range of technologies. GTS institutes offer knowledge, technology and consultancy, cooperation on technological and market-related innovation, testing, optimisation, quality assurance, certifications and benchmarking, mainly on a commercial basis.<sup>31</sup> As for investments, the Ministry for Higher Education and Science co-finances research and development activities annually with approx. DKK 300m aiming at developing new technological competences and services of importance to Danish enterprises. Services can include tests and demonstrations.

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<sup>27</sup> <http://ufm.dk/forskning-og-innovation/indsatsomrader/forskningsinfrastruktur/danske-roadmap-for-forskningsinfrastruktur>

<sup>28</sup> <http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/viden-netvaerk-og-kommercialisering-til-virksomheder?searchterm=innovationsinfrastruktur>

<sup>29</sup> DFIR has a much broader definition of the innovation infrastructure, which has two dimensions. First, various services offered (access to knowledge, consulting and capital) and, secondly, a geographical dimension (national/ state, regional and local). However, the definition does not introduce other organisations or initiatives having dedicated focus on test and demonstration facilities. (Danmarks Forsknings- og innovationspolitiske råd (DFIR), 2017).

<sup>30</sup> <http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/viden-netvaerk-og-kommercialisering-til-virksomheder/godkendt-teknologisk-service>

<sup>31</sup> <https://en.gts-net.dk/>

However, the financial support can only be spent on development of competences, not on investment in physical test and demonstration facilities, such as laboratories, apparatus (Styrelsen for Forskning og Innovation, 2012). The GTS institutes will typically invest in physical test and demonstration facilities based on a market assessment estimating the total demand. A GTS institute may be reluctant to invest due to uncertainty and economic risk. Within specific technological areas, programmes can co-finance test and demonstration facilities, see below;

- *Cluster and innovation networks*, which organise enterprises, RTOs, universities and other institutions involved in innovative activities. The clusters and networks are hubs for knowledge sharing and dialogue, and they also initiate collaborative innovation projects (Regeringen, 2015);<sup>32</sup>
- *Innovation environments (Innovationsmiljøer)* can offer innovative entrepreneurs (starts-ups) risk capital (loan or equity) and professional consulting on business development (Regeringen, 2015).<sup>33</sup>

Cluster and innovation networks and the innovation environments only have a minor and indirect impact on test and demonstration facilities originating from innovative entrepreneurs or projects' use of test and demonstration facilities.

The innovation policy, including the policy for test and demonstration facilities, mainly focuses on encouraging commercialisation. A key element is to connect or bring together knowledge institutions and enterprises in joint projects or activities, also known as "knowledge bridges" (In Danish: "videnbroer") aimed at dissemination, employment and commercialisation of new knowledge (Regeringen, 2016).

### ***Programme and instruments aiming at the development of test and demonstration facilities***

The Ministry for Higher Education and Science is responsible for the Danish research and innovation policy but within some technological areas the policy is anchored in the ministries responsible for these technical areas.

The EUDP programme (*Energiteknologisk Udviklings- og Demonstrationsprogram*) has a dual purpose. On the one hand, EUDP supports projects that aim at a transformation towards use of substantial forms of energy, and, on the other hand, it supports Danish business opportunities within green technology (Energistyrelsen, 2017). In the new programme period 2017–2019, the EUDP programme consists of three sub-programmes. Test and demonstration facilities are included in the "general programme" as one among several activities that EUPD can support within a budget of DKK 170m.

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<sup>32</sup> <http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/viden-netvaerk-og-kommercialisering-til-virksomheder?searchterm=innovationsinfrastruktur>

<sup>33</sup> <http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/viden-netvaerk-og-kommercialisering-til-virksomheder?searchterm=innovationsinfrastruktur>



The previous EUDP programme period included a sub-programme called "Green Lab DK"<sup>34</sup> dedicated to supporting the establishment of large-scale test and demonstration facilities with the aim of encouraging development and demonstration of new energy technologies. In the period 2011–2014, "Green Lab DK" granted 10 test and demonstration projects with a budget of DKK 201m.

*MUDP (Miljøteknologisk Udviklings- og Demonstrationsprogram)* aims at encouraging Danish industry to carry out development, testing and demonstration within environmental technologies. Generally, MUDP supports innovative projects where the ambition is to develop efficient and competitive environmental solutions. However, for the ongoing strategy period, full-scale demonstration projects will be prioritised to develop and commercialise new environmental solutions (Bestyrelsen for MUDP, 2015). The MUDP-grant is expected to reduce the economic uncertainty connected with investment in full-scale demonstration facilities and also encourage cross-sectoral collaboration (MUDP, 2016), (Miljøstyrelsen, 2015).

*GUPD (Grønt Udviklings- og Demonstrationsprogram)* supports a green transformation of the Danish food sector, which also must be environmentally and financially sustainable (NaturErhvervsstyrelsen, 2015). GUPD grants demonstration projects but also R&D-projects and networks. According to the 2017 action plan for the programme, approx. 90% of the budget will be allocated to large development and demonstration projects where the grants can be between DKK 2–15m (Miljø- og fødevareministeren; Naturerhvervsstyrelsen, 2016). However, GUPD demonstration projects mainly focus on testing or demonstrating innovative products or processes to be applied by the food sector rather than supporting establishment of physical test and demonstration facilities (Miljø- og Fødevareministeriet, Landbrugs- og Fiskeristyrelsen, 2016).

New technologies and applications have emerged. Drones and drone technologies are an example of a new technology with new commercial perspectives. The Danish government has launched a *Drone Strategy*, which facilitates the establishment of framework conditions for technological and commercial development in this area (The Danish Government, 2016). A key element of the strategy is the establishment of test facilities with the ambition of turning Denmark into an internationally attractive hub for testing, development and use of drones. An international test centre for drones<sup>35</sup> became a reality in 2017, but the initial initiative goes back to 2011, when Odense Municipality gave financial support for establishing the centre.<sup>36</sup> The international aviation manufacturing company Boeing then began testing drones at the centre<sup>37</sup>, and other service providers settled in the area and collaboration was established with universities and RTOs.<sup>38</sup>

The Danish Government has invited private and public partners to join "growth panels" to formulate strategy recommendations to encourage development and

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<sup>34</sup> <https://ens.dk/ansvarsomraader/forskning-udvikling/green-labs-dk>

<sup>35</sup> <https://www.uasdenmark.dk/testcenter/testmuligheder/kom-i-gang-med-at-teste>

<sup>36</sup> <http://politiken.dk/oeonomi/virksomheder/art5570025/Verdens-st%C3%B8rste-flyproducent-vil-teste-droner-i-Odense>

<sup>37</sup> <http://www.dr.dk/nyheder/regionale/fyn/boeing-vil-teste-droner-i-danmark>

<sup>38</sup> <https://www.uasdenmark.dk/medlem/medlemsoversigt/virksomheder>

economic growth within significant industrial sectors/clusters. For the maritime cluster, the growth panel recommend developing test facilities for shipbuilding and autonomous ships and exploitation of seafood (Erhvervsministeriet , 2017). Other growth panels, e.g., the Digital Growth Panel may give similar recommendations. However, these recommendations are not accompanied by a roadmap for a possible implementation of the recommendations.

### *Evaluation of policies and strategies – or a matter-of-fact observation*

Evaluations are typically carried out for individual programmes, etc., but occasionally a meta-approach has been applied to gain an overview of the impact of the innovation policy.

A meta-review of all analyses and evaluations focusing on the innovation system in the period 2011–2016 found that test and demonstration facilities are very rarely in focus or address issues related to test and demonstration facilities. Typically, focus is on the innovation system, performance and impact (Danmarks Forsknings- og innovationspolitiske råd (DFiR), 2017), (Damvas Analytics, 2017).

Every year the Advanced Technology Group (GTS) publishes a performance account. In 2015, all GTS institutes had 16,629 unique private business clients with an annual turnover of approx. DKK 1 billion of which 41% came from testing and calibration. (GTS, 2016). There is no indication of whether these testing and calibration services are routine tests or whether they are related to innovative projects.

An evaluation of the Green Labs DK (see above) was carried out in 2015 (Green Labs DK, 2015).<sup>39</sup> However, the evaluation was carried out shortly after the facilities were established. Consequently, it was too early to estimate the benefits and impact for Danish industry. Nevertheless, some of the main observations included:

- Success factors for establishing test and demonstration facilities:
  - Backing by the industry and even co-funding/resale by the industry;
  - The new facilities are based on existing test and demonstration facilities;
  - The technical focus is on areas of industrial position of strength.
- Challenges:
  - Estimating the commercial demand. In several cases, the demand has been overestimated.

Moreover, the industry has mainly used the facilities for testing new technology (new, innovative products), and often, the tests are an incorporated part of other RDI-activities. Therefore, a high international technical standard is crucial not only to Danish industry, but also for attracting foreign customers.

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<sup>39</sup> The evaluation of The Green Labs DK programme had been carried out by the secretariat of the programme.

The support from Green Labs DK can also include a discount programme. The preliminary experience is that the discount programme has had some impact on attracting SMEs but many users are large companies with limited access to public grants and/or many test activities are incorporated into research projects, which are funded by other public RDI-programmes. Consequently, the discount programme is neither attractive nor relevant.

## Finland

### *National policies and strategies for test and demonstration facilities*

In general, the Finnish Ministry of Economic Affairs and Employment and the Ministry of Education and Culture focus on implementing ecosystem policies that place emphasis on supporting growth arising through cooperation, various platforms and networks.<sup>40</sup>

The latest Finnish Research and Innovation Policy Council's Policy review<sup>41</sup> points the way to the creation of globally known, large-scale clusters of expertise. The review clearly states that public support is needed for creating various testing and pilot environments and cooperation platforms. Policies targeted at supporting clusters comprise more applied activities, experimentation and piloting as well as visible business participation.

Test and demonstration platforms and environments cover a wide range of different types of facilities and platforms. Moreover, a wide range of different organisations are operating and developing these platforms. The industry also has a significant role in exploiting, using, developing and funding the services of these platforms. Generally, the use of test and demonstration facilities is based on joint R&D projects and market conditions, where the users pay for the piloting services.

There are many policy initiatives and agendas to promote test and demonstration facilities. The main strategies are:

- Finland's strategy and roadmap for research infrastructures 2014–2020 (The Academy of Finland)<sup>42</sup>
- Innovative Cities (INKA) programme (coordinated by Tekes)<sup>43</sup>
- SHOK programme (coordinated by Tekes)<sup>44</sup>
- The Finnish Bioeconomy Strategy (Coordinated by the Ministry of Economic Affairs and Employment)<sup>45</sup>

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<sup>40</sup> <https://tem.fi/en/ecosystems>

<sup>41</sup> [http://80.248.162.139/export/sites/default/OPM/Tiede/tutkimus-ja\\_innovaationeuvosto/julkaisut/liitteet/Review2015\\_2020.pdf](http://80.248.162.139/export/sites/default/OPM/Tiede/tutkimus-ja_innovaationeuvosto/julkaisut/liitteet/Review2015_2020.pdf)

<sup>42</sup> [http://www.aka.fi/globalassets/awanhat/documents/firi/tutkimusinfrastruktuurien\\_strategia\\_ja\\_tiekartta\\_2014\\_en.pdf](http://www.aka.fi/globalassets/awanhat/documents/firi/tutkimusinfrastruktuurien_strategia_ja_tiekartta_2014_en.pdf)

<sup>43</sup> <https://www.tekes.fi/en/programmes-and-services/tekes-programmes/innovative-cities/>

<sup>44</sup> <https://www.tekes.fi/en/programmes-and-services/strategic-centres/>

<sup>45</sup> [http://biotalous.fi/wp-content/uploads/2014/08/The\\_Finnish\\_Bioeconomy\\_Strategy\\_110620141.pdf](http://biotalous.fi/wp-content/uploads/2014/08/The_Finnish_Bioeconomy_Strategy_110620141.pdf)

- Government Strategy to Promote Cleantech Business in Finland (Ministry of Economic Affairs and Employment)<sup>46</sup>
- Finnish Road Map to a Circular Economy 2016–2025 (Sitra)<sup>47</sup>
- Health Sector Growth Strategy for Research and Innovation Activities, Roadmap for 2016–2018 (Ministry of Economic Affairs and Employment)<sup>48</sup>
- Smart Procurement programme (Tekes)<sup>49</sup>
- The Road Map to Platform Economy (coordinated by Tekes, upcoming).

A respondent also mentioned the EU-level becoming more important in connection with strategies covering test and demonstration platforms, such as S3 Thematic Platforms – Digital Innovation Hubs.<sup>50</sup> An ESFRI loan has also been granted to a bio-product mill in Äänekoski, which provides a platform for other firms' piloting.

Many of the strategies have focus areas identified as strategically significant growth sectors. In the government's decisions and strategies from the spring of 2014, bioeconomy, cleantech, digital economy, the health sector and intangible value creation were selected as the targets of public measures and resources aiming to promote growth. However, the funding of policy instruments for test and demonstration platforms is not only restricted to these focus areas, even though more earmarked funding is available to them.

### *Research infrastructure*

In 2014, Finland's strategy and roadmap for research infrastructures 2014–2020 was launched as the first-ever research infrastructure strategy in Finland. Finland's research infrastructure ecosystem includes major national research infrastructures, partnerships of Finnish actors in European infrastructure projects (ESFRI), international research infrastructures that Finland has joined through state agreements or other agreements, and local infrastructures denoted as significant by their host research organisations. Finland's Strategy and Roadmap for Research Infrastructures 2014–2020 steers the development of all parts of this ecosystem.<sup>51</sup> The Finnish Research Committee, appointed by the Academy of Finland, assesses the urgency and priority level of research infrastructure projects included in the roadmap. It also drafts the proposals on funding of public research infrastructure projects for the national budget and for other funding sources.

An important actor in policies for test and demonstration facilities is the Academy of Finland, which provides funding for the acquisition, establishment or upgrading of

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[https://ec.europa.eu/environment/ecoap/sites/ecoap\\_stayconnected/files/documents/government\\_strategy\\_to\\_promote\\_cleantech\\_business\\_in\\_finland.pdf](https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/documents/government_strategy_to_promote_cleantech_business_in_finland.pdf)

<sup>47</sup> <https://media.sitra.fi/2017/02/24032659/Selvityksia121.pdf>

<sup>48</sup> <http://tem.fi/en/health-sector>

<sup>49</sup> <https://www.tekes.fi/en/programmes-and-services/tekes-programmes/smart-procurement/>

<sup>50</sup> <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs>

<sup>51</sup> [http://www.aka.fi/globalassets/awanhat/documents/firi/tutkimusinfrastruktuurien\\_strategia\\_ja\\_tiekartta\\_2014\\_en.pdf](http://www.aka.fi/globalassets/awanhat/documents/firi/tutkimusinfrastruktuurien_strategia_ja_tiekartta_2014_en.pdf)

nationally important research infrastructures that promote scientific research in Finland. However, the funding from the Academy of Finland does not focus on maintaining or developing company use of the innovation infrastructure

### *Innovation infrastructure*

From a business innovation perspective, the most common services of test and demonstration platforms used by companies are laboratory tests and product testing, commissioned studies as well as joint development of innovations in collaboration with the research organisation. Use is most commonly financed by one-time payments or as part of a joint RDI project. It is still quite rare that a platform has joint ownership as a way of financing. There are only few examples of strategic company partnerships and companies as co-owners of platforms in Finland. Funding models and strategic partnership would be one of the main focus areas – especially from a funding point of view. Especially SMEs cannot afford to build their own pilot facilities. However, the platforms have a lot to learn and improve regarding customer relationship management, marketing and sales, but these facilities and platforms rarely have a contact person or a person who could promote and sell the services on an international scale. Finland has many test and demonstration facilities. However, especially commercialisation of the innovation services and funding to strengthen this know-how (such as innovation scout funding) are needed to develop them to reach the next level.<sup>52</sup>

### *Programme and instruments aiming at the development of test and demonstration facilities*

#### **National level**

*The Strategic Centres for Science, Technology and Innovations (SHOK) and the Innovative Cities (INKA)* programme have been the main instruments used to support the creation of centres where public actors and companies establish attractive platforms for growth and a test environment. Particularly the Innovative Cities programme launched in 2014 has supported the creation of regional centres of expertise and innovation in selected leading areas of competence, i.e., energy, health, smart cities, cybersecurity and bioeconomy. One of the main focus areas of the programme has been to support creation of test and demonstration platforms and public-private partnerships (PPP's) in these. For example, the case examples from Finland have received funding from Tekes to develop the following test and demonstration facilities:

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<sup>52</sup> [https://www.tekes.fi/globalassets/julkaisut/julkiset\\_tutkimusinfrastruktuurit\\_336\\_2017.pdf](https://www.tekes.fi/globalassets/julkaisut/julkiset_tutkimusinfrastruktuurit_336_2017.pdf)

- VTT Bioruukki
- SMACC – Smart Machines and Manufacturing Competence Centre
- Oulu 5G Test Network  
(and VEBIC – Vaasa Energy Business Innovation Centre)

However, both SHOK and INKA were discontinued by the present government, and new instruments for PPP's are being formulated at the moment.

Finnish innovation policy is now directing resources to and exceedingly focusing on scaling up as well as companies that are on the verge of internationalisation. One good example of the policy instruments is public procurement for innovation, which has also become a tool to facilitate test and demonstration platforms – especially in city environments. Many of the test and demonstration platforms have been triggered by projects funded by the Tekes' *Smart procurement programme*. And now Tekes is preparing a centre of expertise around public procurement for innovation to create new knowledge and share good practices. One important aspect is how to support test and demonstration platforms.

Furthermore, *Tekes'* funding can be used to develop the platforms. However, in practice this funding has been integrated as a part of development projects, and the funding models are not suitable for long-term and need-oriented development of business. A noteworthy fact from the viewpoint of Finnish platforms is the reduction in Tekes' RDI financing, which reduces the financing available to large companies to collaborate with research organisations in particular. The challenge with project-based funding generally is that it leads to fluctuations depending on market volatility faced by companies, as well as the challenges of targeting the funding towards the strategic, long-term development of platforms. Tekes also has loan instruments to support test and demonstration facilities. However, these instruments do not seem to be economically attractive since only few loans have been requested. The facilities operated by VTT Technical Research Centre of Finland are regarded as very important for the industry, and these facilities have received earmarked national spearhead funding (e.g., VTT Bioruukki).

Important instruments and funding for testing and demonstration facilities are also EU structural funds and national funding (including innovation vouchers<sup>53</sup>), which are administered and allocated by regional councils, the Centres for Economic Development, Transport and Environment (ELY Centres), and Tekes. By granting funding for investment, innovation vouchers and development projects, the ELY Centres and Tekes encourage firms to purchase services from test and demonstration facilities and these service providers at reduced prices.

Test and demonstration facilities and platforms are now a top priority in Finnish innovation policy. Even though the government's budget cuts made a significant dent in the budgets of Tekes, public research institutions and universities, the government's mid-term policy review has suggested giving something back. As a part of this mid-

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<sup>53</sup> <https://www.tekes.fi/en/funding/SME/innovation-voucher/>

term policy review, it is proposed that EUR 10m be transferred to the loan authorisation of the Finnish Funding Agency for Innovation (Tekes) from appropriations earmarked for the capitalisation of Tekes Venture Capital Ltd. to be spent on accelerating piloting and demo projects even though the guideline is not very clear. The government will also invest in companies' product development, renewal, high-level research and research effectiveness by allocating a total of EUR 70m for 2018 and 2019 to Tekes. The funding will be directed at joint projects between companies, research institutes and central government to boost growth, and indirectly encourage the use of test and demonstration facilities. In addition, a total of EUR 50m will be allocated to the Academy of Finland to implement flagship research centres. These new instruments will support PPPs and a closer link between research, innovation and business ecosystems encouraging market oriented research (innovation), where test and demonstration platforms also become a central part of these instruments.

### *Regional National level*

Finnish innovation policy is formulated through a co-evolutionary process between various stakeholders in national and regional/local levels. National initiatives, like INKA, combine both national and local/regional aspects and interests to develop innovation environments, state-of-the-art innovation centres and test and demonstration platforms based on the idea of developing a city as a living lab. Thus, these national strategies are implemented at regional level and most of the large cities in Finland have made their own INKA-programme strategy, which has been coordinated by the cities as well as smart specialisation strategies coordinated by regional councils. Both of these regional strategies support and direct resources to test and demonstration platforms, which are usually part of the regional strategies' spearhead clusters.

One of the most important joint regional initiatives to support test and demonstration platforms is *6Cities strategy (6Aika)*.<sup>54</sup> Launched as a joint bottom-up initiative for cities, the strategy is funded by European Regional Development Fund, the European Social Fund, the Finnish government and the participating cities. The strategy aims to support companies in developing smart city related products and services. The idea is that the six largest cities in Finland join forces to tackle their common urban challenges and launch cooperative projects, test and demonstration platforms, and co-creation models, which will enable the cities and companies to experiment with themes like smart mobility and cleantech together. The six cities have launched up to 26 cooperation projects with a budget of EUR 45m between 2014–2016 and the total budget for 2014–2020 will increase to approx. EUR 100m.

The best examples of working test and demonstration platforms are found in cities that have been part of the INKA-programme and 6Cities strategy. For example, Vaasa, Oulu and Tampere have been on the front line to develop these platforms and facilities. Even though there are no exact regional strategies for test and demonstration

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<sup>54</sup> [https://6aika.fi/wp-content/uploads/2015/11/6Aika-strategia\\_p%C3%A4ivitys\\_2015\\_EN.pdf](https://6aika.fi/wp-content/uploads/2015/11/6Aika-strategia_p%C3%A4ivitys_2015_EN.pdf)

platforms, the idea is included in the public funding criteria. For example, the Tampere region has made a road map for innovative public procurement. The idea is to harness the potential in city and service development to facilitate innovation and set up test and demonstration platforms (one such example is a new city).

As noted above, regional strategies also tend to focus more on scaling up and companies that are on the verge of internationalisation. Thus, regional strategies direct resources at these test and demonstration platforms where companies can get proof of concepts, develop their products and references to go global.

### *Evaluation of policies and strategies – or a matter-of-fact observation*

When referring to test and demonstration facilities, most often it comes down to platforms administered by universities, universities of applied sciences and (public) research institutes. Especially the services of VTT are important. It is becoming increasingly common that the facilities and platforms are developed in close cooperation with companies and the public sector (cities becoming also more vital actors). It is worth noticing that in Finland one very important aspect of many of these publicly funded platforms is to create an environment that brings together different types of knowledge and know-how. In addition to providing services, the idea is to facilitate new partnerships and cooperation between companies, the public sector and universities.

Since national funding for Tekes, and the SHOK and INKA-programmes in particular, has been discontinued, there are no specific strategies or programmes supporting innovation infrastructure and platforms. The latest Research and Innovation Council policy review recognises the need to support innovation infrastructures (and policy has done so for the last 10 years). However, the national operationalisation is mostly still in the hands of cities and universities. Thus, emphasis is on the research infrastructure and services related to these infrastructures. In Finland, supporting test and demonstration facilities tends to rely on a bottom up approach. One exception is VTT Bioruukki, which is an example of national government spearhead funding directed at one specific innovation infrastructure.

Cities play an important role in supporting innovation platforms. But so far, fostering demand side innovation (and supporting use of test and demonstration facilities) is still emerging and looking for its place and right tools in Finnish innovation policy. Innovation procurement is one of the main tools for supporting use of test and demonstration facilities and there have been extensive efforts to support the creation of these innovation platforms around Finland.

When it comes to self-assessment of Finnish innovation policy to support test and demonstration facilities, Finland lags behind Sweden, Denmark and Netherlands, but it is actively benchmarking what happens in this sector in other countries. There are no specific evaluations or (impact) assessments regarding test and demonstration facilities. However, the INKA programme is under evaluation after the government decided to make cuts in its funding and one important aspect of the evaluation is to explore and analyse these regional test and demonstration platforms.



## Iceland<sup>55</sup>

### *National policies and strategies for test and demonstration facilities*

In Iceland, there is no national strategy as such for test and demonstration facilities. The Science and Technology Policy Council's policy paper from 2017 on science, technological development and innovation<sup>56</sup> mentions an action on the creation of a research and innovation roadmap and policy, which also includes access to test and demonstration facilities.

The policy paper states that one of the key prerequisites for successful science, innovation and technology is good access to research facilities. Research facilities include facilities, resources and services that researchers use in research and to promote innovation in their fields of study. Test and demonstration facilities are part of the research facilities.

In recent years, there has been a great deal of emphasis on the development of research facilities in neighbouring countries of Iceland. Most European countries have formed a special policy structure and increased investment in research facilities. Such policies are widely regarded as an important part of promoting knowledge in the country, both in public institutions, universities and companies in innovation. It is understood how the development of research facilities can support the goals of enhancing service institutions and companies, create jobs in the knowledge industry and attract well-educated and expert staff.

In April 2017, the Ministry of Education, Science and Culture published a report on the future structure of the research infrastructure of Iceland. The report is the outcome of a working group set up on behalf of the Science and Technology Council.<sup>57</sup> Among other things, it proposes that a policy on research be prepared as well as a roadmap based on this policy. Iceland is one of the few countries in Europe that has not yet created such a roadmap. A roadmap can be described as a strategic research infrastructure development plan prepared in close cooperation between the government and the scientific community, and it should include a strategic focus on test and demonstration facilities. For now, there are no such policies in Iceland. Instead, Iceland has a bottom-up approach where institutions offer test and demonstration facilities to companies.

However, there is a system in Iceland where companies receive tax deductions for R&D activities. The system that is inspired by the Skattefunn system in Norway. Iceland does not have innovation vouchers, but it is considering introducing such vouchers.

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<sup>55</sup> Based on interview with Halgrímur Jonasson, General Director, Rannis Iceland, and interview with Steinunn Sigríður Jakobsdóttir, Senior Adviser, Division of Science and Innovation, Rannis Iceland.

<sup>56</sup> Mennta- og menningarmálaráðuneyti (2017): Stefna og aðgerðaáætlun Vísinda- og tækniráðs 2017–2019.

<sup>57</sup> The Science and Technology Policy Council's policy paper from 2017 on science, technological development and innovation (in Icelandic) <http://www.stjornarradid.is/lisalib/getfile.aspx?itemid=7997a35e-54d8-11e7-9410-005056bc4d74>

### *Programme and instruments aiming at the development of test and demonstration facilities*

Iceland has an infrastructural fund that can support the country's research institutions and companies. The infrastructural fund provides funding for buying physical instruments as well as databanks, etc. The fund has ISK 206m and it therefore a relatively small fund. However, there have been political discussions about increasing the fund. The Science and Technology Policy Council's policy paper recommends making a roadmap for infrastructural funds. In the next two years, the Science and Technology Policy Council will work on mapping the infrastructural facilities and create a new roadmap to highlight preferences for what to invest in.

Rannis has a Technological Development Fund offering 90% support to companies. This fund can be used to support certain test facilities – but adhering to the competition rules.

Although there is no strategy for test and demonstration facilities, there are institutions that offer test and demonstration facilities to companies, i.e., the Innovation Center Iceland (a government-run institution) and Matís (a government-owned corporation).

#### *Innovation Center Iceland<sup>58</sup>*

Innovation Center Iceland is a leading R&D and business support institute in Iceland. It reports to the Ministry of Industry and Innovation. The mission of the centre is to enhance the innovation, productivity and competitiveness of Icelandic trade and industry by carrying out innovative technology research, disseminating knowledge and giving support to entrepreneurs and start-up companies.

The core activities of Innovation Center Iceland are divided into two domains:

1. *Technology Research and Consulting*, where the tasks are in different fields of research such as nanotechnology and renewable energy;
2. *The Innovation and Entrepreneur Services*, which assists entrepreneurs in the start-up, growth and management of SMEs. It operates an incubator centre, for instance, which offers support and facilities to start-up companies working on innovative business ideas.

Ten years ago, Innovation Center Iceland established test facilities for themselves pertaining to both domains thinking that companies could also make use of these facilities. Innovation Center Iceland received support from the government to establish these test and demonstration facilities, but the funding was based on the needs of Innovation Center Iceland and not based on a specific strategy.

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<sup>58</sup> <http://www.nmi.is/english>

Looking back at the past five years, Innovation Center Iceland has had strong focus on test and demonstration facilities in relation to bio science and health science. However, this has not been based on a government strategy.

### ***Matís<sup>59</sup>***

Matís is a government-owned corporation. It is a science and knowhow community based on strong infrastructure and collaboration aimed at maximising the impact of investment in research and innovation.

Matís is also the designated Icelandic national laboratory for certain areas of chemical and microbiological analyses of foods. The company operates the most advanced laboratories in the country and offers its expertise over a broad range of analytical services, training and product development.

Like Innovation Center Iceland, Matís can give companies access to test and demonstration facilities – but they decide what test facilities to offer to the companies. Again, it is not part of governmental strategy, but up to each institution to provide this service. The instruments that are made available to companies depend on the applications of the companies.

### ***Collaboration with other Nordic countries***

In the Science and Technology Policy Council's policy paper, it is clear that collaboration should be in focus. A small country like Iceland cannot guarantee its researchers access to first-class test and demonstration facilities in all areas except by cooperating with other countries. It is the vision of the Science and Technology Council that Icelandic scientists and scholars gain easy access to modern and good research areas at home and abroad.

At the moment, the synergies are not fully developed, but Rannis has a relatively good collaboration with the Nordic countries. The collaboration partners include the Research Council of Norway and Swedish Research Council (Vetenskapsrådet) in Sweden, as well as cooperation mainly through Nordforsk.

### ***Evaluation of policies and strategies – or a matter-of-fact observation***

In conclusion, there is currently no governmental strategy for test and demonstration facilities in Iceland. The Science and Technology Policy Council's policy paper from 2017 recommends presenting a strategy and roadmap for the research infrastructure of the country, including test and demonstration facilities. Currently, test and demonstration facilities for Icelandic companies are mainly available through the Innovation Center Iceland and Matís.

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<sup>59</sup> <http://old.matis.is/english>

## Norway<sup>60</sup>

### *National policies and strategies for test and demonstration facilities*

Many industrial companies in Norway experience an increasing rate of innovation these days.<sup>61</sup> The development involves a closer link between production and innovation in the industry to become smarter and faster in product development. In many cases, the need for infrastructure and equipment to test, simulate, visualise and train has increased. Close collaboration between industrial companies and the research environments could be a competitive advantage for Norwegian industry in the future by which further research can be generated, commercialised and realised faster in the market.

### *Research infrastructure*

In 2010, the Norwegian national strategy for research infrastructure was initiated in line with similar roadmaps drawn up in other countries and the EU (the European Strategy Forum on Research Infrastructures' (ESFRI) Roadmap). Since then, the strategy has been revised in 2012, 2014 and 2016.<sup>62, 63</sup> The roadmap has several functions, such as:

- highlighting major research infrastructures that are essential for achieving research policy objectives
- communicating the strategic basis for the Research Council of Norway's priorities relevant to emerging funding announcements under the National Financing Initiative for Research Infrastructure
- providing a guide for public and private funders of research infrastructures by presenting thoroughly reviewed projects that are quality-assured and considered worthy of support, but are in need of full or partial funding
- emphasising Norwegian participation in international research infrastructures and demonstrate the balance and proportionality between such participation and national investments.<sup>64</sup>

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<sup>60</sup> Based on interview with Øystein Jørgensen, Senior Advisor ("Fagdirektør"), the Ministry of Trade, Industry and Fisheries, Norway. Johan Vigrestad, Department Director ("Avdelingsdirektør"), the Research Council of Norway Gaute Moldestad, Hired consultant ("Innleid konsulent"), SIVA.

<sup>61</sup> Meld. St. 27 (2016–2017): Melding til Stortinget. Industrien – grønnere, smartere og mer nyskapende (Report to the Parliament, the Ministry of Trade, Industry and Fisheries, Norway. The Industry – greener, smarter and more innovative).

<sup>62</sup> [https://www.forskningsradet.no/prognett-](https://www.forskningsradet.no/prognett-infrastruktur/Norwegian_Roadmap_for_Research_Infrastructure/1253976312605)

[infrastruktur/Norwegian\\_Roadmap\\_for\\_Research\\_Infrastructure/1253976312605](https://www.forskningsradet.no/prognett-infrastruktur/Norwegian_Roadmap_for_Research_Infrastructure/1253976312605)

<sup>63</sup> The Research Council of Norway (2016): Norwegian Roadmap for Research Infrastructure 2016.

<sup>64</sup> [https://www.forskningsradet.no/prognett-infrastruktur/The\\_function\\_of\\_the\\_roadmap/1253976312686](https://www.forskningsradet.no/prognett-infrastruktur/The_function_of_the_roadmap/1253976312686)

The Norwegian Roadmap for Research Infrastructure 2016 has two main parts:

- A description of the strategic basis for the Research Council of Norway's priorities regarding research infrastructure in specific disciplines, thematic areas and technology areas, called area strategies.
- A presentation of large-scale research infrastructures of national importance, which have either received funding after the call for proposals in 2014 or previously, or are considered as "worthy of funding" by the Research Council.<sup>65</sup>

### *Innovation infrastructure*

The Ministry of Trade, Industry and Fisheries wants to support both well-established and new test and demonstration facilities. Part of the strategic thinking related to supporting well-established facilities is to strengthen these facilities to make them capable enough to operate and compete internationally. It should also be noted that a strong, well-established facility may not remain as strong over time.

The Ministry of Trade, Industry and Fisheries does not have an explicit strategy for establishing test and demonstration facilities. However, the rationale and overall guidelines for establishing the facilities are mentioned primarily in Meld. St. 27 and in the Norwegian national budget for 2017.<sup>66</sup> The Ministry of Trade, Industry and Fisheries delegates the responsibility to the policy instruments/funding agencies *SIVA*, *Innovation Norway* and the *Research Council of Norway* and *Enova* to ensure the establishment of test and demonstration facilities. These are the key players in relation to financing test and demonstration facilities.

### *Programme and instruments aiming at the development of test and demonstration facilities*

A test facility that meets the requirements of different schemes can get support from several sources. The focus with respect to establishing test and demonstration facilities is on both research, innovation and technology development.

The government has contributed with funding to get most facilities established through actors such as *Enova*, the *Environmental Technology Scheme* ("Miljøteknologiordningen") in *Innovation Norway* and various programmes in the *Research Council of Norway*. After the establishment of and initial support for the facilities, the facilities rely on paying customers/users. The funding does not support further/future operation and maintenance of the established facilities. The payment from the companies that the facilities receive must cover further operation and maintenance of the facilities. For example, the companies that use the facilities can

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<sup>65</sup> [https://www.forskningradet.no/prognett-infrastruktur/Front\\_page/1253976313255](https://www.forskningradet.no/prognett-infrastruktur/Front_page/1253976313255)

<sup>66</sup> Meld. St. 27 (2016–2017): Melding til Stortinget. Industrien – grønnere, smartere og mer nyskapende (Report to the Parliament, the Ministry of Trade, Industry and Fisheries, Norway. The Industry – greener, smarter and more innovative)

make use of the *Tax Financing Scheme* ("SkatteFUNN-ordningen") to get financial assistance to pay for the services that they obtain from the facilities.

Within a framework for renewing and developing the campaign on research, innovation and technology development, the government focuses on 17 elements. Two of these elements are directly connected to test and demonstration facilities:

- Continue the strong commitment to industry-oriented research and innovation
- Strengthen the infrastructure to address the need that the industry has for testing, pilot-testing, visualisation and stimulation through the establishment of Catapult Centers ("Katapultsentere"). The government will prioritise increasing the Catapult scheme if it turns out to be a success.

The government will make it easier for Norwegian industrial companies to access infrastructure and other equipment needed to carry out good research and innovation projects. In the 2017 national budget, SIVA received NOK 50m to start the Norwegian Catapult scheme to support national multipurpose facilities for testing, demonstration, simulation and visualisation. The Ministry does not propose any guidance as to the industries and technologies to which the testing centres should be connected, but assumes that the choice is seen in relation to already existing facilities. The facilities should be established where there is a large customer base, and for that reason, it may be natural that they are linked to strong existing business communities.

### *The Norwegian Catapult scheme*

The Norwegian Catapult scheme<sup>67, 68</sup> provides the possibilities to align with other mechanisms such as User-driven Research-based Innovation (BIA), Norwegian Centres of Expertise (NCE clusters), and Centres for Research-based Innovation (SFI) to facilitate research, innovation and technology development.

The Norwegian Catapult scheme provides grants for institutions that would like to establish test and demonstration facilities. The grants do not support further/future operations and maintenance of such facilities. Payment from companies using the facilities must cover further operation and maintenance of the facilities. For example, the companies that use the facilities can make use of the *Tax Financing Scheme* ("SkatteFUNN-ordningen") to get financial assistance to pay for the services that they obtain from the facilities.

SIVA will manage the Catapult grant and cooperate closely with other policy instruments in the development and management of the scheme and coordinate and complement other and existing resources. Further, The Catapult scheme is also a response to Menon Economic's mapping of existing test facilities and investigation of the possibilities of increasing the utilisation of unused capacity in the existing test

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<sup>67</sup> Norsk katapult – Beskrivelse av ordningen (2017): (Norwegian Catapult scheme – Description of the scheme).

<sup>68</sup> The Catapult scheme is inspired by the UK Catapult scheme and similar schemes and programs in Sweden and Germany.

facilities.<sup>69</sup> This investigation is relevant for designing the proposal/application pertaining to the Catapult scheme.

*SIVA, Innovation Norway* and the *Research Council* of Norway have started collaborating in connection with the Catapult scheme in accordance with a letter of commission ("oppdragsbrev") for 2017. The Ministry of Trade, Industry and Fisheries delegated the responsibility to these three actors. A working group has been set up to prepare a proposal for the means and priorities of the scheme including prospectus, evaluation criteria, etc. The work should be completed during 2017 so that the funds can be announced. The government will give priority to increasing the Catapult scheme, if the scheme turns out to be a success.

The Norwegian Catapult scheme will support the establishment and development of centres (facilities) for testing, simulation and visualisation. This will contribute to faster, less expensive and better innovation processes, which are crucial to the companies' competitiveness, and they will thus become the prerequisites for value creation (new employment opportunities, etc.) in Norway. According to the Technology Readiness Level (TRL), Norwegian Catapult targets TRL Level 4–7.

The Norwegian Catapult scheme requires that a catapult centre satisfy the following requirements, which can be seen as an overall framework for establishing the centre (test and demonstration facility):

- Provide equipment, facilities and expertise to businesses across the country, thus serving as a national multi-use centre;
- Specialise their business within one or more key enabling technologies and thus be relevant to companies within different industries and sectors;
- Have good access to high-quality expertise and resources;
- Can document/ensure a close collaboration with R&D environments and a strong business affiliation;
- Could document/ensure a binding ownership (to the facility) and a realistic and sustainable operating model for the facility's operations;
- Mobilise small and medium-sized businesses to use the centre and be able to refer to established structures and forms of collaboration that ensure the businesses' high usage rate of the centre.

According to *SIVA*, these requirements stem from the consideration of two underlying, guiding aspects, i.e., national priorities and key enabling technologies.

Users of the Catapult centres that need to test, simulate or visualise as part of their innovation process are mentioned below in the following order of priority:<sup>70</sup>

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<sup>69</sup> Menon Economics. (2016): *Infrastruktur for testing, piloting, visualisering og simulering*. Rapport. Menon publikasjon, nr. 41/2016. (Infrastructure for testing, piloting, visualising and simulation. Report Menon Publication, no. 41/2016) Oslo: Menon Economics.

<sup>70</sup> Norsk katapult – Beskrivelse av ordningen (2017): (Norwegian Catapult scheme – Description of the scheme).

- Small and medium-sized production companies
- Large manufacturing companies
- Service providers
- R&D actors
- Educational institutions

The Norwegian Catapult scheme does not have a specific regional focus seen from an ex-ante perspective. However, it considers possible mechanisms that can encourage companies situated remotely/away from the facilities (situated in different regions) to use the facilities. *SIVA* describes how clusters such as Norwegian Centres of Expertise (NCE) can be seen as one of the collaborative actors along with the Catapult scheme to improve the competences of the Norwegian Industry.

### *Evaluation of policies and strategies – or a matter-of-fact observation*

Since the Catapult scheme has only been launched in 2017, and since it is not operating yet, no evaluation of the scheme has been made, but according to *SIVA* the response from the involved actors and the industry is positive so far.

It is possible to give an overview of test and demonstration facilities in Norway. On behalf of the Ministry of Food and Fisheries, Menon Economics has mapped private and public test and demonstration facilities in Norway.<sup>71</sup> They have identified 115 test and demonstration facilities in the business community. These facilities include private facilities that are used exclusively by the owner-companies as well as facilities where public actors are involved in the ownership.

In addition, they have identified 78 test facilities that mainly have research and development (R&D) as their *raison d'être*. Thus, it can be assumed that these R&D facilities primarily provide access to companies in the form of collaborative research projects. Menon Economics also points out that several of these facilities can be used to test pilot projects and demonstration projects.

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<sup>71</sup> Menon Economics. (2016): Infrastruktur for testing, pilotering, visualisering og simulering. Rapport. Menon pulikasjon, nr. 41/2016. (Infrastructure for testing, piloting, visualising and simulation. Report Menon Publication, no. 41/2016) Oslo: Menon Economics.



## Sweden<sup>72</sup>

### *National policies and strategies for test and demonstration facilities*

There are numerous government bills, plans and policies addressing the issues of test and demonstration in relation to innovation in Sweden.

In the following, we discuss three different types of such documents, i.e., general government bills, specific thematic strategies from the central government, and other strategies and plans. For each type, we give a few examples. However, before doing so we introduce the organisational infrastructure for public investment in test and development facilities in Sweden.

### *Public investment in test and development sites in Sweden*

Public investment into research, development and *testing facilities* stems from different sources. Public capital is invested in publicly owned academic institutions (mainly universities) and publicly owned research institutes (mainly those under the RISE institutes) as owner capital. Public resources are also invested in research, development and testing infrastructure of semi-public/private characters, such as institutes operated by regional or industrial organisations. Funding for such organisations' investments stems from different sources and is often of a once-and-only-character.

Funding is also provided for the *testing activities* in relation to a variety of research and innovation funding programmes (e.g., through national authorities such as Vinnova with an annual budget of SEK 2.6 billion and the Energy Agency with an R&D budget of SEK 1.5 billion), but also through national research councils, such as the Swedish Research Council. Funding for such activities also draws substantially on regional and ESI-fund budgets.

Public funding is also channelled through a series of public trusts. For 2016, these trusts spent a total of SEK 1.6 billion of public money on R&D.

Government bills or legislation and other government strategies and plans are guided by the flow of budget spending on R&D as discussed below. It is important to note that the changes promoted in such documents are often marginal in comparison to the total levels of spending.

### *General government bills*

General Government Bills (GGB) are proposals that the government put forward to the Swedish parliament (Proposaler). They are often wide in scope, spanning an entire

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<sup>72</sup> Based on interviews and meetings with Mikael Damberg, Minister for Entrepreneurship and innovation, and Eva Lindström, Secretary of State, Ministry for Entrepreneurship and innovation, Lars Guldbrand, Senior Advisor, Ministry for the Environment and Energy, Carin Dahl, Head of Innovation, Region Skåne, Thomas Johansson, Head of Maritime Planning, Swedish Agency for Maritime and Water Management.

policy field. They are also intended to cover a relatively long period – often more than a mandate period and certainly longer than the annual budgets.

A recent example is the Research & Innovation bill presented to the parliament in 2016 – Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft, Regeringens Prop. 2016/17:50.<sup>73</sup>

The function of such bills is to guide the government in its budget and legislation process. The bills are closely linked to the budget process, and their potential impact on actual policymaking can therefore be seen as potentially considerable, especially in comparison to some of the other forms of strategic documents discussed below.

A number of such bills may and do contain policy proposals regarding test and demonstration activities. Apart from the research and innovation bill, the most interesting bill is perhaps the energy research bill.

### *The Research and Innovation Bill (Prop. 2016/17:50)*

The Research and Innovation Bill spans a policy field with a budget of some SEK 3 billion annually, corresponding to 3.7% of total government spending, which corresponds to 0.78% of GDP (which in a Nordic comparison is less than Finland, Norway and Denmark). The question of testing and demonstration is given a more prominent role in the research and innovation bill than in previous bills.

Large investments in research infrastructure are proposed in the bill, predominately in the European Spallation Source and the MAX IV labs in Lund. However, in relation to the investments in research infrastructure the bill explicitly raises the issue of test and demonstration facilities:

“(...in which) complex products, services and ideas may be tested and assessed under live conditions. It may concern the testing of self-driving vehicles in a real city, or the construction of new dwellings using innovative systems for energy supply where tenants are part of the assessment, thereby contributing directly in the development and improvement of systems.”<sup>74</sup>

The bill specifically focuses on such “living lab” real world test sites. This implies involving “need/challenge-owners” in the innovation process more closely.

The government agency Vinnova is commissioned to develop measures to support and enhance its support for living labs, and test and demonstration facilities. In practice, this is done by increasing Vinnova’s budget. In the bill, the government proposes an increase in Vinnova’s budget by SEK 75m for 2018 and a further SEK 25m for 2019 for this purpose.

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<sup>73</sup> Regeringens proposition 2016/17:50.

<sup>74</sup> Regeringens proposition 2016/17:66.

### *The Energy Research Bill (prop. 2016/17:66)*

The Energy Research Bill – *Forskning och innovation på energiområdet för ekologisk hållbarhet, konkurrenskraft och försörjningstrygghet* – was launched in conjunction with the Research and Innovation Bill, but it focuses on the approx. SEK1.5 billion annually administered by the Energy Agency.

In the bill, the government proposes an increase in the Energy Agency's budget for research and innovation from approx. SEK 1.4 billion to SEK 1.6 billion annually. This increase is supposed to allow for an increased focus on "usefulness" of research, involving, for instance, following up on demonstration projects more closely and increasing investments in innovative public procurement as a means of promoting innovation, often by involving open innovation and test and demonstration. Furthermore, several thematic fields are most likely to mean increased focus on open innovation, and living labs are introduced, e.g., specific efforts in relation to circular economy and sustainable cities.

With its suggested increase in annual spending on energy-related research and development of more than 15% annually the Energy Research Bill means new resources for green innovation in general and energy-related innovation in particular. With its focus on innovation and social challenges as thematic drivers for energy research the chance is that the bill will mean more money being spent on testing and demonstration in Sweden over the next few years.

A related but different government policy document is the so-called strategies or often-national strategies. Their backgrounds and contexts vary but they share the long-term view with government bills. Unlike government bills, they are mostly less explicit on budgetary issues and often stop at pinpointing already allocated resources that may be used or targeted differently by government agencies to accomplish the objectives of such a strategy. The reason for this vagueness on budgets is that strategies are often cross sectoral by nature, they often involve budget resources from several policy fields, ministries, and agencies, which leads to a delicate balance not often challenged by the strategies and often avoided to challenge by governments. Such strategies are designed to guide the government actions in a tacit or softer way.

In the following, we highlight the three different strategies of different types and with different backgrounds and emphasis.

### *Programme and instruments aiming at the development of test and demonstration facilities*

#### **National strategy for sustainable growth**

Our first example is *Nationella strategin för hållbar tillväxt och attraktionskraft (NShtak)*.<sup>75</sup> This strategy has a slightly different background than the other strategies we are looking at here. NShtak is mainly designed to guide the implementation of EU

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<sup>75</sup> <http://www.regeringen.se/4a8706/contentassets/98919a0caof1427491a3eef22a7d177c/en-nationell-strategi-for-hallbar-regional-tillvaxt-och-attraktionskraft-20152020.pdf>

cohesion policy in Sweden and points out the priorities set out for Sweden in the negotiations with the EU Commission on the use for the European Structure and Investment (ESI) funds in Sweden. NShtak is also important as a guideline for regional strategies throughout Sweden, primarily because regional development policies are formed in a multilevel policy framework from the EU, National and Regional levels, and because the funding comes from all these three sources.

In NShtak one focus area for priorities with resources from ERDF is to “Utveckla starka regionala kluster, forsknings- och innovationsmiljöer inklusive forskningsinfrastruktur, samt demonstrationsanläggningar och testbäddar”, i.e., to develop strong research and innovation environments including investments in research infrastructure, test and demonstration sites. In practice, this priority has meant that approx. 33% of the total ERDF resources in the programmes 2014–2020 is allocated to research and innovation (and investment in research and innovation).

### *Smart industry – a strategy for new industrialisation for Sweden*

The second strategy is the Smart Industry Strategy – Smart industry – En strategi för nyindustrialisering, launched by the government in early 2016.<sup>76</sup>

The purpose of the strategy is to highlight the importance of Sweden’s manufacturing industries for Sweden’s prosperity and at the same time acknowledge and try to address the challenges facing manufacturing in Sweden as well as other industrialised countries in the era of digitalisation and globalisation.

The strategy sums up and proposes four strategic routes forward for the renewal of Swedish manufacturing:

- Industry 4.0 (focusing on the introduction of new technologies both in production and as new business models)
- Sustainable production (focusing on integrating a sustainable perspective both in production and as for the emergence of new industries and/or business models)
- Industrial skill boost (focusing on competence in manufacturing jobs); and finally.
- The so-called Test Bed Sweden.

Test Bed Sweden focuses on stressing new forms of promoting innovation in relation to Swedish manufacturing, involving focus on test and demonstration sites, living labs, innovative public procurement, etc.

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<sup>76</sup> <http://www.regeringen.se/49a937/globalassets/regeringen/dokument/naringsdepartementet/pdf-i-genvagsblock/smart-industry.pdf>

### *National Maritime Strategy*

In late 2015, the government launched Sweden's first strategy for maritime development (NMS).<sup>77</sup> The strategy focuses on three overall areas, i.e., clean and safe seas; attractive and accessible coast- and seaside regions; and competitive maritime industries.

In several parts, NMS promotes the use of test beds and demonstration facilities for enhancing the usefulness of maritime research and the promotion of maritime industries, not the least in relation to sea-based energy.

This strategy deals with what in a Swedish perspective has been considered a marginal sector until now, but it demonstrates the government's determination to use national strategies for trying to give priority to different sectors or perspectives without necessarily allocating new or redirecting already allocated resources. However, so far there is limited evidence as to the efficiency of such strategies.

### *Other plans, programmes and strategies*

There are several national and regional programmes, plans or strategies often of great importance to innovation in general and the development and funding of test and demonstration sites. In the following, we take a brief look at two such initiatives, i.e., one national programme involving funding and one regional strategy.

### *Strategic Innovation Programmes – a national initiative*

The Strategic Innovation Programmes (SIP) are a national initiative designed to address social challenges from an innovation perspective, funded by the national budget and pointed out in previous research bills and taken further in the most recent research bill.<sup>78</sup> Currently, 16 such programmes have been decided within fields such as the Internet of Things, the aerospace industry, materials, life science, mining and minerals. The initiative is a collaboration between the government, regional governments, universities and research institutes and the industry. National public funding is provided via the government agency Vinnova, the national research council Formas, and the Energy Agency.

One of three focus activities in the SIPs (SIPs must include triple helix partners) is the funding of test demonstration sites.

### *Region Scania's Strategy for Innovation*

Like most of Sweden's 21 regions, Region Scania (Skåne) has launched its own regional development and innovation strategy. This means a specific innovation strategy

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<sup>77</sup> <http://www.regeringen.se/contentassets/86a578f7a521469e9b6b8c62ac5aa128/maritim-strategi.pdf>

<sup>78</sup> <http://www2.vinnova.se/sv/Var-verksamhet/Gransoverskridande-samverkan/Samverkansprogram/Strategiska-innovationsomraden/strategiskainnovationsprogram/>

identifying three innovation areas of priority for regional innovation, i.e., Smart Materials, Sustainable Cities, and Personal Health.<sup>79</sup>

Under the heading of these three focus areas, the regional government of Scania attempts to accomplish international excellence for the region's research institutes and innovative companies.

The strategy highlights a number of "Whys" and "Hows". One important concept is the term "collaboration", which is particularly important, as it is a strategic tool to emphasise the role of testing, open innovation and living labs. Especially in the priority areas of Sustainable Cities and Personal Health that Region Scania is often able to take the lead because of the regional government's role in areas such as health care and regional transport and it can therefore actively invite both academia and the private sectors to meet social challenges jointly.

The region of Scania also directly and indirectly oversees relatively large resources – both income from the region's taxpayers and regionalised government grants. Through these resources, the region indirectly has an influence on primarily ERDF resources where regional resources are used for cofunding.

### *Evaluation of policies and strategies – or a matter-of-fact observation*

The conclusion addresses how bills, plans and strategies work together to enhance test and demonstration in Sweden. The description above has demonstrated the complexity of Sweden's innovation policy landscape, where sector and cross-sector, national and EU, national and regional, annual budgets and long-term strategies mix to form a complex web of plans and strategies.

Most of the strategies are recent and therefore share a focus on modern forms of innovation. There appears to be a shared focus on innovation as well as testing and demonstration as important aspects of innovation. Moreover, there appears to be a common focus on the importance of opening up testing and demonstration towards social challenges and a collaborative approach involving "problem owners" (such as national, regional and local authorities), academia and industry.

However, it is more difficult to see how these strategies influence real innovation processes.

One way of bringing clarity is to separate funded plans and programmes from non-funded ones. Even though they are not funded, government bills are per se still bearers of government funding to be realised in the national budget. When government bills address innovation activities as they do in the two national bills these efforts are likely to be transformed into increased funding and commissions for the responsible agencies mentioned in the bills. In this case, they would be the Energy Agency and Vinnova.

The other national strategies, however, often take different forms. In this instance, normally no budget resources are directly allocated to the objectives of the strategies. Instead it is hoped that government agencies with the strategies as a background

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<sup>79</sup> [https://utveckling.skane.se/siteassets/publikationer\\_dokument/internationell\\_innovationsstrategi\\_for\\_skane.pdf](https://utveckling.skane.se/siteassets/publikationer_dokument/internationell_innovationsstrategi_for_skane.pdf)

themselves will initiate and redirect some of the already allocated funding to meet the priorities stressed in the national strategies. However, in the case of Smart Industry, there is an action programme related to the strategy in which funding and implementation of at least part of the strategy's content is pinpointed.

Regional strategies are designed to meet the specific needs and priorities of the region. However, regional strategies also tend to operate very much alongside both national and European programmes and strategies as a way to ensure as many resources for development and innovation for the region as possible.

Hence, what may seem as a large number of strategies focusing on the same issues and targeting innovation, testing and demonstration, etc., may not mean that resources are channelled to this from an equally large number of funding resources. However, it is important for the possibility of funding to be able to achieve this joint focus, as the focus of one strategy is often a prerequisite for the funding from another. In particular, it is important for the region to show its commitment if national funding is to be released.



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## **NORDIC TEST AND DEMONSTRATION FACILITIES**

In the Nordic countries, manufacturing plays a vital socio-economic role by contributing to employment and the economy at large. The key prerequisites are a high productivity and a strong competitive edge. One of the ways to obtain and maintain a competitive edge is if (small and medium-sized) companies apply new knowledge and new technologies. To support the use of new technologies by companies, easy access to testing of new products and technologies is a decisive factor for the companies to gain knowledge of and inspiration for the use of the new technologies in their current business. This report presents a mapping of test and demonstration facilities in the Nordic countries, including ten good practice examples of such facilities as well as political initiatives in the Nordic countries, including specific strategies for setting up and structuring test and demonstration facilities.

