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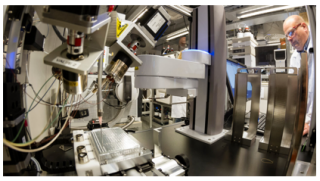
Sharing Test and Demonstration Infrastructures

- an opportunity for Smart Specialisation in the Baltic Sea Region



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1. Background and introduction

This report was commissioned by the Nordic Council of Ministers within the framework of the BSR STARS S3 project[1], co-financed by European Union Interreg Baltic Sea Region Programme. BSR STARS S3 aims to promote innovation in the Baltic Sea Region, including by identifying new opportunities for smart specialisation. The partner regions in the project are: Greater Copenhagen (Denmark), Sør Trøndelag (Norway), Skåne (Sweden), Tampere (Finland) and Lithuania (participating at the country level) – and thus this report has a particular emphasis on these regions.

The report maps a large number of bioeconomy test- and demonstration infrastructures in the Baltic Sea Region – and it discuss opportunities for collaboration between test- and demonstration infrastructures to realise benefits from complementary areas of expertise around the macro-region. The rationale for such cooperation would be that whereas SMEs today usually only access regional and national test and demonstration facilities, a larger network of facilities would provide SMEs access to more specialised test and demonstration infrastructures in their particular business area. There is strong evidence for the correlation between the competitiveness of technology-based SMEs and their access to advanced test and demonstration infrastructures. Thus, improving access to specialized test and demonstration infrastructures will be likely to increase the competitiveness of SMEs in the bioeconomy.

The mapping takes the baton from a comprehensive 2016 report – "Development of the Nordic Bioeconomy"[2]. The report was prepared as part of the Nordic Prime Ministers green growth initiative, "The Nordic Region – leading in green growth". It concludes that the Nordic countries have not yet exploited many of the opportunities that the bioeconomy provides for generation new jobs and sustainable development. Other studies show that the situation is similar for the Nordic countries' neighbours in the Baltic Sea Region. One of the key findings of the Nordic study is that there are "shot-comings especially within the pilot scale test centers for upscaling of technologies and processes" that "pose significant obstacles to the further efficient development of the bioeconomy". The Nordic report goes on to argue that the macro-region lacks mechanisms for sharing of best practice. "There is a surprising lack of open access to test facilities available in the Nordic countries for upscaling new processes or products" – and the national and regional test facilities that are in place are generally not open to partners from neighbouring countries. Thus, it is advised that the macro-region should do more "to move forward and harvest solutions from synergies".

This report attempts to take further steps in this area. The findings will be presented at a macro-regional workshop in Tampere on 6 April 2017 – and there it will provide a starting point for a stakeholder dialogue on opportunities for actually and practically sharing test and demonstration infrastructures, including by use of a macro-regional innovation voucher scheme.

[1] http://www.bsr-stars.eu/bsr-stars-s3/
[2] http://www.norden.org/en/theme/nordic-bioeconomy

2. Bioeconomy test and demonstration infrastructures in regions and countries

Below follows an overview of bioeconomy test and demonstration infrastructures in project partner regions *and* countries. The reason for focusing at country level in most cases rather than regional level is that the majority of bioeconomy test and demonstration infrastructures are not provided exclusively for companies located within the boundaries of a particular region. The services are provided at country-wide.

Also, regarding the extend of this mapping: A number of pilot, test and demonstration projects are ongoing in the Baltic Sea Region, aiming to demonstrate more generic potentials of new green business models – e.g. in within the area of biorefining for purposes of for example drugs, materials and fuels. This report includes only those test and demonstration infrastructures that are open to companies *also* beyond those companies that participate in a given project or test pilot partnership.

A large number of universities provide through joint research activities with the private sector also access to laboratory facilities for testing and demonstration of product ideas or concepts within the bioeconomy. However, where such infrastructures are exclusively available for companies engaging as partners with a university within the context of a specific research project – and not in the form of partly or fully commissioned test and demonstration services – these university test and demonstration infrastructures are not included in this mapping.

Also, test- and demonstration services offered by fully owned and fully commercial private companies/laboratories are not included in the report. The reason for this is that investigation of opportunities for integration of such private test- and demonstration companies/laboratories goes beyond the scope and target group of the BSR STARS S3 project.

2.1 Denmark / Greater Copenhagen

In Denmark test and demonstration services to SMEs in the bioeconomy are predominately provided by the GTS institutes (technological service centres, "GTS – Advanced Technology Group"). The GTS institutes do not have funding available to cover or co-finance companies costs of hiring lab facilities. Therefore, either the companies must pay for the test services on commission basis or they may apply for public support.

The key financial incentive scheme in Denmark for companies seeking support to benefit from test and demonstration infrastructures is **InnoBooster**. Under this scheme entrepreneurs and SMEs can apply for project support to develop a new product or service that currently is not on the market – or alternately to significantly improve production processes to increase company competitiveness. More specifically companies can get support to engage expertise – including advisory services and use of test and demonstration infrastructures. Successful applications may receive between DKK 50.000 and 5 Mio in support from InnoBooster[3].

[3] http://innovationsfonden.dk/da/investeringstype/innobooster

Another support programme is one targeting the food industry – the "Green Development and Demonstration Programme" (Grønt Udviklings- og Demonstrationsprogram, **GUDP**). This programme provides public and private partners (including SMEs) in the food industry with support for applied research, development, demonstration and networking. The period of funding may be up to 4 years and amount to DKK 0,25 to 15 Mio depending on the type of activity[4].

Also, there is the funding programme Environmental Technology Development and Demonstration Programme (Miljøteknologisk Udviklings- og Demonstrationprogram, **MUDP**). This programme does not target any particular industry but is open to public and private partner from all sectors to co-finance costs related to development, testing and demonstration of environmental technologies[5]. And finally there is a support programme targeting the energy sector, namely the Energy Technology Development and Demonstration Programme (Energiteknologiske Udviklings- og Demonstrationsprogram, **EUDP**). Here companies can benefit from support to test and demonstration of energy solutions with potential to accelerate a transitions away from the fossil-based society[6].

GTS – Advanced Technology Group

A total of 7 GTS institutes offer a range of services to companies throughout the country, including: knowledge, technology and consultancy, co-operation on technological and market-related innovation, and testing and demonstration.

As mentioned above the GTS institutes do not have funding available to cover or co-finance companies' costs of hiring lab facilities. Therefore either the companies must pay for these services on commission basis or then may apply for public support schemes.

The following GTS institutes provide test and demonstration services targeting the bioeconomy:

Bioneer A/S

Bioneer A/S was established in 2003 as a spin-out of the Danish Technical University (DTU). It is an independent research-based service company within the areas of biomedicine, biomedico technology and biotechnology – with a strong focus on the health and pharma side of the bieconomy. Bioneer perform contract research, research-based service and licencing and advisory support.

Product development and test services is an important component of efforts. Bioneer aims to act as catalyzer for effective utilization of Danish biotechnology research – and aims thereby to support the Danish governments ambitions for biotechnology as a driver for future growth.

Key areas of work are: Mammalian cell technology; Immune targeting; Protein Manufacturing; Drug

[4] http://naturerhverv.dk/tilskud-selvbetjening/tilskudsguide/groent-udviklings-og-demonstrationsprogram-gudp/#c5712
[5] http://ecoinnovation.dk/tilskud/soeger-du-tilskud-under-mudp/
[6] https://ens.dk/ansvarsomraader/forskning-udvikling/eudp

Development; Dynamic gastric model; and Biomarkers.[7]

As a member of the GTS network companies (big and small) are offered to collaborate with Bioneer in product development, for example to prove the feasibility of a new medico technology or to develop and test a pharmaceutical product for side effects. The costs of product development are covered by Bioneer (through government support) whereas the companies themselves need to pay for the actual testing. However, Bioneer often supports companies in attracting co-financing for testing expenditures, such as through national schemes like Innoboost[8] and European Union programmes like Eurostar[9].

DHI Water and Environment

DHI is an independent international advisory and research organisation. DHI's objective is to address water and environment challenges around the world by advancing knowledge, technological development, and competence building – and share this knowledge globally with customers, partner and society.

DHI offers a range of services within advisory services, modelling tools, chemical and biologic laboratories, testing facilities, and measuring and fitting programmes. DHI employ 1.000 people around the world. Key competences include: Aquaculture, agriculture, climate change, surface and ground water management, industrial production and technology; product safety and environment, ecosystem management and software-related water management for marine, urban and industrial water usage.

DHI engage in research and innovation activities through partnership in projects (such as under Horizon 2020) and through commissioned work. Generally, the commissioned work tend to involve assessments (including test and demonstration at DHI labs and at labs located at other GTS institutes, universities etc.) of processes or products that are nearing the commercial stage. DHI also offers certification services.

DHI has no own funds to co-finance costs for test and demonstration services for SMEs. However, often DHI supports SMEs with information or through partnerships to access governmental support schemes, including InnoBooster presented above.

DTI Danish Technological Institute

For more than 100 years DTI has worked to develop, utilize and communicate research and technology-based knowledge for the benefit of Danish companies. These efforts happen often in cooperation with education and research institutions in Denmark and internationally.

[7] www.bioneer.dk
[8] www.innovationsfonden.dk/en/investment/innobooster
[9] www.eurostars-eureka.eu

It is a key objective for DTI's to ensure that new knowledge quickly is transformed into value for its customers in the form new of improved products, materials, processes, methods and/or ways of organizing.

DTI offers consultancy and services to more than 15.000 company clients annually, within a large range of business areas, including: agri-business, chemical and biotechnology, climate and energy, food & packaging and material technologies.

Also, DTI has an extensive amount of 69 testing laboratories, including in areas of calibration; eco-design and eco-labelling; energy efficiency; feed, food and ingredients; piping systems; and renewable energy[10].

In 2016, AgroTech became part of DTI. AgroTech aims to transforms science into business through knowledge-based consultancy, technological services and innovation within the fields of environment, plants and food. Customers are technology companies, nurseries, food companies, food service, plant breeding companies and public customers[11].

With testing and demonstration AgroTech provides services e.g. within areas of plant production optimization, test and validation of field equipment, soil and plant analysis, product development and testing of agricultural technologies; environmental technology verifications; and development of biomaterials from plant fibers and biomass residuals.

Overall, in the area of biobased business DTI offer services in the full chain of the bioeconomy: Biomass (e.g. algae, straw, grass, manure and food residues); Technology (e.g. fragmentation, insect conversion, fermentation, and extraction); and Products (e.g. feed, food, materials, packaging and building materials).

More specifically DTI[12] (and AgroTech[13]) test and demonstration facilities focusing on the bioeconomy include:

AgroTech Labs

Five labs – the Biotechnological Service Laboratory, the Plant Pathological Laboratory, the Foodture Lab, the Microalgae Lab, and the Greenhouse Laboratory – support in various ways test and demonstration. This includes biotechnological field trials, developing environmental technology, testing of prototypes to make products or processes market-ready, farm stall and biogas technology development, and development of new foods.

[10] www.dti.dk
[11] www.agrotech.dk
[12] www.dti.dk/services/, www.dti.dk/biobased-society/35083, www.dti.dk/marine-biomass/34510, www.dti.dk/services/wood-and-bio-based-materials/31755, www.dti.dk/testing/, www.dti.dk/testing/www.dti.dk/services/chemical-analyses/31464
[13] www.agrotech.dk

Danish Meat Research Institute

The Danish Meat Research Institite (DMRI) support SME's with equipment and IT solutions for measuring quality of slaughter animals for classification or sorting purposes. This includes solutions for foreign object detection, automation, bone fragment removal, predictive model for meat and food safety and more.

Other test and demonstration services and facilities include: design of meat processing facilities, animal feed, food safety, ingredients, hygiene design, meat products and product development, and production optimisation in meat and fish industries[14].

Biobased society

In this line of activities DTI focus on building up competencies and facilities to utilize biomass more efficient. The different biomasses covers algae-, food-, grain-, manure-, straw-, and wood- that can be pretreated, processed, tested and investigated. For example, for wood, the biomass laboratory offers accredited tests of wood pellets; we i.a. test the water and ash content. On the pilot production system wood can also be pelletized and the pelletation properties tested. For straw, facilities enable polymer and fibre fractions extraction properties analysis to determine use the fibre materials.

Biomass Processing Technology

In this line of activities DTI offers a number of laboratories and pilot production systems for various tests and production processes. For example there are facilities for testing bioconversion with insects like insect cultivation and laboratories for characterization of substrate for insect production (biomass) and insect-based products (e.g. food and feed). Another example is within enzymes where tests can be done to develop biobased products with maximum value creation such as proteins and lipids based on by-products from food and farm products and aquatic biomass. At DTI in Sdr. Stenderup is sited a 1.300 m2 test facility for testing and production in pilot scale. This gives companies the opportunity to try out new formulas, ingredients and additives for animal- and fish feed and food. In the pilot production companies can carry out tests in a controlled atmosphere and gain reliable data. This provides a unique opportunity to have confirmed whether a product is ready for market. DTI also has a biorefinary at pilot scale within wood and biomaterials. By means of dry fractionation it is possible to achieve a separation of high-fibre fractions (mainly from the stem). These fractions can be processed additionally or be used e.g. for the preparation of fibre plates.

Products of Biomass

In this line of activities DTI one the one side work to inspire companies to pursue new opportunities in the biobased society. Dialogue and showcasing is one instrument used. More practically DTI also works with companies on e.g. fermentation tests and development of digestion processes in relation to energy carriers such as ethanol, butanol and biogas, and tests verifying to which degree it is possible to extract proteins from a by-product that can be used to boost the protein content in feed.

[14] http://www.dti.dk/services/equipment-and-it-solutions-dmri/36913

At DTI extraction of fibres and biopolymers from plant feed-stock takes place and can be used for building materials. By dry fractionation of annual plant raw material such as straw or other crops and processing are adjusted to optimise the fibre and/or biopolymer properties.

The extracted fibres can be used to make new products or to replace e.g. wood fibres in existing products.

FORCE Technology

FORCE Technology provides a range of technology consulting services – including testing and demonstration. This happens within six areas: Energy, Oil and gas, Maritime sector, Manufacturing, Service sector, and Infrastructure.

FORCE's cooperation with companies takes many forms – from contract works on commercial basis to research and development projects. In many cases FORCE supports companies in attracting public funds for innovation activities, and FORCE also partners with companies to attract national and European Union R&D funds.

FORCE has a number of facilities for testing and demonstration on site, including laboratories where companies for example can have tested fuels and fuel residuals; content of hazardous substances; food items; and properties of plastics and composites.

In the *Energy* field FORCE offers consultancy and services in a number of areas from fuel analysis and emission measurements to the planning and design of complete biomass and waste facilities. Force also provides certification services, as well as courses and training for employees working at biomass and waste facilities.

In *Manufactoring* FORCE is active in 7 business areas: Biotechnology and pharma; Construction materials; Consumer products; Food; Chemicals; Machinery and metals; and Plastics, composites and rubber[15]. Analyses and consulting is offered on e.g. technology and product development, product and service resource optimisation, product safety, environmental profiles and critical environmental issues; and documentation and communication of such testing and demonstration for marketing purposes.

FORCE *Chemical Analysis Lab* can support companies by performing environmental analysis of e.g. air and water, characterization of fuel and residual products, contents of harmful substances in toys and jewels, and identification and characterization of metal alloys, plastics, composites, rubber and foods.

[15] www.forcetechnology.com

2.2 Norge / Sør-Trøndelag

In Norway test and demonstration infrastructures are predominately provided by The Industrial Development Corporation of Norway (SIVA), the Norwegian Research Council and The Foundation for Scientific and Industrial Research (SINTEF)

On initiative of SIVA, the Norwegian Research Council and Innovation Norway a new **funding programme** – **Katapult** – has come into effect from 2017 with a budget of NOK 50 Mio per year. The programme supports test and demonstration activities in companies with a view to develop further conceptual ideas and make them market ready.

The test and demonstration centres will be managed by Siva. No decisions have been made so far as to what specific industries the centres will target – as the government wish for this to be demand-driven based on company interest.

Before Katapult there were no innovation voucher-type support programmes in Norway co-financing test and demonstration activities of SMEs[16].

SIVA

The Industrial Development Corporation of Norway (SIVA) is a government owned entity responsible for government investment in incubators, science parks, industrial parks and real estate through partial ownership of other companies. SIVA aims to stimulate economic growth, through strengthening Norway's capacity related to innovation and creativity.

SIVA is headquartered in Trondheim. Key activities of SIVA is to support business start-ups through incubation – and to provide businesses with access to expertise, networks and an academic and social community to facilitate growth, cooperation and development.

Development of industrial test arenas for future industries is a strategic priority for SIVA. So is the strengthening of regionale arenas for commercialization of research and ideas from the business sector[17].

The Research Council of Norway

The Research Council promotes an integrated R&D system that supplies high-quality research, develops knowledge for dealing with key challenges to society and the business sector, fosters dynamic interaction within the R&D system nationally and internationally, and creates a framework for learning, application and innovation[18].

The Norwegian state provides basic funding to 48 research institutes each year under the public funding scheme administered by the Research Council. The institutes fall in four areas (Technical-

[16] http://siva.no/wp-content/uploads/2015/03/norsk-katapult-forslag-til-program-1.pdf
[17] www.siva.no
[18] www.forskningsradet.no

industrial institutes; Primary industry institutes; Social science institutes, and Environmental institutes). A number of these institutes provides test- and demonstration services for companies in the bioeconomy:

NorBioLab and Paper and Fiber Research Institute

NorBioLab is a national laboratory for biorefining. NorBioLab is organised as a project led by the Paper and Fiber Research Institute, and financed by the Norwegian Research Council and the partner organisations. Key partners are the Norwegian University of Science and Technology (NTNU), SINTEF and the Norwegian University of Life Sciences (UMB).

NorBioLab aims to strengthen cooperation between national stakeholders involved in the development of processes for sustainable conversion of Norwegian land and sea-based biomass into new, environmentally friendly biochemicals, biomaterials and bioenergy products. With advanced research tools, the laboratory aims to help develop new climate - and environment - friendly processes and products based on forest, agricultural and marine biomass, and to verify new technological processes before further implementation. NorBioLab is available to national and international universities, institutes and industry.[19]

NorBioLab focus in particular on providing testing and demonstration services within biofuel and energy but the area of food and feed and biochemicals is increasingly becoming important business areas.

NorBioLab provides its services to companies on commercial contract basis as well as by engaging in research and development projects with co-financing from national and European Union partners.

Beyond leading NorBioLab, PFI support business development in the bioeconomy in a number of ways. Located in Trondheim, PFI is a centre of expertise for fibre, pulp and paper, wood fibre composites and sustainable woodbased biofuels and biochemicals. PFI is organized in 4 lines of research and business: Fibre and PulpBiorefining and Bioenergy; Nanocellulose and carbohydrate polymers; and Biocomposites[20].

PFI works closely with industry. A testament to this is the new innovation cluster "The Forest industries of Trøndelag" which in 2016 was awarded the status as a national arena for innovation. PFI is one of the partners in this effort involving 46 companies, with efforts focused on innovation and product development based on wood fibres.

PFI is for 5% owned by the Norwegian Pulp and Paper Industries and for 95% by Swedish Innventia (now part of RISE, refer chapter on Sweden). As a result of this ownership PFI engage in a number of Nordic and Baltic Sea Region cooperations[21].

[19] www.pfi.no/Biorefinery/Biorefinery-Projects/NorBioLab/
[20] www.pfi.no
[21] E.g. Interreg project "BioRaff – mer av Trä", http://www.interreg-sverige-norge.com/?portfolio=bioraff-mer-av-tra

Nofima

Nofima is a large institute for applied research within fisheries, aquaculture and food research. Research and solutions are provided in a number of ways to develop competitive advantages along the complete chain of value in this part of the bioeconomy. Nofima is headquatered in Tromsø, with research activities in Alta, Bergen, Stavanger, Sunndalsøra, Tromsø and Ås.

As part of services Nofima organizes symposia, courses and seminars where our scientists share their expertise with food producers and others.

Also, Nofima is home to a number of laboratories and pilot plants. Companies can use these facilities to carry out experiments and to test production methods. For example: BioLab offers analytical services in chemistry, microbiology and physical measurements; Biotep offers hi-tech companies access to test and optimize their processes for extraction of components from marine- and plant-based biomass; and in Patogen Pilot Plant scientists study life-threatening bacteria such as Listeria and E. coli in a realistic production environment, thereby assisting e.g. food companies in preventing serious food poisoning.[22]

One of the Nofima test and demonstration infrastructures is Nofima BioLab which is an accredited contract and research laboratory located in Bergen. BioLab offers analytical services in chemistry, microbiology and physical measurements, using its expertise in marine raw materials and products. Key competence areas are raw materials, process development and products in marine and vegetable ingredients for feed and aquaculture as well as for human use.

Another test and demonstration infrastructures of Nofima is Biotep located in Tromsø. Biotep is mini-factory where high technology companies can test and optimize their processes to extract all desired components from marine- and plant-based biomass. At Biotep, companies can perform test productions based on their own processes and technology. Nofima can also collaborate with the companies in the development of these processes and technology. Smaller companies can rent the facility to perform periodical or regular production. At Biotep companies can test their production on a larger scale without the risk of large investments. From the test production, a cost estimate can be made and a product prototype can be tested in the market.[23]

Barents Biocentre Lab

Also in Tromsø is the Barents Biocentre Lab that offers modern laboratories with advanced equipment for biotechnology companies, research communities and educational institutions. Barents Biocentre Lab aim to facilitate the development of biotech industry, by offering affordable laboratories and equipment for rent; by contributing to a strong biotech cluster in Northern Norway; by providing a meeting place for industry and academia; and by establishing strong national and international networks[24].

[22] www.nofima.no
[23] www.nofima.no/en/research-facilities/biotep/
[24] www.barents-biocentre.com

Barents Biocentre Lab and Biotep (refer above under Nofima) are both members of the Biotech North cluster that aims to facilitating innovation, network and businesses within the blue biotech sector. The Biotech North cluster programme is supported by the Norwegian Government.

Tel-tek

Tel-Tek is a technological R&D institute with three sets of main activities: Powder technology; CO2 capture, transport and storage; and Energy and Environment – and through four types of services: Smart Manufacturing; Tel-Tek Adacemy; Cost Estimation; and Laboratories.

In Tel-Tek Smart Manufacturing the aim is to improve production throughout the value chain in an industrial production process. A concept is applied to help companies better understand the complexity of industrial processes and product/process development, including Analysis/diagnostics; Understanding/hypothesis; Models; Simulations/Optimization; Verification; and Implementation. Laboratory services target Characterization and CO2, where companies can get access to laboratory services for modelling, simulation and experiments[25].

SINTEF

SINTEF, The Foundation for Scientific and Industrial Research, is headquartered in Trondheim but supports through a number of subsidery organisations research and development throughout Norway and this to thousands of companies annually.

The applied research, technology and innovation areas targeted by SINTEF includes:

- Renewable energy – where SINTEF partners with industry and government agencies to create more efficient, less polluting and more flexible energy solutions.
- Climate and environment – where SINFEF provides expertise and laboratories for development of environmentally friendly buildings, renewable energy, energy efficiency, and more.
- Industry – where SINTEF in cooperation with industry seeks to advance fabrication methods, automation, systems and logistics, and to develop sustainable manufacturing processes.
- Materials – where efforts target the full value chain from raw materials, to environmentally-friendly production processes, to casting and moulding, assembly etc. State-of-the-art characterisation methods and laboratory facilities are available to model and determine the structure of materials and the properties of products.
- Biotechnology – where SINTEF provides research partnerships and laboratory facilities to develop biotechnological processes used for production of a wide range of products such as pharmaceuticals, vaccines, biomaterials, enzymes, food, feed, chemicals and energy.

A number of laboratories are available for testing and demonstration in the biomass, biomaterials, biotechnology, sustainable foods and bioenergy including:

[25] www.tel-tek.no

A fermentation laboratory providing cultivation facilities with a wide range of analytical instruments, including HPLCs and several different mass spectrometry instruments. This enables metabolomics, monitoring of substrate consumption and formation of product(s) and by-products.

Furthermore:

A robotic screening facility optimized for high throughput analytical and cultivation work enables processing of thousands of samples or cultures per day.

A mass spectrometry lab enables for analysis within areas such as: biotechnology, metabolomics, protein profiling, virus studies, food/feed/nutrients, bioprocess development and optimization, bioprospecting for novel bioactive compounds, and chemical process development.

A molecular biology laboratory provides equipment for molecular biology and protein separation and equipment for protein purification. The lab is equipped with experts to assist also in topics and protocols related to genetic modification of bacteria.

2.3 Finland / Tampere region

In Finland it is the VTT Technical Research Centre of Finland, Tekes (Finnish Funding Agency for Innovation), science parks and a number of universities that provide the majority of test and demonstration infrastructures benefitting SMEs in the bioeconomy.

The test and demonstration infrastructures collaborate with SMEs – either based on commissioned work or through joint research and development activities.

Tekes offers a programme – **Innovation Vouchers** – supporting innovation activities in SMEs. "Innovation activities" refers in this programme to all measures employed by a company to develop its products, services or processes, or to acquire new knowledge and competencies required in innovation activities[26].

More specifically an innovation voucher can be used to purchase new knowledge and skills, for purchasing expert services related to innovation activities, e.g. from companies providing innovation services, universities, universities of applied sciences and research organisations. The innovation vouchers amount to a maximum of EUR 5,000 + VAT. Test and demonstration costs beyond this must be fully paid by the companies.

The Tampere Region Economy Development Agency (**Tredea**) also offer an **Innovation Voucher** scheme. This pilot programme is implemented with support from the European Union Regional Development Fund. It targets innovation in SMEs under five priorities: Renewing Industries, Smart City, Smart Mobility, IoT and Healthcare. The funds are disbursed by Tredea to pay for test and demonstration services provided by Tampere Technical University (TUT) and Tampere University of

[26] https://www.tekes.fi/en/funding/SME/innovation-voucher/

Applied Sciences (TAMK). The regional innovation vouchers can amount up to EUR 5000 per SME. Practically it works in a way where the two universities provide information in the form of "Product Cards". In these cards they offer details on the universities' test and demonstration service. SMEs can then apply for the services – using a web-based platform. If a SME is granted a Tredea innovation voucher, the regional financial support flows directly to the universities once the test and demonstration service has been provided to an SME.

The programme started in November 2016 and runs until June 2018. The scheme has received much interest with 100 vouchers disbursed in the first 3 months. The next call under the scheme will be in September 2017. Here Tredea aims to open up the programme for also non-Finnish services providers i.e. test and demonstration infrastructures in other EU countries.

For more information reference is made to the section below on Tampere University of Applied Sciences (TAMK).

Finnish universities also provide services that involve components of testing and demonstration through the **Demola** programme. Demola is a common innovation platform of the higher education institutions in Tampere. It offers companies an opportunity to develop and test their ideas together with students. The company provides a topic for a project (idea/challenge) and a student will then work for three-four months with support from a facilitator and the partner company. The result may be a demo or something else that validates the feasibility of the original idea. If the partner SME finds the outcome commercially useful, the company can acquire the right to use the results. There is also a small administration fee for the service[27].

VTT Technical Research Centre of Finland

VTT Technical Research Centre of Finland Ltd operates (non-for-profit) under the mandate of the Ministry of Economic Affairs and Employment. VTT provides research and innovation services and information for domestic and international customers and partners – within Finland and beyond. One of the four subsidiary companies is VTT Expert Services Ltd (the others being VTT Ventures Ltd, VTT International Ltd and VTT Memsfab Ltd):

VTT Expert Services Ltd

VTT Expert Services offers expertise, certification and product approval services, testing and inspection services and calibration services.

Expertise services include analysis on damage investigation and material failures; structural strength and performance; product safety and chemical analysis; and calculation, modelling and simulation services.

Certification and product approval services include e.g. fulfilment of requirements of markets, users and the authorities for food contact materials. Testing and inspection services include product and

[27] http://www.demola.net/

systems property analysis to support modelling, assessment and decision making in packaging and product safety; furniture and interior textiles; and chemical analysis[28].

Bioruukki

While VTT has been around since 1942 a more recent and very significant investment of VTT is Bioruukki. Located in Kivenlahti, Espoo, Bioruukki is a piloting centre aimed at refining biomass and demonstrating bioeconomy enabling technologies in practise. Bioruukki focus on four strategic areas: bioenergy; biochemical; biomass fractionation; and recycling.

Bioruukki supports business development in the following areas: low carbon energy solutions; efficient biomass refining; new biomass-based products; recycling and waste utilization; and sustainable chemicals – and this more specifically by offering test- and demonstration services such as:

- Thermochemical conversion: Gasification and pyrolysis test facilities and modelling of conversion processes.
- Biomass processing: Development of biomass fractionation (biorefinery) processes and novel cellulose fibre applications (including e.g. textile fibres).
- Green chemistry: New bio-based chemicals and polymers and separation technologies.
- Process concept modelling: Techno-economic feasibility studies, modelling and simulation.[29]

Tampere University of Applied Sciences

Tampere University of Applied Sciences (TAMK) offer companies a number for laboratory services for testing, analysis and product development.

Services at the *paper and packaging laboratory* include: measurement of physical and optical properties of paper and paper board; paper making and pulp analysis; calendering, coating and printing of paper; coating colour analyses and printing tests[30].

Services at the *chemistry and environmental laboratory* offers analysis and product development services; including chemical and microbiological analyses; water analyses; determination of biodegradability; and fertilizer analyses[31].

Textile laboratory offers analysis for physical properties, like tensile testing, abrasion, colour fastness or flammability. Textile laboratory offers also consulting, training and quality manuals.

Also, specialized labs are available for companies to use in collaboration with students and researchers or through rental services with the areas of construction, mechanical, physics and textiles.

[28] www.vttresearch.com
[29] www.vttresearch.com/Documents/VTT_Pilot_Bioruukki_NEW_Lowres.pdf
[30] http://www.tamk.fi/web/tamken/paper-packaging-laboratory
[31] http://www.tamk.fi/web/tamken/chemistry-environmental-laboratory

Aalto Bioeconomy – Aalto University School of Chemical Technology

At Aalto Bioeconomy – Aalto University School of Chemical Technology – research infrastructures for testing and demonstration are available against a fee for commercial use at the departments of Forest Products Technology and Biotechnology and Chemical Technology for development of chemicals, fuels, fibre products and materials from renewable biomass utilizing biotechnical, chemical and thermal processing technologies[32].

The infrastructure contains research laboratories, characterization and analysis equipment and modeling and simulation tools in the field of biorefinery and well as processing and testing of biobased materials[33].

SIB LABS – University of Eastern Finland

"SIB Labs // Science – Innovation – Business" collects and markets the expertise and equipment infrastructure in the fields of biomaterials, materials technology, photonics, spectral color research and digitisation.

SIB Labs, promote the transfer of technologies in the field of natural science and serves both research organisations and industrial partners. SIB Labs offers various infrastructures for testing and demonstration including specialised laboratory equipment. Key areas of competence are photonics and materials technology and the transfer of such competence into commercial use.

At the biomaterials laboratory at Kuopion campus research, development and services related to microscopy and biorefining are provided, including material characterization, material testing, tissue-material interactions, surface structures and compositional analyses. As regards biorefining, a growing research area at the University of Eastern Finland, key technologies include slow pyrolysis and thermal processing[34].

The main lab instruments available are for analysing different thermally treated solid biomass samples (e.g. biochar, charcoals etc...) and different thermally produced biobased distillates (bio-oil, tar, etc.). In addition to different chemical analysis instrumentation (e.g. 2D-GC-MS), SIB Labs also has instruments for analysing the structure of solid samples, such as a scanning electron microscopy (SEM) and micro-computed tomography.

Smart Chemistry Park

Smart Chemistry Park is located at Turku Science Park. Smart Chemistry Park was established in January 2015. It is an innovation platform and a cluster for start-ups and SMEs operating in the fields of chemistry, process chemistry and technology. The companies based in Smart Chemistry Park deliver novel technology solutions and business models to bio and circular economies.

[32] http://chemtech.aalto.fi/en/ and http://puu.aalto.fi/en/
[33] www.bioeconomy.aalto.fi
[34] www.uef.fi/en/web/siblabs/biomateriaalit

Smart Chemistry Park is located in Raisio, Finland and it offers office space, laboratory, test and demonstration facilities – and a broad network public sector, universities and industry partners. In Smart Chemistry Park, SMEs work independently, sharing infrastructure, equipment and know-how – with an emphasis on prototyping and proof of concept[35]. A small secretariat is established to facilitate cooperation between the partners.

The infrastructures for testing and demonstration are not owned by Smart Chemistry Park but established by the companies – sometimes in partnership with other companies, thus saving costs – and paid for by the companies themselves (with or without public support from Tekes' innovation vouchers and similar).

13 companies from the wood industry are currently co-located at the Smart Chemistry Park, with another 30 companies collaborating closely, but not collocated.

2.4 Sweden / Skåne

In Sweden it is RISE Research Institutes of Sweden (since 2016 merging Innventia, SP and Swerea) that provide the vast majority of test and demonstration infrastructures benefitting SMEs in the digital economy.

The test and demonstration infrastructures collaborate with SMEs – either based on commissioned work or through joint research and development activities.

Vinnova (Swedens innovation agency) supports testing and demonstration of products, processes or services in SMEs through an **innovation voucher scheme** (innovationscheck)[36]. Support amounts up to SEK 100.000. The innovation voucher may be used to buy external expertise from research institutions, universities or private consultants – and more specifically to investigate innovative and new business models, products, services or processes. The voucher may also be used to develop a strategy for mastering novel immaterial approaches. The vouchers are provided through innovation coaches at Almi regional business development centres, IUC (Industrial Development Centres) and Companion (regional business advisory and cooperation network).

RISE Research Institutes of Sweden

RISE Research Institutes of Sweden is a recently formed network merging a number of research and technology organisations (RTOs) that is wholly or partly owned by the Swedish state. The RTOs within RISE perform industrial research and innovation. RISE is headquartered in Gothenburg but provides its services throughout the country.

[35] www.smartchemistrypark.com
[36] http://www.vinnova.se/sv/Var-verksamhet/Innovationsformaga-hos-specifika-malgrupper/Innovativa-sma-och-medelstora-foretag/For-Foretag/Innovationscheck1/

Some of the RTOs also perform testing, demonstration and certification. RISE is organised in six divisions: RISE Bioeconomy; RISE Built Environment; RISE ICT; RISE Life Science; RISE Safety & Transport; and RISE Certification. As RISE is a recent initiative currently testing and demonstration activities and company services are provided by the RISE founding fathers, namely Innventia; the Technical Research Institute of Sweden; and Swedish ICT.

Innventia

Innventia[37] is research institute that works with innovations based on forest raw materials. The majority of operations are project-based via research programmes involving many partners or in development projects with individual customer companies. Innventia also carries out a large number of direct commissions in the form of analyses, testing and demonstration services in its lab facilities. Innventia aims thereby to produce and refine research findings and ideas based on forest raw materials, for the benefit of customers throughout the entire value chain. At Innventia they call the approach *Boosting Business with Science.*

Services to companies includes commissioned work fully paid companies (25-30% of activities) as well as joint research and innovation activities with Swedish government and European Union co-financing (70-75% of activities). Currently about 90% of activities are directed towards Nordic companies (the majority coming from Sweden and Finland, and to some extend Norway) and 10% towards the rest of the world, most of these though in the Baltic Sea Region.

A number of test and demonstration facilities are available to companies through Innnventia's infrastructure, including[38]:

FEX - a complete pilot-scale papermaking facility

The FEX system is a complete pilot-scale papermaking facility serving the pulp and paper industry and its suppliers with process studies, product development and the evaluation of new technologies and raw materials. The full-length paper machine enables customized papermaking research, and flexible stock preparation allows opportunities for endless adaptations.

In connection to the pilot-scale paper facility FEX also operates the world's first pilot facility for large-scale production of nanocellulose (a pseudo-plastic).

Pilot Plant for Nanocellulose

In 2011, Innventia opened the world's first pilot plant for large scale production of nanocellulose. The facility makes it possible to produce nanocellulose on a large scale for the first time and is an important step towards the industrialisation of this technology. Having the capability to produce larger volumes means it is now possible to study the use of nanocellulose in applications that demand significant amounts of material.

[37] www.innventia.com
[38] www.innventia.com/en/Our-Ways-of-Working/Demonstration-and-pilot/FEX/

Lab and test extrusion equipment

Extrusion is the used for e.g. producing plastic components with a specific profile or shape. Within the packaging industry, extrusion is also used to create plastic films or to coat other materials with a layer of plastic, aiming for example to protect products from moisture or air transmission, or to weld together packaging made from board.

A *minilab extruder, medium sized lab extruder, pilot extruder* and *injection moulder* enables studying, development, testing and small scale production of new bioplastic materials and what their formulation should be for subsequent upscaling in commercial production when developing new plastic mixtures or composites for e.g. films, coatings and fibres; for developing processes for gravimetric feeding, liquid injection, degassing, air or water cooling and pelletizing; for developing existing material mixtures, testing and evaluating new plastics; and for supporting development of methods for producing plastic details.

Packaging Test Centre

At the Packaging Test Centre transport testing can be carried out to ensure that product packaging protects the product against the stresses it is exposed to in the transport chain. For example, this involves changes in climate, drops and bumps, storage for varying periods of time, and vibration during transportation.

The Packaging Test Centre also carry out packaging testing on, for example, pallets, shock-absorbing materials and box constructions.

LignoBoost demonstration plant

The LignoBoost demonstration plant in Bäckhammar opened in 2007. It is owned and operated by a subsidiary to Innventia, LignoBoost Demo AB. At the plant assignments are carried out for clients wishing to evaluate their own black liquor or the lignin product from it. It is also possible to perform large-scale product- and process development at the LignoBoost Demo plant. A new initiative, called LignoCity, aims to further develop the demonstration plant and make it an open test bed for companies who want to evaluate and validate new refining concepts in the lignin area.

Cooking and bleaching equipment

A flexible digester-system enables test and demonstration of pulping processes with injections, withdrawal and displacement of cooking liquor/s at controlled compositions, temperatures and pressures. For example companies can have studied delivery losses in industrial pulping; and they can test production of large volumes of cooking liquor and pre-treatment liquids in alkaline or acidic conditions as well as pulp fibres or other materials.

Multifilament extruder and carbon fibre lab

This lab enables testing of conversion of lignin into carbon fibre in different ways – including to

screen the processability of fibre conversion. At the lab new efforts are ongoing to also design a laboratory device where lignin fibre can be semi-continuously stabilized and carbonized. Furthermore, the lab works with converting other materials than lignin, in particular cellulose.

Innventia is also working towards a large pilot plant facility to continuously convert lignin into carbon fibre.

Swerea

Swerea is the Swedish Research Institute for Industrial Renewal and Sustainable Growth – and a part of the RISE network. Swerea supports industrial renewal and sustainable development. Its objectives are to create, add value and disseminate research results in material development, process and product development – and this is close cooperation with academia, business and society. Swerea consists of five subsidiaries each focused on different research areas such as composites, polymers, metals, ceramics and textiles.

Swerea support companies with testing and demonstration through smaller facilities as well as large test and demonstration infrastructures. Associated researchers support the companies with preparation, implementation and evaluation as well as in making proposals for solutions and improvements.

Swerea SICOMP - Composite Laboratory

Swerea SICOMP is a part of the Swerea group and employs 50 persons with expertise in polymer composite materials and the following three technology areas: dimensioning, manufacturing and material.

The facilities of Swerea SICOMP are situated in three locations in Sweden: Piteå, Linköping and Mölndal and houses large-scale test and demonstration equipment for the development and evaluation of new lightweight composite materials, applications, and production concepts. It is one of the largest composite institutes in Europe. Some examples are: robotic cells for advanced manufacturing and handling, equipment for material analysis and characterization, process equipment for filament winding, injection moulding, biocomposites, high temperature composites as well as facilities for crash testing. Alongside the physical testing facilities the laboratories houses advanced simulation tools for design and virtual manufacturing.

The Composite Laboratory focus on a variety of state of the art material systems, thermoset and thermoplastic polymers used as well as future materials, some examples being high temperature carbon nanotubes and biocomposites. Equipment is available for the development of test materials, the measurement of the chemical and mechanical properties of materials, and the development and testing of industrial-scale production methods.

Test- and demonstration services for SME's are provided both as commissioned work (often in the case of design, calculation and material testing) and through collaborative development efforts between Swerea SICOMP and industrial partners. About 15% of Swerea's total budget is funneled

from RISE and designated for strategic development. The majority of funds are coming from national and European research programs, industry and research institutions.

Thus, Swerea SICOMPs test beds are open to companies – Swedish and foreign. In practice, the vast majority of the customers are Swedish companies – though collaborations are since many years established with a number of international laboratories as well as some of the larger European industries and research organizations within the aerospace and automotive sector[39].

Technical Research Institute of Sweden, SP

SP Technical Research Institute of Sweden – also part of the RISE network – works closely with companies to create value, delivering high-quality input in all parts of the innovation chain, thereby assisting industrial competitiveness and sustainable development.

SP is headquartered in Borås (Gothenburg) but operates out of 30 sites all over Sweden, including through services to industries in Chemistry, Materials and Surfaces. Here services include problem solving, damage analyses, tailor-made and standardised tests, and evaluations. SP is also involved in a large number of research projects, often in collaboration with industry, other institutes, and academia, including within organic and inorganic analysis, surface characterisation, environmental analysis. Basic and applied research include advanced analysis and material characterization, biomaterial and diagnostics, and product durability[40].

SP Processum

SP Processum AB started in 2003 and is now Swedens leading biorefinery initiative. SP Processum support and initiate research and development regarding biotechniques, energy techniques, inorganic and organic chemistry and sustainable raw materials.

SP Processum is owned by RISE (60%) and a group of 20 companies (40%) and have two overall lines of business: biotechnology and organic chemistry. Historically most research, test and demonstration efforts has been in the area of refining lignocellulosic biomass and residual streams from the pulp industry but efforts are now also involving biomass from agriculture (straw for example).

SP Processum collaborates closely with industry (big and small), providing contract services for laboratory use, demonstrations, use for analysis instruments and for running pilot trials in its pilot equipment. Services include research experiments, analyses and verification of product and process ideas in laboratories; pilot facilities for biomass pre-treatment; fermentation; chemical processes; and downstream processing. At the Biorefinery Demo Plant in Örnsköldsvik, Sweden, companies can test conversion of biomass to final products like e.g. carbohydrates, lignin, proteins, enzymes, chemicals, material and ethanol – and have other tests and demonstrations undertaken needed for product or process development and market introduction.

[39] www.swerea.se
[40] www.sp.se

Already today SP Processum collaborates with a number of other partners in the biorefinery industry in the Baltic Sea Region, including with partners in Finland, Iceland and Norway. SP Processum cooperates in biorefinery projects with universities and research institutes as well as with private companies. Important is that good and successful ideas are turned into process and products and brought to the market[41].

ETC Energy Technology Center

The Energy Technology Center (ETC) located in Piteå provides both research work and professional services to the academia, public agencies, and industry[42].

The focus area of research for ETC Energy Technology Center is thermo-chemical conversion of biomass. Technology services provided relate to applications in combustion, gasification, and bio-refining processes. The site in Piteå is located next to the paper mill Smurfit Kappa Kraftliner.

In more details key competence and capability areas of ETC include:

- Pretreatment and feeding of biomass.
- Sampling and diagnostics in conversion processes.
- Process modelling.
- Analyses for conversion products.
- Spray characterization.
- Upgrading of syngas.

By providing tailor-made experiments, advanced computations, and in-depth investigations, ETC aims to be a pioneer in providing tomorrow's energy solutions for sustainable development.

RISE Agrifood and Bioscience

The Agrifood and Bioscience unit (formerly SIK – The Swedish Institute for Food and Biotechnology) conducts strategic and applied research on behalf of industry in accordance with an industry-driven research programme and also in the form of contracts and joint projects. This includes product development and testing, process engineering such as development and adaptation of processing technologies, and environmental impacts analysis of products, production facilities and transportation – and this along the entire food chain, from farm to fork. The unit also runs a development program for bioeconomy food chain for the future[43].

The Agrifood and Bioscience unit support agriculture, food and bioscience companies at all levels of their innovation process – from business analysis, to problem solving, to competence development and product development.

Lab facilities are available for different food science competences and the unit also have pilot plant facilities and test and demo facilities for GreenCleaning, InfraRead processing etc.

[41] http://www.processum.se
[42] http://www.sp.se/en/units/risebio/etc/Sidor/default.aspx
[43] https://www.sp.se/en/units/risebiovet/fb/Sidor/default.aspx

Companies may benefit from these facilities through commissioned work and through participation in joint (research) projects with the RISE Agrifood and Bioscience unit. The unit also works with solutions for attracting funds to support development costs for SMEs (e.g. innovation vouchers).

The services and test facilities of the Agrifood and Bioscience unit are open to both domestic (65% of turnover) and international (35% of turnover) companies. Also, collaborations are well established with a large number of universities, laboratories and test centres in the Nordic and Baltic Sea Region. These partnerships mainly focus on research cooperation and joint EU-programs, but also on development issues on food production infrastructure and facilitating business cooperation.

SP Biofuels

SP Biofuels focus on production and use of renewable motor fuels. Research projects are carried out within seven competence areas, and in some of these areas services include testing, inspection and development assignments for companies[44].

One example is biogas where laboratory work support also business innovation through testing and demonstration of anaerobic digestion of different raw materials, optimization of the production process and development of measurement methodologies for analysis of biogas quality.

Another example is efforts to develop algae production for biofuels. Here companies in cooperation with SP Biofuels can have tested and demonstrated how lipids in algae can be extracted for biodiesel production, use of carbohydrates for ethanol production, and use of parts of whole algae cells for biogas production.

In some cases SP Biofuels works fully on commission for companies and in other cases SP Biofuels collaborates with companies in project funded research activities. Also, SP Biofuels seeks to support companies in applying for financial support to offset some of their test- and demonstration costs. Furthermore SP Biofuels attract EU funding. Currently for example SP Biofuel engage in different international cooperation project including the EU-funded project "European Research Infrastructure for Circular Bioeconomy" (ERIFORE)[45].

Örnsköldsvik Biorefinery Demo Plant
At the Biorefinery Demo Plant in Örnsköldsvik companies are able to test all the necessary steps to convert biomass to final products like e.g. carbohydrates, lignin, proteins, enzymes, chemicals, material and ethanol. The plant is open to all kinds of customers, such as national and international companies, universities and institutes. Customers and partners can scale up their research, fractionate biomass or produce larger amounts of intermediates or products needed for development and market introduction[46].

[44] www.sp.se/en/centres/spbiofuels/Sidor/default.aspx
[45] http://erifore.eu
[46] http://www.ri.se/erbjudanden/testbaddar-och-demonstratorer

LUBRIC – Lund University Biobased Research Centre

Biobased waste streams from food-, forrest-, and agriculture industry is an important foundation for a sustainable bioeconomy. At LUBIRC (Lund University Biobased Industry Research Center) efforts target optimal use of land and available feedstocks without risking food supply[47].

LUBIRC is a research center at Lund University within the field of Industrial Biotechnology and Biorefineries. The aim is to promote the growth of a bioeconomy-based industry starting in the Öresund region, building on the combined competence of researchers at Lund University together with industry, public organizations and other scientists. The center aims to gradually increase to cover a wider region including Nordic countries and Europe.

LUBIRC has initially been supported by Region Skåne and Lund University and collaboration has been introduced with SLU Alnarp and IKEM - Innovation and Chemical Industries in Sweden.

The Process Development Unit (PDU) is sponsored mainly by the Swedish Energy Agency and used for research. The PDU group has a long and successful tradition within the lignocellulose-to-bioethanol, but also in biorefeinery applications.[48]

2.5 Lithuania[49]

The Lithuanian Agency for Science, Innovation and Technology provides SMEs support to research and innovation activities through **Innovation Vouchers**. The programme is a component of Lithuania's Operational Programme for EU Structural Funds Investments for 2014-2020.

The Innovation Voucher provides for companies to buy R&D expertise or knowledge from research institutions with a view to speed up knowledge transfer and commercialization of research results. Companies may receive up to EUR 5.682 and 70% of eligible costs

Testing and demonstration is not specifically mentioned in the programme – the reason being that Lithuania currently do not have many of such technological service institutions. Rather, collaboration between SMEs and companies takes place in the form of joint research and entrepreneurship incubation activities at a number of university research institutions/centers. The universities and research institutes have recently established what is called "open access R&D centres/laboratories", where business and public partners can access the R&D resources, advanced technologies and get advanced knowledge services. The "Open R&D Lithuania network" is a cooperation between 14 Lithuanian Universities, 13 Public Research Institutes as well as 8 Science and Technology parks.

[47] http://www.lth.se/lubirc/saa-haer-kan-vi-samarbeta/
[48] http://www.chemeng.lth.se/pdu/
[49] This chapter on was drafed with kind support of the Nordic Council of Ministers Office in Lithuania.

Kaunas University of Technology

Kaunas University of Technology (KTU)[50] is has two Centres of Science, Studies and Entrepreneurship, also called the "Santaka" and "Nemunas" valleys. Santaka and Nemunas is part of the National Innovation and Entrepreneurship Centre located KTU (since 2014) and they provide a hub in Lithuania for applied scientific research and innovation in Lithuania.

KTU key areas of expertise are within physics, technological and social sciences, as well biomedical sciences and humanities and experimental development. KTU research and development activities is organized around 10 research institutes. Some of these have activities that relate to testing and demonstration of products, services or processes in the bioeconomy.

For example the Food Institute/Food Research Centre is accredited to perform analysis of food materials, and physical, chemical and microbiological analysis of products and water. Also at the institute other types of assistance is available for product development and market introduction (including prototyping and evaluation/analysis).

Another example is the Institute of Environmental Engineering (APINI). APINI performs research in the fields of sustainable development and environmental protection. The majority of activities are in the field of applied/practical engineering as well management and political solutions related to environmental quality issues. APINI's mission is "to disseminate sustainable development principles in Lithuania and all over the world through application of innovative sustainable solutions by means of interdisciplinary research, topical studies and continuous spread of knowledge and values". Research areas includes cleaner production; environmental management systems and standards; eco-design and life cycle assessment (LCA); and integrated waste management.

Vytautas Magnus University

At Vytautas Magnus University research activities in biomedicine and physics support innovation in the Lithuanian bioeconomy. Research areas include: Biophysics for Bio-nanotechnology and Biomedicine (BIOMEDTECH), Alternative Energy, Molecular Bioenergetics, and Analysis Methods of Safety, Reliability and Risk[51].

Vilnius University

Research areas at Vilnius University includes Diagnostics and Treatment of Diseases, Genomics, Biomolecules and Biotechnologies, Changes in Ecosystems, Protection, Natural Resources, and New Functional Materials and Derivatives.

[50] http://ktu.edu/en/institute-materials-science/

[51] www.vdu.lt/en/about-vmu/

Companies and other organizations can collaborate with Vilnius University through joint research activities, commissioned research services, use of research infrastructure and services at Open Access Centres – including assistance with licensing inventions and patent applications[52].

Vilnius Gediminas Technical University

Vilnius Gediminas Technical University (VGTU) is a leading university in technological science. Scientific research and experimental development is performed by 14 institutes, 2 research centres and 34 research laboratories.

The main VGTU initiative targeting product development and prototyping is the Creativity and Innovation Centre, "LinkMenų Fabrikas", that aim very practically to nurture research and innovative ideas into commercial products, services or processes. However, currently at LinkMenų Fabrikas the emphasis is on audio, electronics, metal engineering, picture, color and paint[53].

Aleksandras Stulginskis University

Aleksandras Stulginskis University (ASU) has currently over 5000 students in a wide range of study programmes of biomedicine, technologies and social sciences. ASU is the only university in Lithuania awarding degrees at PhD, MSc and BSc levels in the fields of food sciences, agriculture, forestry, water and land resources management, bioenergy and mechanical engineering, climate change and sustainable use of natural resources[54].

ASU research areas include:

- Agro-biotechnologies, development of plant varieties and assessment of their genetic potential; Quality of environment, climate change; Bioenergy, chemical and biotechnological processes; Sustainable agriculture and rural development.
- Food safety and security.
- Sustainable technologies for agriculture, forestry and water management, sustainable use of resources.

Center for Physical Sciences and Technology

The Center for Physical Sciences and Technology (FTMC) is the largest scientific research institution in Lithuania with the areas of fundamental research and technological development in laser technologies, optoelectronics, nuclear physics, organic chemistry, bio and nanotechnologies, electrochemical material science, functional materials and electronics[55].

The main activity of FTMC is to carry out fundamental and applied research as well as experimental investigations in the fields of physics, chemistry and technologies – to the benefit of the Lithuanian society and economy.

[52] www.vu.lt , www.vu.lt/en/research/intellectual-property-and-innovations/for-business
[53] http://linkmenufabrikas.vgtu.lt
[54] www.asu.lt
[55] www.ftmc.lt/en/science/directions-of-scientific-activity

FTMC has both a large pool of laboratory facilities and experts, including 38 habilitated doctors of science, 246 doctors of science, more than 500 researchers and 60 PhD students. In January 2017 more than 300 scientific investigations were ongoing commissioned by companies.

Key areas of scientific expertise in the digital economy space include development of new optoelectronic devices as well as electronics and sensors.

The State Scientific Research Institute Nature Research Centre

The State Scientific Research Institute Nature Research Centre (NRC) is specialized in the area of research in ecosystems, as well as studies and development of environmental protection technologies. In co-operation with representatives of business, government and society, the Nature Research Centre conducts contracted scientific research and experimental development work[56].

3. Summing up and what's next…?

As mentioned in the introduction the background for this mapping is that the Baltic Sea Region seem to have a number of test and demonstration infrastructures that are available for SMEs for researching, developing, prototyping, amending, evaluating, certifying and marketing a product, service or process technology or application in the bioeconomy. Q.E.D.[57] – that is indeed the case.
It appears from the analysis that there is quite many – and a growing number of – test, demonstration and verification infrastructures in the Baltic Sea Region that SMEs can benefit from when attempting to commercialise new products, services or processes in the bioeconomy.

It also appears that there are both overlapping and complementary areas of test and demonstration excellence relevant to SMEs in the bioeconomy in regions and countries around the Baltic Sea Region.

Looking at complementarities, very generally, Denmark has a stronghold in test and demonstration infrastructures in the agriculture-based bioeconomy; Norway has such stronghold in the maritime-based bioeconomy; and Finland and Sweden has particular in test and demonstration infrastructure excellence in the forestry-based bioeconomy. This provides opportunities for SMEs in the Baltic Sea Region to access technology services that in some cases will be better tailored to their specific needs by simply seeking test and demonstration services across borders, rather than just at home. That is of course if the SMEs know where to go…

It also appears that test and demonstration infrastructures in Lithuania are developing – including with encouragement from an innovation voucher scheme. Still, Lithuania have some way to go to reach the level of test, demonstration and verification infrastructures that are available to SMEs in Denmark, Finland, Norway and Sweden. This offers opportunity for transnational experience

[56] www.gamtostyrimai.lt/en/projects/iimtepp_1
[57] Quod Erat Demonstrandum, meaning "what was to be demonstrated"

exchange across the Baltic Sea on the “nuts and bolts” for successfully delivering test and demonstration services to SMEs in the bioeconomy economy. It also offers further arguments for encouraging SMEs in Lithuania to acquire test and demonstration services in neighbouring countries.

This report was prepared to provide a basis for dialogue – among policy makers, practitioners of testbeds and SMEs (as the users) on testbed policy approaches – on opportunities for benefitting from joint and complementary areas of bioeconomy economy testbed excellence in the Baltic Sea Region.

This dialogue will be commenced in connection to the presentation of this report at the macro-regional seminar in Tampere on 6 April 2017. To further set the stage for dialogue, as a first next step a **Discussion Paper** will be made available to participants at the seminar. The discussion paper will include a set of practical recommendations to enhance cooperation among bioeconomy testbeds in the Baltic Sea Region.