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REGION BLEKINGE

Innovation Testbeds and Opportunities for Blekinge

Kickstart S3 Pre-Study Report

In English

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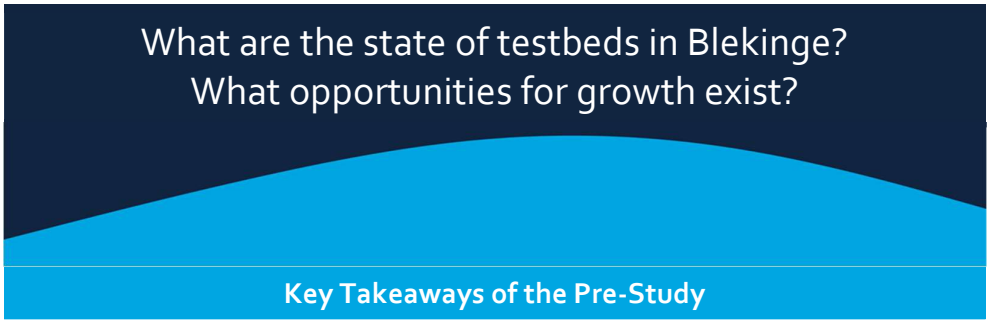
1 Overview

This pre-study aims to describe the state of testbeds and test facilities across the region of Blekinge, recognize some obstacles specific to testbed success, and present possible opportunities for regional growth aligned with the regional strategy for smart specialization, which was started by the Kickstart S3 project. The pre-study draws on 28 interviews and existing research of testbeds for a preliminary regional analysis.

This report will prove most useful for:

- Regional business leaders and startup teams curious to learn what type of test facilities are available and the level of thinking about test environments in Blekinge.
- Public sector authorities and city managers who want to support regional economic development using testbeds as one part of a greater innovation ecosystem, aligned with national and international insights.
- Local regulators seeking to explore opportunities for getting involved in testbed development and growth.
- Academics and researchers who want initial input for studying or setting up regional testbeds and living labs.
- Anyone interested in understanding the value of real-world testbeds and how they fit within the innovation process and landscape.



- Four initiatives are currently underway in Sweden related to capitalizing on testbeds, which are being led by RISE (Research Institutes of Sweden), Swedish Incubators & Science Parks, Business Region Göteborg, and Region Skåne.

- This pre-study investigated 8 open testbeds and 10 closed testbeds that provide a representative sample of testbeds in Blekinge, backed by 29 in-depth interviews.

- Four obstacles hinder testbed growth and ecosystem development within Blekinge:
  1. Testbeds are an ambiguous concept.
  2. An actual need for shared resources must exist.
  3. A testbed community does not grow without help.
  4. Every city acts as an island.

- We propose 13 recommendations to address overall regional action of testbed development in Blekinge, as well as aligned with the three categories in the Kickstart S3 project of Technology, Smart Industry, and Missions.

SUMMARY OF RECOMMENDATIONS

For General Regional Action

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1.1 Kickstart S3 project

This pre-study is part of a project called Kickstart S3 being conducted by Region Blekinge. In autumn 2021, Region Blekinge started an EU-funded project called Kickstart Smart Specialization Strategy (abbreviated as "S3") that will be completed by autumn 2023.[1] The project goal is to start the implementation of a regional strategy in smart specialization that aims to strengthen green and digital transformation and increase the long-term innovative power and resilience of small and medium-sized enterprises operating in the region's areas of specialization. In particular, Region Blekinge has identified three areas of smart specialization that are important to Blekinge, which are Technology, Smart Industry, and Missions that entail the following sectors and applications:

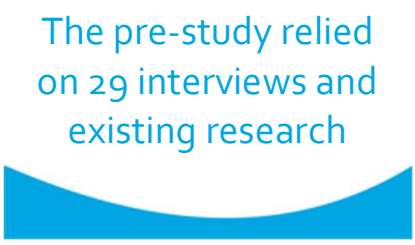
a. **Technology**: digitalization and smarter cities
b. **Smart Industry**: forming technology and marine technology
c. **Missions**: focus on healthy oceans, adaptation to climate change, and climate neutral and sustainable cities

1.2 Pre-study focus

The Kickstart S3 project for Blekinge includes a testbed pre-study, conducted jointly by Blue Science Park and Innovation Leadership Group. A pre-study is typically designed to assess the value and feasibility of a particular topic, aiming to advance a group's understanding and determining if further action is warranted. As the term suggests, a pre-study is an initial analysis and does not undertake a thorough inventory, complete a full benchmarking report, or produce a detailed business case, although those may be possible recommendations.

The objectives of this pre-study are to describe the state of testbeds across Blekinge and its regional cities, better understand the need for local testbeds by various groups and stakeholders, and identify potential next steps that contribute to regional innovation and economic growth. Testbeds is a loose term. Typically, testbeds refer to any type of testing environment – either in a physical location or virtual space – that helps a team verify or validate scientific hypotheses, computational tools, or new technologies, often for business or research purposes. This broad definition has been refined in the pre-study; please see section 2.1 for further clarity and discussion.

1.3 Data set & methodology



The pre-study's data set combines secondary and primary sources. Our research team started by looking broadly at publicly available reports, published in either Swedish or English, in order to gauge the current understanding of testbeds. We found only a handful of reports published in the last few years, which were conducted largely by a mix of governmental groups and non-governmental organizations, such as the UK innovation foundation Nesta and the industry

[1] Region Blekinge. (2022). Projekt Kickstart S3. https://regionblekinge.se/utveckling-och-projekt/innovation/smart-specialisering/projekt-kickstart-s3.html

association Swedish Incubators & Science Parks (SISP). These reports provided us with some testbed statistics and helped validate data themes from the primary sources.

We selected personal interviews as our mechanism for primary research for several reasons. First, personal interviews provide rich qualitative data, which is valuable when developing a more nuanced understanding of a new topic, so we felt doing interviews would be highly appropriate for this emerging topic of testbeds in Blekinge. Second, Blue Science Park had used quantitative measures of data collection, such as web-based surveys, for other member studies during the pandemic that had produced low response rates. This outcome gave us another reason to choose interviews as a research method because we wanted higher user engagement. Third, we felt that interviews would help build important relationships and lay the foundation for future action with local partners.

All interviews were individually arranged and semi-structured, so they each followed the same basic set of questions. As Blekinge is an emerging innovation ecosystem with a smaller number of stakeholders than other larger regions in Sweden, we estimated a regional pre-study could effectively collect a preliminary set of impressions from a total of two dozen interviews. In the end, our pre-study relied on 28 in-depth interviews in total.

The interviews fall into two categories: local and external. Nearly 90% (n=25) of interviews were in the local category, which represented the dominant perspectives in Blekinge as a regional innovation ecosystem. These individuals work in Blekinge, and their organization or position was selected as dominant in terms of total revenues, number of local employees, or overall local influence. We also considered different types of organizational structure – such as corporation, university, government agency, or consultancy – to broaden the perspectives we heard about in relation to testbeds. See Table 1 for a percentage breakdown of the local interviews by organizational type.

Organization Type	# of Interviews (% of Total)	Representative Organizations
Government	10 (34%)	• Business Blekinge • Karlskrona Kommun • Olofström Kommun • Sölvesborg Kommun • Swedish Incubators & Science Parks • RISE (Research Institutes of Sweden) • Ronneby Kommun • Stamping & Forming Center of Excellence
Small and Medium-Sized Enterprises	5 (14%) *	• Cetetherm • CLUK (Centrum för Livsmedelsutveckling / Center for Food Development) • iStudios Visuals • Hyper Island • S-Group Solutions • TrueSec AB
Corporation	4 (17%)	• Ericsson • Roxtec • Telenor • Tetrapak

Organization Type	# of Interviews (% of Total)	Representative Organizations
Academia / Education	3 (10%)	• Blekinge Institute of Technology • Hyper Island
Mixed Sector	4 (14%)	• NetPort • SPOK (Samtida Produktion och Konsumtion / Contemporary Production and Consumption) • Techtank

Table 1: Distribution of local interviews by organizational type (n=25)

We would like to clarify the SME subcategory because SMEs are generally understood as companies with 250 employees or less. Our SME list includes several companies that have significantly smaller offices as part of larger parent organizations; however, in all cases in the pre-study, these entities regarded themselves more as SMEs with corresponding constraints. For example, our Cetetherm interviewee mentioned the parent organization briefly, but then described its company testbed as mainly a local resource run entirely by one staff operator without headquarters' (HQ) support or financing. In addition, CLUK has been run by an SME (i.e., Marc Ljungström of Maseco) and been operating largely as a SME. CLUK only recently became affiliated with NetPort Science Park in Karlshamn. It is currently a complicated association – although CLUK has not received any material public entity support or funding to date, NetPort owns the CLUK brand, while much of its equipment assets were sold recently to a local food company. As such, we have classified CLUK as a SME in the pre-study.

SME in Pre-Study	# of Employees	Parent Organization	# of Employees	Notes
Cetetherm	38	NIBE	18 740	Spoke of testbed as mainly a local resource without HQ support
CLUK	1.5	NetPort	7	Run by a local SME before May 2022
iStudios Visuals	8	–	–	
Hyper Island	15	Talent Garden	Unknown	Spoke of testbed as mainly a local resource without HQ support
S-Group Solutions	54	Addnode Group	1 758	
TrueSec AB	22	TrueSec Group	140	

Table 2: Additional profile details of SMEs in the pre-study

The external category of interviews (n=3) were comprised of people who lived outside of the region of Blekinge; they either had researched testbeds or were in the process of studying testbeds.

1.4 Pre-study constraints

This pre-study has several limitations that should be mentioned. While the pre-study objective is to spotlight key developments in the topic of testbeds and suggest possible areas for further attention, our team may have missed certain elements due to our data sample, study bias, or other factor. Further studies should address these limitations.

1. **Sample size and profile**: The data set is a small regional sample, and while care was taken to find a representative set, certain groups – such as SMEs – may not be as dominant in the pre-study mix as desired.
2. **English-speaking bias**: Another study limit is a possible English-speaking bias because all data interviews were conducted in English (though Swedish translation was available), which might have excluded those who preferred speaking Swedish.
3. **Growth bias**: We designed the pre-study on the premise that the region would like to develop its innovation ecosystem and contribute to further testbed development in Sweden, given the current national attention and available European funding. In particular, we have assumed that the purpose of testing new products and services in a testbed or at a test facility means that respective group or testbed member intends to innovate or commercialize further. Nonetheless, additional conversations with regional stakeholders would be good to hold in order to recheck the actual interest to grow – and what growth means – locally and regionally.

2 State of testbeds overall

Currently, the topic of innovation testbeds is at the top of Sweden's national innovation agenda as a way to be more competitive, so the regional leadership of Blekinge is equally keen to contribute and clarify its role in this broader dialogue.

2.1 What is a testbed?

An important element for developing shared understanding became establishing a clear definition of a testbed, which emerged as a theme in both the literature review and our interviews. What do we mean by a testbed? Other terms we saw or heard included "sandbox", "living lab", and "system demonstrator". OECD (Organisation for Economic Co-operation and Development) classifies testbeds as:

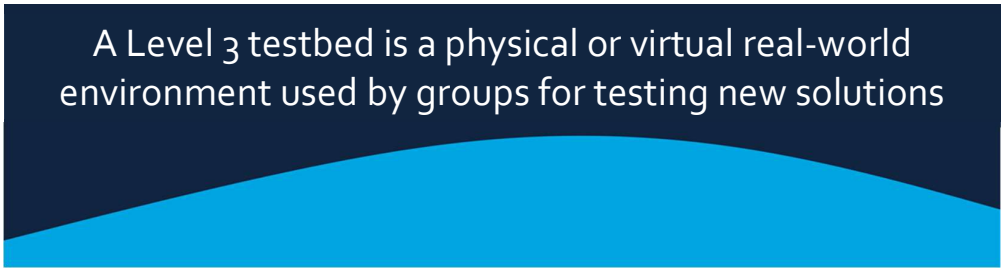
> *Testing environments (or test beds), where new technology developments can be tested in controlled but near to real-world conditions.*[2]

In Sweden, Vinnova has defined testbeds broadly as:

> *A physical or virtual environment in which companies, academia and other organisations can collaborate in the development, testing and introduction of new products, services, processes or organisational solutions in selected areas.*[3]

[2] OECD. (2019). Digital innovation: Seizing policy opportunities.
[3] Vinnova. Accessed at https://www.vinnova.se/en/m/testbed-sweden/testbeds-in-sweden/

Vinnova then outlines three levels of testbeds: as level 1 (laboratories), level 2 (simulated or constructed environments), and level 3 (real-world environments used for testing innovation), where level 3 corresponds closest to OECD's definition.



For its 2019 report on global testbeds, UK's innovation agency Nesta adopted the Vinnova definition and focused primarily on level 3 environments, investigating how innovation testbeds are used in real-life settings. They clarified the level 3 testbed definition further as:

> *Controlled or bounded environments for testing innovation in real-world, or close to real-world, conditions in the manner (or close to the manner) in which they will be used or operated.*[4]

The Nesta study found that real-world testbeds share two features: unlike research labs or test simulations, real-world testbeds are designed to contain risk and provide a controlled way to learn and evaluate as close to real-life conditions as possible. This setup allows new solutions and related technologies to be explored relatively safely via various use cases when the solutions are close to commercialization.

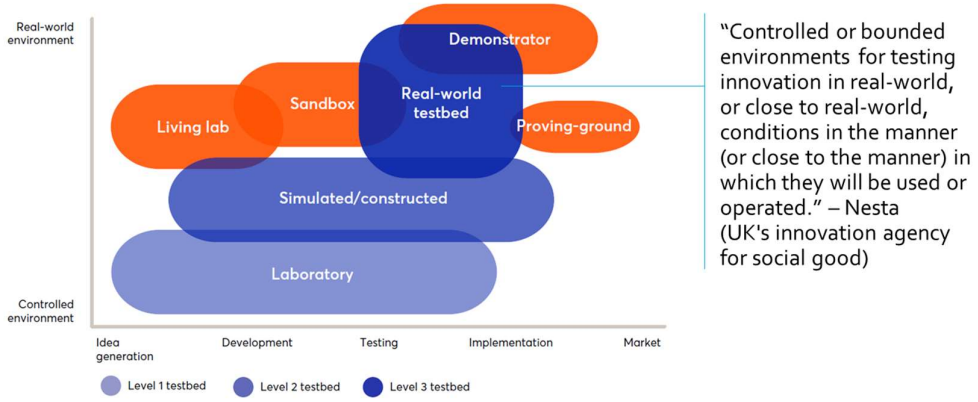


Figure 1: A spectrum of testbeds as characterized by Nesta

As Blekinge is a region in Sweden, we have adopted the Vinnova definition during our pre-study interviews with an emphasis on level 2 and level 3 test facilities.

[4] Nesta. (2019). Testing innovation in the real world: Real-world testbeds.

2.2 What are international & national insights for Blekinge?

The Nesta report completed an inventory of 91 real-world testbeds from various global sites, and several report findings are relevant to Blekinge:

1. **Planning**: Nesta found that many groups did not take the time to fully evaluate the actual market need for a new testbed before launching it, thus struggling financially. They recommend this evaluation step as critical to long-term testbed success.
2. **Actors**: Another insight was that mainstream public services – such as schools, public health, police forces, and welfare offices – did not use testbeds much. Although a clear explanation was not provided, a reader could gauge that over half of testbeds (56%) in the Nesta data sample operated in four main sectors, largely commercially focused: smart city and transport technology, health and social care, automotive (specifically connected autonomous vehicles), and energy. The report does note that while the researchers heard Sweden wished for more public sector involvement in Swedish testbeds, roughly 10 per cent of these testbeds were actually driven by public sector groups.
3. **Usage**: Testbed utilization rates range greatly. The report mentions that many Swedish testbeds only use about 50 per cent of their full capacity and recommends that those pursuing testbeds consider developing plans for the "full exploitation of the testbed to make the most of the investment".

Two other points are worth mentioning from Nesta's research for Blekinge:

1. The greatest number of examples in Nesta's global study came from Sweden and the United Kingdom, reinforcing the view that Sweden is a global leader in testbed efforts. In particular, the report featured Sweden's national testbed strategy as one of its six case studies. Funded by the national budget, the Testbed Sweden initiative aims to coordinate existing test and demonstration facilities across the country, part of Sweden's Smart Industrialisation Strategy launched in 2016. Several national organizations have been involved in Testbed Sweden, specifically RISE, Vinnova, Business Sweden, Tillväxtverket, and the National Energy Body. RISE has had the main responsibility for testbed ownership, and Tillväxtverket has provided funding for rural testbeds. One project output was an online testbed inventory maintained by Vinnova. However, since the Nesta publication in 2019, the Vinnova testbed webpage does not look to be actively maintained, nor is there a clear connection to another related website of https://swedishtestbeds.com.
2. The Nesta report features a special section about engaging small- and medium-sized enterprises (SMEs) in testbeds, given their low participation but high desirability. Table 3 illustrates some known challenges and possible solutions to SME engagement, drawn from Nesta's report, that would be wise to consider in Blekinge.

Challenge for SMEs	Potential solutions
The testbed is too costly for participation.	• Subsidizing the participation of SMEs either directly or through challenge funding earmarked for a certain type of innovator. • Providing SMEs with free access to the real-world testbed.

Challenge for SMEs	Potential solutions
Lack of knowledge about real-world testbed opportunities for relevant SMEs, or doubt in the worthiness of the testbed participation	• Having part of the real-world testbed budget earmarked for marketing purposes. • Creating support structures for SMEs that increase their potential benefits and outputs.
SMEs not the primary target group	• As many real-world testbeds may prefer to work with large companies, those that involve SMEs, or plan to do so, can be rewarded or gain preference in funding applications. • Smaller innovators can be involved through working methods such as workshops or labs concerning the real-world testbed topic.
Fear of exposing their products / processes	• Having clear frameworks on Intellectual Property (IP) implications and building trust and transparency within the testbed.

Table 3: Challenges and solutions for SME engagement with testbeds (source: Nesta)

2.3 What are existing testbed initiatives underway in Sweden?

Our pre-study uncovered four testbed efforts underway now in Sweden that can influence the discussion in Blekinge and offer additional Swedish experts to work with and share insights. These four efforts are being led separately by RISE, Swedish Incubators & Science Parks (SISP), Business Region Göteborg, and Region Skåne.

4 other testbed studies are now underway in Sweden

2.3.1 RISE: INIT project

RISE is leading a project called ”Inventory of national and international testbed capacity” (INIT) funded by Vinnova, which runs from January 2021 to September 2022. The project objective is explore the international potential of testbeds, specifically how they could attract more foreign customers to use existing testbeds and to invest in new ones.[5][6] The rationale is that if Swedish testbeds are to be able to offer world-class services to Swedish businesses and the public sector, they must be able to measure themselves internationally. The project has several outcomes: map Swedish testbeds and analyze their international potential, analyze competition from foreign test beds and their interest in Sweden, and develop a model for managing results and continuous support for the internationalization of Swedish testbeds. The mapping is primarily made from questionnaires, complemented by interviews.

INIT’s preliminary analysis has identified 141 active testbeds in Sweden – with the majority (80-90% estimated) affiliated with RISE. A large number of these testbeds is focused on transportation or automotive applications (40%) and paper and pulp processing (35%). Many testbed staff welcome international partners but lack active outreach or the international connections. INIT project manager Adam Edström confirmed that ”Most testbeds are small

[5] RISE. (2021, December). Internationalisering av testbäddar: Projektlägesbeskrivning.
[6] RISE. (2022). Inventory of national and international testbed capacity (INIT). https://www.ri.se/en/what-we-do/projects/inventory-of-national-and-international-testbed-capacity-init

and physical."[7] Over half (54%) of the testbeds in their analysis make less than 10 million SEK in annual sales, and only a minority (5%) earn over 100 million SEK in annual sales.

In addition, the INIT team has found several areas – such as tourism, financial services, and creative industries – are underserved across Sweden, which our team interprets as a possible lack of commercial interest or, conversely, a competitive opportunity for Blekinge.

2.3.2 SISP: testbed pre-study

The Swedish Incubators & Science Parks (SISP) organization started a gap analysis of testbeds in autumn 2021 to be completed by late 2022. The SISP study objective is summarize existing research about testbeds and then recommend a testbed model for their member base to better support Swedish SMEs.[8] SISP's initial analysis reinforces the findings of this pre-study for Blekinge. SISP found that SMEs in Sweden do not generally see the benefits of testbeds, so it has been challenging to engage them.

In addition, testbed usage has been historically low, which matches the challenges identified from the 2019 Nesta study. In fact, SISP's research found that the Swedish average occupancy in 2015 was 55% across all participant types, and in nearly two-thirds of testbeds, SMEs made up less than 10% of the occupancy. An emerging SISP reflection is to adapt its testbed approach, especially to help finance or lower the barrier for SMEs to participate. Another reflection is to create a "sector-oriented structure" that can help facilitate resources, actors, and competencies. How these suggestions might be executed is unclear.

Another emerging finding from the SISP testbed project is that understanding SME needs is a crucial factor for higher utilization rates and long life of testbeds. This raises the importance of finding a solid business model and developing a business-oriented mindset in testbed staff. The SISP project's final report will be published by late 2022.

2.3.3 Business Region Göteborg: Testbädd Göteborg

In 2017, Business Region Göteborg (BRG) had conducted a scan of active testbeds in Western Sweden, focusing on the greater Gothenburg area, so they updated their list in summer 2021.[9] In their 2021 testbed report, BRG defines testbeds as:

> *A shared development environment where you can develop new technologies, services, ideas or work methods. It is a place where companies, academia and other organizations must be able to collaborate on the development, testing and introduction of new products, services, processes or organizational solutions.*

BRG's group manager Lars Bern described the recent project outreach, saying: "You have to spend a few minutes explaining the concept [of a testbed]"[10].

The BRG study identified 143 testbeds total, and it is unclear how much of their inventory overlaps with the RISE INIT testbed list. Since the last survey, 17 new testbeds had been introduced and 18 testbeds previously listed had been closed in the Western Sweden area, mostly due to restructuring or weak financing. Nearly two-thirds (66%) of the testbeds surveyed reported that their current financing relied on commercial fees (30%), time-limited

[7] Edström, Adam. (2022, February 8). Personal communication [virtual interview].
[8] Swedish Incubators & Science Parks. (2019). Initial findings prestudy: Swedish test and demo for SME.
[9] Business Region Göteborg. (2021). Kartlaggning av testbaddar i Vastsverige. Augusti.
[10] Bern, Lars. (2022, March 7). Personal communication [virtual interview].

project funding (22%), or city/regional funding (14%). Lars Bern said, "We can conclude that not many have any dedicated business development or innovation function."[11]

The more successful testbeds in Gothenburg include:

- Astazero used by international car manufacturers for road safety tests
- ElectriCity used by public sector and industry partners for electric bus evaluation
- HSB Living Lab at Chalmers University of Technology as an active building testing flexible living units and sustainable lifestyles, funded partly by EU's Climate-KIC initiative

Using a mix of surveys and interviews, the BRG study found mixed usage rates of testbeds. Since the project team found no standard model to measure testbed access, they asked survey participants to complete a simple use scale from 0 (= only internal operations) to 10 (= available for all). Approximately half of the testbeds (50%) were reported as being open to public access; a quarter of the testbeds (25%) straddled the spectrum; and the remaining quarter (25%) were largely closed for internal operations. In addition, the BRG study found the testbeds operated evenly across the various Technology Readiness Levels (TRLs)[12], which BRG interpreted as positive representation of all commercialization stages. Our team is curious how the TRLs level correspond to the testbeds' industrial sectors or areas, as that could outline a more specific lesson for Blekinge.

BRG's report recommendation was to consider a membership model across multiple testbeds. For a reasonable fee, a member would gain access to several different testbeds in the area and have other benefits, such as additional meeting spaces, connections to other industries and networks, and possibly attract funding for larger research projects nationally and internationally.

Beyond this report, the BRG project team has organized several activities that have helped bring more attention and support to testbeds within the local innovation ecosystem, which offer good lessons for Blekinge. In particular, BRG has established Testbädd Göteborg as a community platform to meet regularly with local testbed stakeholders, which includes two universities and the city of Gothenburg, in order to share best practices and other resources related to testbed development.[13,14] As part of this effort, BRG heavily promotes specific hashtags, namely #testbäddgöteborg and #testbedgothenburg, on LinkedIn and other social media to raise testbed awareness and rally the community. BRG also sponsors working group meet-ups to share experiences about specific testbed topics, such as funding, legislation, and business development.

2.3.4 Region Skåne: testbed pre-study

The Department of Economic Development & Innovation in Region Skåne has started a study of testbeds in its region, which was partly provoked by Vinnova's Testbed Sweden

[11] Ibid.
[12] In the 1970s, NASA introduced Technology Readiness Levels (TRLs) as a type of measurement system to assess the maturity level of a particular technology on 9 levels going from scientific research to ready for implementation.
[13] Business Region Göteborg. (2022). Testbed Gothenburg - the initiative.
https://www.investingothenburg.com/advantage-gothenburg/testbeds/testbed-gothenburg
[14] Business Region Göteborg. (2022). Testbädd Göteborg tar tillvara och accelererar innovationskraften.
https://www.businessregiongoteborg.se/innovation-samverkan/innovation-samverkan/testbaddar/testbadd-goteborg

initiative in 2016. The project team expects to complete the survey by late 2022 and would like to learn from Region Blekinge's analysis.

Wilhelm Ast, a development manager at Region Skåne, said, "We have a hunch that we have too few testbeds [in Skåne]."[15] He perceives that Blekinge has more big companies, such as Ericsson and Telenor, while Skåne has more medium-sized companies, and that successful testbeds engage bigger companies.

3 Local testbed landscape

Based on our interviews, our pre-study identified a small representative sample of testbeds, which generally provided either open or closed access to a range of users across Blekinge. Our sample features a total of 8 open testbeds and 10 closed testbeds.

The data sample features 8 open and 10 closed testbeds

3.1 Open testbeds in the pre-study

A test environment qualifies as "open" if anyone from the public can visit and/or a member can request or pay to join given shared interests. Please see Section 0 for more details on each open testbed.

#	Open Testbed Name	Host Organization	Location	Application Area(s)
	Blue eHealth Testbed	Blekinge Institute of Technology & Blue Science Park	Karlskrona	Health
	Blue Marine Testbed	Blekinge Institute of Technology & Blue Science Park	Karlskrona	Marine
	CLUK (Centrum för Livsmedelsutveckling / Center for Food Development)	NetPort	Karlshamn	Food
	Decision Arena	Department of Mechanical Engineering, Blekinge Institute of Technology	Karlskrona	Industrial manufacturing
	Stamping & Forming Center of Excellence	RISE	Olofström	Automotive manufacturing
	"test lab" [no name]	Sculptur	Karlshamn	Manufacturing, arts
	Visbo	Karlskrona Kommun	Karlskrona	Consumer home

[15] Ast, Wilhelm. (2022, February 11). Personal communication [virtual interview].

#	Open Testbed Name	Host Organization	Location	Application Area(s)
	Visual Data-Driven Lab	Department of Computer Science, Blekinge Institute of Technology	Karlskrona	Technology

Table 4: List of open testbeds in Blekinge from the pre-study sample

3.2 Closed testbeds in the pre-study

The closed testbeds have restricted access because they are primarily dedicated for internal operations and/or staff use. Another indicator of a closed testbed is that the staff did not actively promote the testbed access or services to the public. The closed list also includes some corporate test environments, such as Telenor and Tetrapak, whose staff indicated they would consider qualified access to outsiders, such as business suppliers and partners, on a case-by-case basis. We were not able to investigate several closed testbeds further. Our team feels the closed testbeds do not offer much direct benefit to the broader innovation ecosystem in Blekinge due to their limited access to external users.

Overall, these closed testbeds vary in use. Generally, SMEs have only one primary test facility, often with no formal name other than perhaps ”test lab” or ”lab”. In contrast, larger companies, such as Saab Kockums, have multiple test environments for testing new technologies, new versions of solutions before delivery, and running controlled demos with business partners and customers. The only notable exception in this closed testbed list is Ericsson, which occasionally sets up temporary test environments at their Karlskrona offices that provide external access for specific use cases – such as open innovation events and student competitions – although none of these community events have been held since 2020 due to COVID-19 pandemic constraints.

#	Closed Testbed Name	Host Organization	Location	Application Area(s)
1.	EMC lab	Roxtec	Karlskrona	Manufacturing & marine
2.	Fire lab	Roxtec	Karlskrona	Manufacturing & marine
3.	Global Services Test Center	Telenor	Karlskrona	Telecommunications
4.	T1, T2, T3	S-Group Solutions	Karlskrona	Technology & data services
5.	Technology Development Center	Tetrapak	Karlshamn	Food
6.	Tech room	Hyper Island	Karlskrona	Education
7.	”test lab” [no name]	Cetetherm	Ronneby	Industrial manufacturing
8.	”test lab” [no name]	TrueSec	Karlskrona	Technology & cyber security

#	Closed Testbed Name	Host Organization	Location	Application Area(s)
9.	Various test facilities	Ericsson	Karlskrona	Telecommunications
10	Various test facilities (e.g., shocks lab, steel and welding lab, EMC lab)	Saab Kockums	Karlskrona	Military defense & marine

Table 5: List of closed testbeds in Blekinge from the pre-study sample

3.3 Proposed new testbeds in Blekinge

Our study uncovered two emerging test environments. The Marine Living Lab is an active proposal at the time of writing, and the Virtual Production Studio Lab recently approved funding:

1. **Marine Living Lab**: The Marine Living Lab at Blekinge Institute of Technology (BTH) has been proposed as a physical lab space focused on basic and applied research of marine applications. This living lab would primarily be used by university researchers and corporate partners.
2. **Virtual Production Studio Lab**: On September 9, 2022, Region Blekinge, Karlskrona Kommun, and the Blekinge Institute of Technology announced that they will jointly invest SEK 18 million over 3 years in a virtual film production studio. About half of the studio time is planned for academic research and teaching, while the remaining time will be reserved for commercial testing and development. This studio would be available to any interested vendors and studio partners, likely for a fee.

Figure 3: Example of a vritual movie studio

3.4 Testbeds supporting Blekinge's smart specialization areas

A subset of the testbeds in the pre-study sample fit Blekinge's areas of smart specialization, which are defined again as follows:

a. **Technology**: digitalization and smarter cities
b. **Smart Industry**: forming technology and marine technology
c. **Missions**: focus on healthy oceans, adaptation to climate change, and climate neutral and sustainable cities

Most of the open testbeds fall into the first S3 (smart specialization strategy) category of Technology, as they address some aspect of creating regional business growth through new hardware or software or by using digitized information to make workflows and processes more efficient. For instance, the BTH Decision Arena is focused on testing new research applications related to digital twins in new product development, and Sculptur relies on advances in additive manufacturing.

	Blekinge area of smart specialization:		
	Technology	**Smart Industry**	**Missions**
OPEN TESTBED	1. BTH Decision Arena 2. Sculptur testbed 3. Karskrona Kommun Visbo 4. BTH Visual Data-Driven Lab 5. Telenor Global Roaming Lab	1. RISE Stamping & Forming Center of Excellence	1. BTH Marine Testbed
CLOSED TESTBED	6. S-Group Solutions T1, T2, T3 7. Hyper Island tech room 8. TrueSec test lab Ericsson various test facilities	2. Cetetherm test lab 3. Saab Kockums various test facilities 4. Roxtec Fire lab 5. Roxtec EMC lab	

Table 6: List of testbeds in Blekinge from the pre-study sample aligned by smart specialization area

3.5 Testbed supporting resources

It is important to mention several resources that directly support the operations of testbeds within Blekinge, although they are not test environments themselves.

3.5.1 SPOK Blekinge manufacturing database

The SPOK Blekinge hub is a part of SPOK Sweden. SPOK stands for Samtida produktion och konsumtion, which translates as ”contemporary production and consumption.” SPOK promotes knowledge transfer and collaboration between designers and manufacturers that can lead to new products, more efficient manufacturing, experimentation in new materials and techniques, and sometimes completely new innovations and showcases. For example, associated exhibits were shown at Formex in Stockholm and at the international design festival Southern Design Days 2022 in Malmö.

The SPOK Blekinge database is a testbed resource for locals

As background, Region Blekinge signed an agreement in 2020 with Form Design Center, the owner of SPOK Sweden, to develop SPOK Blekinge. In parallel, Techtank was exploring a proposal to create the Blekinge Industrial Test Center as a physical test facility in Ronneby, which would engage several local companies as members. However, the project manager felt most of the proposed equipment was already available at existing companies, which would make any new center either redundant or less relevant to market demand. As Region Blekinge evolved the SPOK concept into a co-working platform, the two initiatives crossed paths, and a collaboration began. With Region Blekinge’s support, Techtank provided an

inventory of all manufacturing vendors in Blekinge that built on an existing database started by Skåne designer Jenny Nordberg.[16]

Launched in spring 2021, SPOK Blekinge is available online at https://s-p-o-k.se/sv/om-oss/spok-blekinge. Region Blekinge continues the development of SPOK Blekinge with Techtank, who manages ongoing updates of Blekinge vendors and materials.

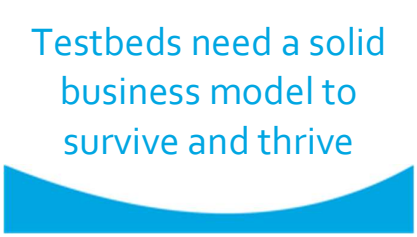
4 Testbed obstacles

In the proposal for the S3 Kickstart initiative, Region Blekinge identifies multiple challenges facing the region that limit broader innovative development and hinder the long-term innovative power and ecosystem resilience, especially for SMEs. We would like to highlight several obstacles here specific to regional testbed development, which we list in order of priority.

4.1 Testbeds are an ambiguous concept

The concept of testbeds has captivated Swedish imagination and the broader European community for its possibility to accelerate innovation and spur SME growth. In reality, other studies have shown that the testbed term is often unclear to multiple groups, especially SMEs. This confusion means that SMEs do not fully understand what a testbed offers and subsequently how they could benefit from participating. Who should be testing what and why? Clarifying the testbed definition and promoting benefits genuinely tailored to SMEs, such as training workshops, would help tremendously. This education is needed first to build awareness in the region, so that small businesses and teams can begin to learn what they need and where to go for help.

4.2 An actual need for shared resources must exist



Our research shows that most testbeds are not used frequently, which makes them a poor investment or mismatched fit for users. Typically, larger companies can afford their own test facilities and thus do not need to seek out or combine resources. A community testbed only makes sense when a community needs it. The lessons from the Nesta report and SISP project show that there should be a clear and documented need of the target users, preferably with commitment from early members, before establishing a new testbed.

However, certain industry sectors that have high costs to entry in new product development, such as food production or movie production, can reveal a higher likelihood of shared need because individual SMEs cannot afford expensive test equipment but would benefit greatly from a communal resource. For example, CLUK is a test space serving an emerging food cluster of companies growing in Karlshamn for the past decade. While CLUK members welcome the ongoing community support and equipment access, the CLUK operations team has struggled to find long-term financing. In this case, the actual testbed need exists, but the

[16] Incidentally jenny Norberg was awarded 2022 Designer of the Year in Sweden.

staff lacks the ability to build a business. A regional entity like Region Blekinge can bolster these local efforts and place them in a larger competitive context for regional advantage – by knowing that over half of food production occurs in Southern Sweden and no other regional group is addressing food innovation outside meat and bakery items.

4.3 A testbed community does not grow without help

There is a saying that if you build it, they will come. In reality, most open testbeds rely on a membership model and/or community partners for their success. It is naive to assume that these smaller ecosystems grow on their own, although our initial data shows more attention is placed on the physical space and operations than on building the community relations. In addition, network studies demonstrate that a dedicated person is needed to foster relationships, organize community activities, and create a shared sense of belonging among members – as well as seek out other best practices of growth and co-development. By ensuring this role exists, a testbed entity can increase its chances for long-term viability and impact. Funding partners should also insist that this type of role is addressed in any funding application or proposal.

4.4 Every city acts as an island

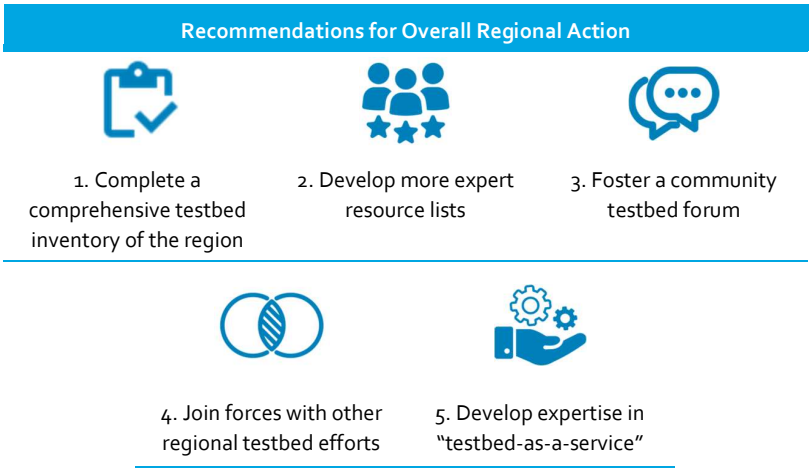
Our preliminary analysis shows few interactions occurring between and across cities within Blekinge, which limits the value and usage of an open testbed in a regional innovation ecosystem. We have identified two likely causes. From an economic and political view, cities are often key funding partners in a testbed, and city officials unsurprisingly expect to see the resources they provide concentrated on their own municipality. However, this financing model narrows the testbed market and its impact in the region. Second, from a historical view, many residents in Blekinge reflect their Viking heritage because native Swedes generally do not consider partnering first with other outsiders. This perception has been shifting slightly in the surrounding area, as recent efforts are working to promote the concept of ”Greater Copenhagen”. Regional entities and testbed investors in Blekinge can spark more bridges, so that testbeds are not acting as disconnected islands but instead linked as an archipelago in the spirit of the region’s geography. Lastly, regional entities and testbed stakeholders can help emphasize the concept of “borrowed size”, prioritizing efforts that combine resources and mix communities across at least two cities in the region.

5 Testbed Recommendations

Based on our pre-study analysis and understanding of testbed best practices, we present 13 recommendations for possible testbed opportunities and regional ecosystem growth. These recommendations are then categorized in terms of overall regional action, SMEs, and Blekinge's area of smart specialization strategy.

5.1 Recommendations for overall regional action

These recommendations are more pertinent to the region overall and are listed in no particular order below.



5.1.1 Complete a comprehensive testbed inventory of the region

The pre-study focused on a small representative sample of Blekinge, especially in the areas of smart specialization as identified in the Kickstart S3 project. We recommend conducting a comprehensive investigation to complete a testbed inventory, expanding the list across more industrial sectors, surveying more local SMEs, and surveying at least the top 50 largest companies in Blekinge. This regional update can then inform testbed tracking efforts underway by national groups, namely RISE and Vinnova.

As part of this inventory, we recommend capturing the specific key performance indicators (KPIs) that each testbed uses to measure its ongoing profitability and community impact. By knowing these KPIs, regional entities like Region Blekinge, local science parks, and testbed investors can set a regional baseline and determine appropriate measures of future growth, as well as what growth means locally and regionally in Blekinge. These KPIs could also help to draft a "market fit checklist" for current and new testbed operators, which they can use to (re-)evaluate the actual market need for their testbed services because prior research has shown that this evaluation step is hugely critical to long-term testbed success.

5.1.2 Develop more expert resource lists

Testbeds provide a physical space with shared equipment; however, knowing who can help is equally as important as knowing what tools to use. The SPOK Blekinge database provides a

list of local contract manufacturers and materials experts. This database should be complemented with additional lists of experts available in Blekinge, who understand testbed operations and their equipment. These testbed experts could include people specializing in electrical engineering, software development, app programming, and other technical areas.

5.1.3 Foster a community testbed forum

Social media could promote hashtags like #TestbedBlekinge

By learning from Testbädd Göteborg's success and committing to having its own dedicated ecosystem manager, Blekinge can pilot a testbed forum. The goal would be to bring together multiple stakeholders from various local test facilities to network, share best practices, and support one another on a regular basis. In addition, group meetups should be organized to learn new topics and invite external experts to share their knowledge – continually growing the ecosystem. A hashtag such as #TestbedBlekinge could further create a sense of shared purpose and solidarity. Finally, an ecosystem manager should be appointed to foster the meta community between and around all the testbeds in Blekinge.

5.1.4 Join forces with other regional testbed efforts

A regional entity like Region Blekinge can spark more collaborative action on a grander scale by becoming more involved with other regions' efforts. This action would also embrace the urban development concept of "borrowed size". Specifically, someone from Blekinge should join Gothenburg's testbed forum at least quarterly – at least as an active observer. Moreover, Blekinge should seek to share the pre-study results with the testbed team at Region Skåne and then discuss how certain test activities could be combined going forward, perhaps related to expanding the food cluster activity in Southern Sweden. A third idea is to pilot a multi-testbed model across cities and regions, so that a Blekinge testbed "passport" also provides entry to other sister testbeds (e.g., perhaps initially across the RISE or SISP network).

5.1.5 Develop expertise in "testbed-as-a-service"

As Sweden updates its national testbed strategy, an opportunity exists to develop the capability to lead "testbed-as-a-service" (TBAAS as a possible acronym in English?) and serve as a role model for other regions seeking to build local testbeds. While RISE has become a dominant testbed operator across Sweden, our interviews revealed that the organization has not formally aggregated lessons across test sites, does not maintain any central authority internally overseeing best practices, or distributed test insights widely to the global R&D community. This gap creates an opportunity for another group to partner with RISE or even take on this leadership role and become a knowledge resource for Sweden and across Europe. This reputation is built over time, and one next step is to find and interview the testbed managers within RISE that can share their lessons for running a testbed successfully. A possible output is to develop an initial knowledge base of testbed practices and studies – written in Swedish, English, and other European languages – that can then be made publicly available and actively shared with other testbed groups in Sweden and beyond.

5.2 Recommendations for SMEs

A separate subsection has been added to specifically address engaging small- and-medium-sized enterprises (SMEs) in local testbeds. As indicated in other studies, such as by Nesta and RISE, SMEs have historically been difficult to engage in testbeds, often because they do not perceive any testbed benefits or can afford most testbed services.

Recommendations for Small and Medium Sized Enterprises

6. Subsidize and engage SMEs directly

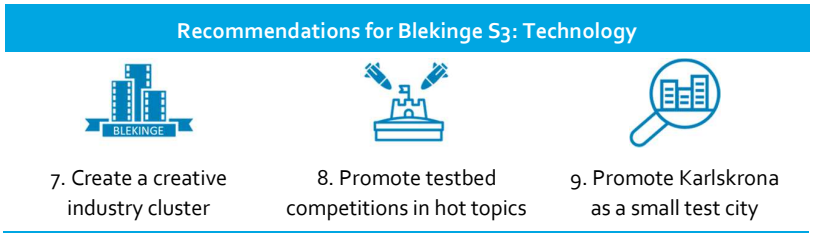
5.2.1 Subsidize and engage SMEs directly

Based on earlier recommendations, regional entities like Region Blekinge, investors, and other champions could pursue the following actions:

- Subsidize the participation of SMEs either directly or through specific funding requirements earmarked for SMEs.
- Update testbed marketing with messaging targeted to SMEs, ideally based on interviews with SMEs.
- Identify specific industry sectors or niches that have many SMEs but are underserved in the region.
- Provide SMEs with free access to a subset of testbed services and related benefits, such as additional meeting spaces.
- Organize workshops and short courses for SMEs that offer testbed tutorials and spotlight hot topics in product development and financing relevant to small businesses.

5.3 Recommendations for Blekinge S3: Technology

Several testbed recommendations directly address the Blekinge S3 project specialization on Technology, particularly aspects of digitalization and smarter cities.



5.3.1 Create a creative industry cluster

The RISE INIT project team has identified several areas, including creative industries, that are underserved across Sweden. There is already a proposal underway to build a new virtual movie production on the outskirts of Karlskrona in partnership with Blekinge Institute of Technology, which will include test functions. This virtual studio can act as the anchor for building a larger creative cluster in Blekinge, which engages related groups in digital media, animation, and gaming, such as the game startups in Karlshamn and elsewhere.

5.3.2 Promote testbed competitions in hot topics

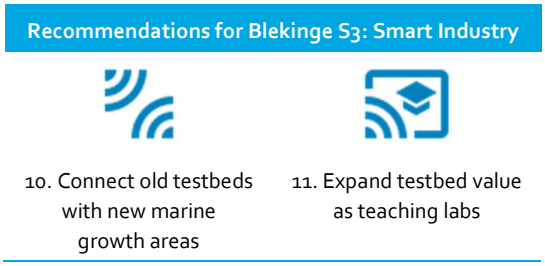
Instead of building a permanent test facility, organizations can consider pop-up simulations and temporary test environments that can be publicized to draw further attention and broaden the support of testbeds. In fact, several companies in Blekinge have already organized semi-closed events that bring multiple groups together for a rapid test simulation, and others can draw from this experience. For example, cybersecurity company TrueSec hosted a water attack game with various partners to test and explore issues of cyberattack. Dual-use topics or security-related themes could bring new partners to Blekinge through similar events.

5.3.3 Promote Karlskrona as a small test city

Karlskrona Kommun is undertaking a major update of its digital services. The city represents a certain population size and density that could offer a model test site for other similarly sized cities in Europe. Business Region Göteborg felt that its city of Gothenburg serves as a role model for a medium size city, while a city like Karlskrona can address a different scale that is equally needed in urban planning and development. In addition, IT services provider Cleura (formerly called City Network) in Karlskrona would be glad to consider subsidizing or donating certain online cloud test spaces as a way to engage more SMEs and support the local innovation ecosystem.

5.4 Recommendations for Blekinge S3: Smart Industry

Several testbed recommendations directly address the Blekinge S3 project specialization on Smart Industry, specifically on metal forming technology and marine technology.



5.4.1 Connect old testbeds with new marine growth areas

Bridging between different generations can bring value to both groups. In terms of testbeds, more established testbeds can continue staying relevant if they are connected somehow to new growth areas, while new testbeds can build on the legacy of their older counterparts.

As a specific example in Blekinge, RISE manages a Stamping and Forming Center of Excellence in Olofström that provides services and equipment for automotive metal testing and production. Karlskrona will review a marine growth proposal from Blue Science Park in August 2022, which outlines a new growth plan for 2023 through 2030. The plan proposes a new Marine Technology Center alongside the creation of 5,000 new jobs related to three pillars of marine growth in offshore energy, defense, and sustainable oceans. Part of the plan's energy focus proposes building offshore wind farms in the Baltic Sea nearby, and these wind farms offer a potential testbed for measuring and testing new designs made of metal and other mixed materials, plus other energy data. While perhaps an unlikely partner, the RISE Center should join early discussions to explore possible ways to extend their services in marine and maritime applications, while the new Maritime Technology Center might benefit from lessons in formation, financing and more from the RISE Center.

Other regions could be engaged in this testbed effort. For example, Region Blekinge has already partnered with Association of Klaipeda Region Municipalities in Lithuania and Kurzeme Planning Region in Latvia on another project, so they might be interested in doing more with the region in related areas.

5.4.2 Expand testbed value as teaching labs

Both the Nesta and Gothenburg testbed reports reinforced the importance of using testbeds for teaching purposes, such as special topic workshops for SMEs. Several pre-study interviews, such as those with Hyper Island and Techtank in Olofström, also highlighted the importance of having testbeds available for practice-based teaching. A recommendation is to incentivize testbeds to feature an educational component with the local community, ideally engaging local gymnasiums and cooperatives in using the testbed. Not only would this effort help instill early awareness of testbeds with a rising workforce, it would also empower young citizens to become more involved with the regional innovation ecosystem.

5.5 Recommendations for Blekinge S3: Missions

Several testbed recommendations directly address the Blekinge S3 project specialization on Missions, focused on healthy oceans, adaptation to climate change, and climate neutral and sustainable cities.

Recommendations for Blekinge S3: Missions	
12. Pilot a Baltic water health meter using a mussels testbed	13. Become Sweden's testbed as a carbon-neutral region

5.5.1 Pilot a Baltic water health meter using a mussels testbed

Blekinge Arkipelag maintains several large mussel farms in Blekinge and Kalmar, and Business Blekinge has identified an opportunity to update an older (and controversial) water sediment Stockholm study using these mussel farms in partnership with researchers from Sveriges lantbruksuniversitet (SLU / Swedish University of Agricultural Sciences). The new research has implications for blue mussel farming and other environmental impacts for Blekinge aquafarmers and others around the Baltic Sea. In addition, market interest is high – for example, the EU-funded Baltic Blue Growth project from 2014-2020 paved the way for blue mussels farming to become common business practice in the Baltic Sea. However, this proposed study of Blekinge Arkipelag's mussels has stalled because only half of the funding has been confirmed. We recommend that a regional entity like Region Blekinge help secure the remaining funding, using this research opportunity as a stepping-stone in BTH's Living Lab proposal, plus telling the bigger story about mussels as nature's fast water purification filter. Could these mussel beds serve as testbeds of Baltic water health? What would a water health meter look like for the Baltic area? By asking a bigger question, Blekinge can capitalize on a timely opportunity with major partners.

Figure 2: Mussel farm in Kalmar (source: Mattias Holmquist)

5.5.2 Become Sweden's testbed for a carbon-neutral region

By definition, missions are pressing societal problems that are addressed through cross-sectoral collaboration. One mission-driven opportunity is reducing a region's carbon

footprint. As heat waves become more widespread across the world, Sweden is finding that its nation is unduly affected. The average temperature in Sweden is rising more than twice as fast as the global average temperature, according to the national weather agency SMHI.[17] The record hot summer of 2018 in Sweden also showed that cities must adapt to higher temperatures and heat waves, so SMHI and Linköping University, in collaboration with the municipalities of Norrköping and Linköping, will collect data about heat island effects and other observations of urban weather in the summer of 2022.[18]

The region of Blekinge can take its own initiative and start to develop and measure the impact of becoming carbon-neutral across its various cities, perhaps by building first on Karlskrona's efforts to go more digital. Blekinge can further offer to act as a testbed for Sweden, similar to how the city of Ithaca is serving as an example for New York state and other U.S. cities. In late 2021, Ithaca announced that it plans to be fully carbon neutral by 2030, providing the first decarbonization plan in the U.S.[19] Ithaca has a population of nearly 32,000 with approximately 6,000 homes and buildings. Ithaca's plan would require all of its buildings – not just its municipal buildings – to be assessed and subsequently retrofitted as needed so that they no longer rely on fossil fuel-based heat sources and appliances. Part of the changes includes the installation of solar panels and high-efficiency ground-source heat pumps, committing to new legislation for newly constructed buildings, and reducing all vehicle-related emissions. The city's strategy is to tap private investors and combine this funding with government incentives that can reduce the cost of capital and interest rates.

Cities are seen as key leaders in climate change efforts. On a smaller scale of showing carbon reduction and healthy air quality, we recommend that Karlskrona consider piloting a city-wide system of air pollution monitors as part of measuring the city's quality of life. Air quality is becoming more important for citizens, especially as part of climate change metrics. As a public awareness campaign, a student team or local firm in Karlskrona could build a simple dynamic visual light that changes to the corresponding air quality color in a commercial air quality sensor (e.g., IQAir or Plume Flow). Residents and tourists alike will see the city's commitment to climate change and greater actions underway to position Blekinge as a missions-oriented testbed.

[17] SMHI. (2019, March 29). Temperaturen i Sverige stiger mer än för jorden som helhet.
[18] SMHI. (2022, June 13). "Sommaren i city…2022" – mätkampanj ökar kunskap om hur värme utvecklas i stadsmiljö.
[19] CNBC. (2021, November 4). Ithaca, New York becomes first U.S. city to begin 100% decarbonization of buildings, an urban climate change milestone.

6 Next Steps

A report like this only becomes useful if it helps lead to meaningful action. As part of creating a bridge to action, we include an initial analysis below of all testbed recommendations. Each idea is evaluated in terms of three filters: potential strategic value to regional ecosystem development and growth, the amount of effort likely required, and potential positive impact if implemented. We also suggest possible local groups which could be responsible to take initial action forward.

Recommendations for General Regional Action	Strategic Value	Effort Amount	Potential Impact	Possible Local Group/s to Lead
1. Complete a comprehensive testbed inventory of the region	High	Medium	High	Blue Science Park
2. Develop more expert resource lists	Medium	Medium	High	Blue Science Park
3. Foster a community testbed forum	High	Medium	High	Region Blekinge
4. Join forces with other regional testbed efforts	Medium	Low	Medium	Region Blekinge
5. Develop expertise in "testbed-as-a-service"	High	Medium	High	Blue Science Park, RISE, BTH (Innovation Office)

Recommendations for Small & Medium Sized Enterprises	Strategic Value	Effort Amount	Potential Impact	Possible Local Group/s to Lead
6. Subsidize and engage SMEs directly	High	High	High	Region Blekinge, Blue Science Park, each city Kommun

Recommendations for Blekinge S3: Technology	Strategic Value	Effort Amount	Potential Impact	Possible Local Group/s to Lead
7. Create a creative industry cluster	Medium	High	Medium	Blue Science Park, BTH
8. Promote testbed competitions in hot topics	Low	Medium	Medium	Region Blekinge, each city Kommun, corporate sponsor/s

	9. Promote Karlskrona as a small test city	High	Medium	High	Karlskrona Kommun, Region Blekinge, Blue Science Park, Business Blekinge

Recommendations for Blekinge S3: Smart Industry		Strategic Value	Effort Amount	Potential Impact	Possible Local Group/s to Lead
	10. Connect old testbeds with new marine growth areas	High	Medium	High	Region Blekinge, Blue Science Park, Marine Technology Center, RISE
	11. Expand testbed value as teaching labs	High	Medium to High	High	Each city Kommun, Hyper Island

Recommendations for Blekinge S3: Missions		Strategic Value	Effort Amount	Potential Impact	Possible Local Group/s to Lead
	12. Pilot a Baltic water health meter using a mussels testbed	Medium	Medium	Medium	Marine Technology Center, LSU
	13. Become Sweden's testbed as a carbon-neutral region	High	High	High	Business Sweden, Region Blekinge, each city Kommun, Karlskrona Expo, Boverket

7 Detailed profiles of local testbeds

Below are details for the 8 open testbeds, plus 4 closed testbeds, sampled in this pre-study, listed alphabetically by testbed name. Our team was unable to study the other 6 closed testbeds identified. This list does not represent a complete inventory of the region.

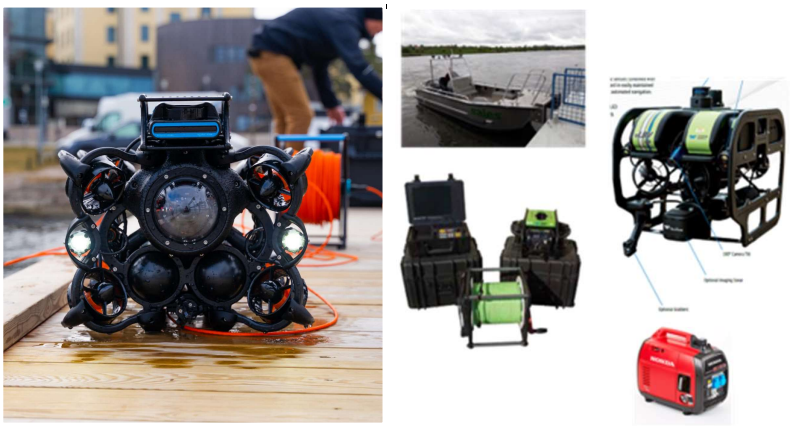
7.1 Blue eHealth Testbed, Blue Science Park

"The development of the Blue eHealth testbed enable companies to test and validate their technical solutions in a clinical environment."

Date established	2020
Location	Blekinge Institute of Technology, Campus Gräsvik 2, Minervavägen 4, Karlskrona
Objective	To provide test equipment and facilities for solutions in eHealth to simulate real-world conditions (i.e., a clinical environment)
Business model	Shared resource for the extended BTH community or Blue Science Park members
Access	Community member, low use
Notes	Affiliated with the BTH Research and Education Clinic

7.2 Blue Marine Testbed, Blue Science Park

"This is an open test bed that also provides underwater equipment including an ROV (underwater robot) with associated systems and sensors."



Date established	2020
Location	Blekinge Institute of Technology, Campus Gräsvik 2, Minervavägen 4, Karlskrona
Objective	To provide test equipment and facilities for marine or maritime solutions to simulate real-world conditions (e.g., ocean)
Business model	Shared resource for the BTH community or Blue Science Park members
Access	Community member, low use
Notes	Approved protected and dedicated area near BTH

7.3 CLUK – Centrum för livsmedelsutveckling i Karlshamn, NetPort

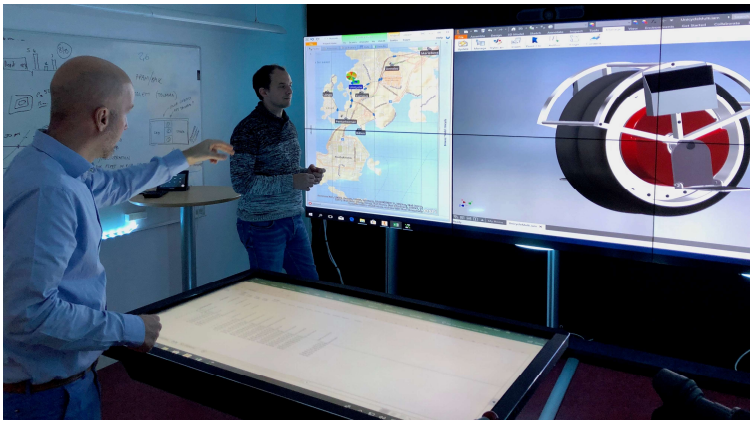
"It is very difficult to scale small manufacturing in food… Did you know 50% of food produced in Sweden is within a 2-hour radius outside Karlshamn?"

Date established	2014

Location	Castellet Bruk, Västra Kajen 8, Karlshamn
Objective	Support a growing cluster of companies to test and develop new food products, specializing in pumpable products and small-scale production in Southern SE
Business model	Managed by Netport, currently a membership fee model
Access	Open, daily use
Notes	Currently seeking funding and new facilities

7.4 Decision Arena, Blekinge Institute of Technology

"The ability to turn data into knowledge is the currency of the future… The Decision Arena is a digital war room for model-driven design."



Date established	2018
Location	Product Development Research Lab, Department of Mechanical Engineering, Blekinge Institute of Technology, Karlskrona
Objective	Study and test experiments for collaborative decision making about product development in a model-driven software environment
Business model	Funded by the research project called "Model Driven Development Decision Support (MD3S)"
Access	Open to BTH researchers and lab partners, low use
Notes	Elements of the research room are furniture, whiteboards, a large multi-touch screen, a computational server, and a video wall intended as canvas.

7.5 Fire Lab, Roxtec

"We are growing in many sectors at the same time and keep on adding safety solutions for use in new applications."

Date established	2018
Location	Rombvägen 1-3, 371 65 Lyckeby
Objective	Test new products in development
Business model	For Roxtec employees and partners, no fee
Access	Closed to employees, open to requests from partners & others (including customers and certifying authorities to witness tests), daily use
Notes	Not open to startups or external use, though being considered

7.6 Global Services Test Center, Telenor

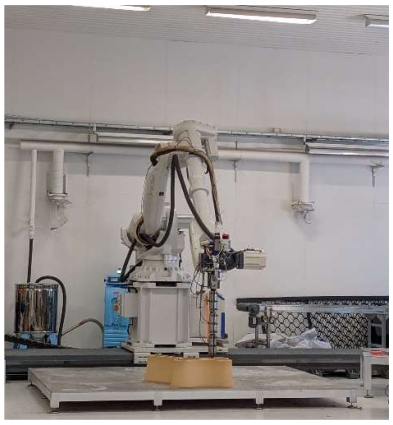
"This is a live radio environment and the only test facility we know of in Sweden and the EU."

Date established	2018

Location	Minervavägen 12, Kalskrona
Objective	Test networking protocols for new mobile handsets
Business model	For Telenor employees and partners as part of Telenor Global Services, no fee
Access	Closed to employees, open to requests from partners & others, daily use
Notes	Not open to startups or external use, though being considered

7.7 Sculptur

"We can make furniture and other items out of car bumpers, fishing nets, coffee beans, and waste from the forestry industry."



Date established	2020
Location	Pilvägen 8b, Karlshamn
Objective	To provide large-scale additive manufacturing for any designer using recycled or biobased material
Business model	Project / usage fee – pondering a franchise model of print hubs in select global cities (e.g., Tokyo)
Access	Open, ad hoc use
Notes	Continued RISE collaboration testing different materials to print, robotic arm made by sister company Spectrum, designs do not require custom molds and can reuse material from prior print jobs

7.8 Stamping & Forming Center of Excellence, RISE

"We have cutting-edge expertise in forming processes, friction control and tool solutions for shell products of high strength steel, aluminum, stainless materials, titanium and nickel base alloys, as well as combinations of steel plate and composites."

Date established	2016 (became part of RISE in 2020)
Location	Vällaregatan 30, Olofström
Objective	Provide a test facility for forming metal and multi-material solutions that are attached to a composite structure, includes sheet metal forming, tensile strength tests, and simulations
Business model	Membership fee, member benefits include joining the Stamping & Forming Center of Excellence network, a local conference, and magazine published quarterly
Access	Open, daily use
Notes	Previously owned by Volvo Cars

7.9 Technology Development Center, Tetra Pak

"We picked Karlshamn [over Lund] due to the existing food facilities here."

Date established	2018
Location	Minervavägen 12, Kalskrona
Objective	Test networking protocols for new mobile handsets
Business model	For Telenor employees and partners as part of Telenor Global Services, no fee
Access	Closed to employees, open to requests from partners & others, daily use
Notes	Not open to startups or external use, though being considered

7.10 Tech Room, Hyper Island

"The whole Hyper Island experience is a testbed. We pride ourselves on not having textbooks, not having tests or teachers. It's all about experiential learning."

Date established	Estimated 2012
Location	Bastionsgatan 8, 371 32 Karlskrona
Objective	Support student projects in motion design, online user experience, and related areas
Business model	For Hyper Island students, included free in program tuition

Access	Not open to community, though could consider special requests
Notes	Each student program includes a corporate-sponsored project

7.11 Visbo, Karlskrona Kommun

"It is important to see and completely relate to this older demographic for real use… one of our goals is to be a part of research and common good for the community."

Date established	2015
Location	Norra Smedjegatan 14 B, Karlskrona
Objective	Provide a demo space for older residents to be inspired and understand possible consumer products and digital services that can offer a safer and simpler home life, also available to rent (and live as a temporary resident) for research purposes up to two months
Business model	Free to residents
Access	Open, returning to weekly use
Notes	Received approximately 800 visitors in 2018

7.12 Visual Data-Driven Lab, Blekinge Institute of Technology

"We want companies to come in; we still need to develop how they will use it."

Date established	2019
Location	Building J, Department of Computer Science, Blekinge Institute of Technology
Objective	To study and develop experiments related to visual and interactive computing, including eye tracking studies for games
Business model	Funded by a research project and university funds
Access	Open to BTH researchers and lab partners, low use
Notes	Have an initial equipment list but not purchased items yet, in process of relocating to a larger lab space on campus

8 Appendix

8.1 About the author

Tamara Carleton, PhD, is a global business executive, educator, and thought leader in strategic foresight and innovation, focused on building innovative, impactful organizations. Her Silicon Valley-based firm Innovation Leadership Group trains and coaches teams around the world, and clients include Airbus Group, Microsoft, Vinnova, and Volvo Group. In addition, Dr. Carleton teaches innovation and foresight at multiple universities worldwide – at Stanford University in the US, University of Zurich and University of St. Gallen in Switzerland, Tecnológico de Monterrey in Mexico, and Osaka Institute of Technology in Japan – which helps her to bridge thinking and doing, plus shape the next generation of leaders. She is one of the few experts that has studied DARPA's model of radical innovation. She holds a doctorate in mechanical engineering from Stanford University.

8.2 About Blue Science Park

Blue Science Park is an innovation environment that strengthens Blekinge. Blue Science Park's mission is to accelerate innovation and digital transformation in business and society. We are a meeting place and development environment. Here, individuals, companies and organizations gather and collaborate to develop themselves, their businesses and society. Today we are over 80 members, representing the entire ecosystem – from research and education to producing companies and advanced users. Blue Science Park was founded in 2015. We are funded by our members, Karlskrona Municipality, Region Blekinge, and Blekinge Institute of Technology. We also receive project funds from various financiers, such as Vinnova, the Swedish Agency for Economic and Regional Growth, and the ESF. See more at https://www.bluesciencepark.se.

8.3 Recommended reading

As an introduction to the topic of testbeds, especially for a regional context, we recommend this subset of readings as a start:

1. Nesta. (2019). Testing innovation in the real world: Real-world testbeds. https://www.nesta.org.uk/report/testing-innovation-real-world/
2. Business Region Göteborg. (2022). What is a testbed? https://www.investingothenburg.com/advantage-gothenburg/testbeds
3. Swedish Incubators & Science Parks. (2022). Forthcoming testbed report.

8.4 List of interviews

Below is a list of the 29 people we interviewed that were conducted for this pre-study, listed alphabetically by first name:

1. Adam Edström, RISE
2. Andreas Larsson, Blekinge Institute of Technology
3. Anton Johansson, iStudios Visuals
4. Cecilia Lindberg, Hyper Island
5. Christian Berger, SISP
6. Daniel Wiklund, Stamping & Forming Center of Excellence
7. Emma Hessbo, Ronneby Kommun
8. Fredrik Anderberg, Olofström Kommun
9. Fredrik Sjölin, Karlskrona Kommun
10. Göran Pantzar, Tetrapak
11. Herman Olsson, S-Group Solutions
12. Ingela Håkansson, Techtank
13. Jenny Nordberg, SPOK
14. Lars Bern, Business Region Göteborg
15. Magnus Olsson, Saab Kockums
16. Magnus Sandell, Karlskrona Kommun
17. Magnus Svensson, Telenor
18. Marc Ljungström, CLUK / Maseco
19. Martin Johansson, Techtank
20. Martin Wallin, Ericsson
21. Mikael Lagström, TrueSec AB
22. PerOla Helin, Cetetherm
23. Peter von Trampe, Business Blekinge
24. Samuel Henningsson, formerly NetPort
25. Siri Arntzen, Nord University (formerly Arup / Nesta)
26. Roger Johansson, Roxtec
27. Ulrika Kastell, Sölvesborg Kommun
28. Veronica Sundstedt, Blekinge Institute of Technology
29. Wilhelm Ast, Region Skåne