Challenge Lab NMS log book

exploring the role of hydrogen in realizing a good life in North Middle Sweden through circular and low carbon industrial transformation: technical report for DG REGIO pilot for regions in industrial transition

Douglas, Anna; Holmberg, John; Holmén, Johan; Williams, Steve; Wise, Emily

2021

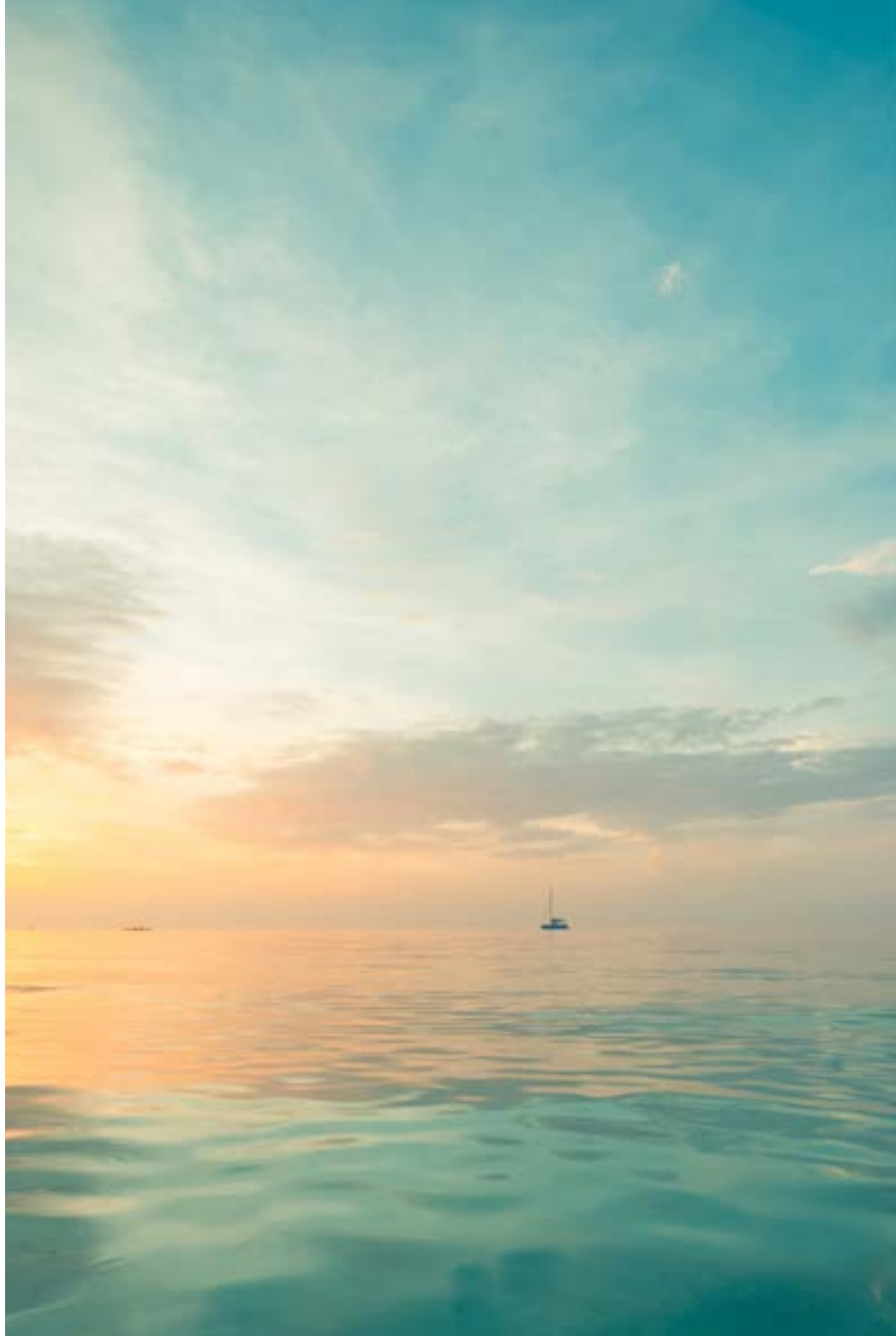
Document Version:
Publisher's PDF, also known as Version of record

Challenge Lab NMS

LOG BOOK

Exploring the role of hydrogen in realising a good life in North Middle Sweden through circular and low carbon industrial transformation

Contents



Think big, start small, Act now!

Industrial transition is a challenge faced by many regions today. We face global challenges that do indeed challenge our entire way of working, being and even thinking.

Regional authorities (Regioner) are responsible for coordination and leadership for regional development and have a responsibility to lead work towards the Sustainable Development Goals, by working together with multiple sectors and actors. Across boundaries, geographical and sectoral, we seek to address our shared challenges and use our regional strengths to identify and develop solutions collaboratively.

This booklet will tell you about our pilot to try to create a space for collaborative transformation: Challenge Lab North Middle Sweden (NMS).

Led and supported by a diverse team, and joined by a bold and creative group of explorers, this expedition has sailed into uncharted waters and returned. Launched at the final project seminar in June 2021, this booklet seeks to tell you about Challenge Lab NMS- the why, the how, the what, and the lessons learned along the way.

Last but not least we want to inspire and generate new ideas on how transformation can be approached, why it is needed and how it can connect to the operations we must complete every day (the cruise ship of normal business), and align them with our long term purpose.

Overview: Challenge Lab NMS

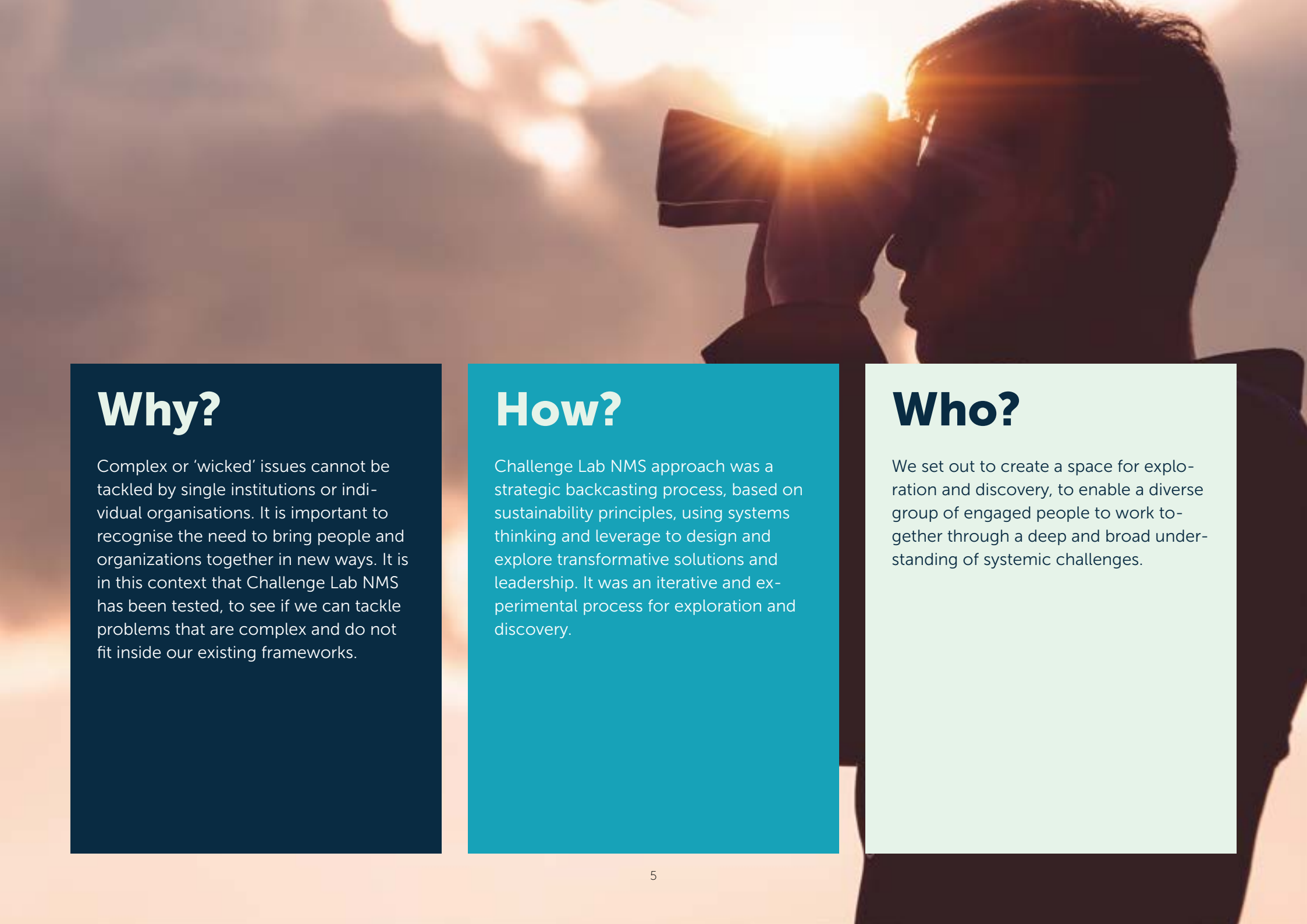
Society is facing major challenges. These include climate change, air pollution, inequality, political polarisation, insecurity and of course a global pandemic. These are BIG issues and BIG ideas are needed to tackle them. But big ideas need to start small, locally, somewhere. So why not here? And to stand any chance of making change, it has to start now.

What do we mean by Challenge Lab NMS?

"Sustainable development has been recognized by the United Nations (2015) as a challenge of transformation and integration. Transformation in the meaning that marginal changes are not sufficient, it is a question of systemic change to shift the world towards a sustainable path. Integration in the meaning that all dimensions of sustainability have to be considered simultaneously, and that we have to work together across sectors and scales"(Holmberg and Larsson, 2018).

Challenge Lab is a challenge-driven innovation and co-creation platform originally developed by Prof. John Holmberg and Chalmers University of Technology. Its aim is to support the transition towards a more sustainable society. Challenge Lab is a process to create space for collaboration between organisations within academia, industry, the public sector and civil society. Based on a backcasting methodology, the process explores complex sustainability challenges from multiple perspectives, and identifies leverage points where there is potential for bridging the gap between a desirable, sustainable future and unsustainable systems of today.

Challenge Lab NMS was a trial, testing a bespoke approach focused on quality & process. We set out to create a learning and adaptable process where our small expedition could venture out to understand how we want our future to be, find out how the present really is, and to identify, design and experiment with interventions that can create transformation. At the same time, our cruise ships, the core business organisations we normally operate within, freed us to explore and take risks, but without putting them at risk. Here we tell you why we did it, how we worked, what we discovered and what we learned along the way.



Why?

Complex or 'wicked' issues cannot be tackled by single institutions or individual organisations. It is important to recognise the need to bring people and organizations together in new ways. It is in this context that Challenge Lab NMS has been tested, to see if we can tackle problems that are complex and do not fit inside our existing frameworks.

How?

Challenge Lab NMS approach was a strategic backcasting process, based on sustainability principles, using systems thinking and leverage to design and explore transformative solutions and leadership. It was an iterative and experimental process for exploration and discovery.

Who?

We set out to create a space for exploration and discovery, to enable a diverse group of engaged people to work together through a deep and broad understanding of systemic challenges.

Background & context

North Middle Sweden took part in a pilot "Regions in Industrial Transition", launched by the European Commission to test new approaches to dealing with industrial transition. By focusing on specific challenges related to industrial transition, the pilot sought to develop new tools for regions and cities.

An outcome of our industrial transition pilot is our "NMS Strategy for Industrial Transition" which identified 5 priority areas to support regional industrial transition. We identified that one of the greatest challenges is to build a society independent of fossil fuels: a challenge that extends far beyond the region and Sweden's borders. Industry and its value chain use large amounts of energy and is thus crucial to being able to solve the climate challenge. The strategy and popular version can be found here.

A Reglab event in 2018 featured an inspiration session on Challenge Labs by Prof. John Holmberg. As part of the EU pilot, each region received support to develop a High Impact Action. The industrial transition NMS steering group decided to develop and deliver the Challenge Lab NMS and Seed Fund, focused on addressing this challenge of transformation to a low carbon, circular and resource efficient industrial economy, as our High Impact Action. We realised that a new approach was needed for sustainable systems transformation and entrepreneurial discovery beyond traditional product and service innovation, and we deliberately created a space for exploration. Challenge Lab NMS was started with a kick off in November 2019.

Challenge Lab NMS Design & Planning

Who is behind Challenge Lab NMS?

From the idea of a Challenge Lab NMS back in 2018 to today, there have been some core people involved in the process.

Anna Douglas has been the Challenge Lab NMS project manager and process leader, navigating the design, planning, implementation, process leadership, setting up the Challenge Lab Seed Fund and management of the entire process. Anna has worked on behalf of the regions of North Middle Sweden employed by Region Gävleborg.

Prof. John Holmberg has been the Challenge Lab coach and advisor. He has worked with Challenge Lab NMS since 2019 and has coached, supported, challenged and developed the transformation capacity of the regions throughout the process. This intentional approach aimed to build capacity for learning, reflection and change within the organisations doing Challenge Lab as a process.

Emily Wise is a researcher at Lund University and also a consultant action researcher. She was engaged by the European Commission to support NMS region during the industrial transition pilot in 2017 and continued as an action researcher in the Challenge Lab NMS.

Johan Holmén and Steve Williams from Chalmers University of Technology have also joined the Challenge Lab NMS team in 2020 to support with evaluation and learning. They are postdoctoral researchers with experience of other similar labs.

Three strategists from the NMS regions have formed a steering group for Challenge Lab NMS, ensuring some connection between the regions and the process, and managing project oversight. They are Carina Åkerberg (Gävleborg), Eva Lundin (Dalarna) and Anders Olsson (Värmland).

Peder Kjellen from the University of Gävle supported the workshops as a facilitator, with additional design, analytical and process support and with report writing.

Facilitators have proven to be vital in the process especially in the digital format. These needs were not well anticipated and were resourced by members of the Challenge Lab NMS working group and others involved in the process. Facilitators and working group members changed throughout the process but the core team was Nicklas Tarantino (Sustainable Steel Region), Paul Bogatir (Hudiksvall Hydraulic Cluster), Anders Lundell (Sandbacka Science Park), Linnea Hassis and Eva Lundin (Region Dalarna) and Paul Nemes (the Paper Province).

Challenge Lab NMS approach

The Challenge Lab is an expedition into the unknown. We use the metaphor of the Cruise ship and the Expedition throughout. The cruise ship is the normal ongoing organization or core business. There the focus is on improvement, efficiency and optimisation. The path is known and the journey safe and

Key concepts

There are several key concepts in a Challenge Lab approach

Cruise ship & Expedition two complementary logics for institutional stability and change that balances exploitation and exploration without compromising either.

Backcasting a structured methodology for transformation work starting from an idea of a desirable future followed by analysis and action to get there.

Sustainability Lighthouse guiding socio-technical transitions towards sustainability to support and inspire conversations on sustainable and desirable futures, in setting purpose and direction.

The Multi-Level Perspective (MLP) is a framework for describing transition processes in complex socio-technical systems at different levels, to help us analyze and better understand transformation processes.

Iceberg model a tool for systemic thinking to understand leverage and transformational potential.

comfortable. But real profound transformation takes us into uncharted waters, so we need expeditions. Here the logic is focused on learning and discovery and cannot be evaluated with the same evaluation tools that you have in the cruise ship. In exploratory mode, it's not about how much you did, it's what you learned when you did it. Even a mistake is a good expedition if you learn and feed that back to the cruise ship. The tension between security and comfort of the cruise ship on one hand and the risky and exciting exploration of the unknown on the other. In the expedition we step away from a focus on safety and avoiding mistakes to being brave, together, by creating networks and connections between people and organisations. And we keep a connection between expedition and cruise ship, via docking in and sharing our learning.

To effectively bring about and guide systemic change you need to understand the systems of which you are part. Challenge Lab NMS trialled a strategy for working with systems innovation, a way to engage with and re-configure whole systems rather than just changing individual parts. This means we are after transformation and not only incremental adjustments. The adopted process recognised and embraced complexity rather than seeking to reduce it, attempted to be systemic and systematic, explored multiple perspectives of both challenges and ways of addressing them, and tried to be inclusive in engaging a diversity of stakeholders.

A background reference to the whole process can be found in Holmberg and Holmen (2020)

The challenge was put in the centre: our intention was to establish a platform for co-creating and learning for transformations; a space for social collaboration and alignment around a shared challenge. We sought to frame the challenge in such a way that it attracted and engaged people.

Challenge Lab NMS was facilitated by a regional authority as facilitator of regional development, creating a separate yet connected space for diverse actors to come together on a challenge.

Collaboration is Queen: when no single organisation can affect meaningful change on their own, as with complex systemic issues, collaboration and coordination is of vital importance. In such a collaboration we do not need to reach consensus, but we need to agree to listen to and understand each other.

The alignment of actors: one of the key shifts is to go from individuals representing their personal and/or organizations' interests into a group aligned around the same transformative issue on a systems level. Such a collaborative platform creates a collective intent, particularly emphasised in the first step in the workshop process.

Challenge Lab and its approach aims towards systems transformation for sustainability transition. This means that the process does not merely aim to find solutions or innovations. Rather it aims to better understand the problem and the system of the problem. In working with a Challenge Lab approach as a form of backcasting expedition, we hoped to generate immediate impacts in at least four directions:

- **Create knowledge:** by exploring the systems of our challenge and sustainability perspectives we aimed to build up a better knowledge base in our expedition.
- **Enable change:** by doing the challenge lab process we aimed to create change through knowledge, awareness and increasing the agency of the participants through creation of new networks and capacity.
- **Address our challenge:** by exploring our challenge and the systems and perspectives, we aimed to identify transformative interventions that could identify how hydrogen can generate industrial transition and the good life in our region.
- **Build capacity**: by designing, facilitating and evaluating as well as participating in a Challenge Lab approach we try to generate an enhanced capacity to purposefully address complex sustainability challenges in present and future work.

Together these combine to form the aims of Challenge Lab NMS.

Challenge Lab NMS process

Creation:

We engaged a working group formed to identify and frame our core challenge. The working group started late 2019, understanding the process and identifying our core challenge. We put that challenge in the centre to engage people in a complex issue, without pre-defining outcomes or particular deliverables. This aimed to give the backcasting approach an opportunity to succeed, and appreciated that transformation is open ended and agile.

In this phase, a working group had the task to design the process, coordinate the work, and engage stakeholders to form the larger group of lab participants. The the covid-19 pandemic drastically changed the conditions for design, planning and delivery. A new digital approach was needed and this led to both changes and delays, including reducing the participant numbers that could engage in the process.

Our core challenge was finalised in the autumn 2020, formulated as "Exploring the role of hydrogen in realising a good life in North Middle Sweden through circular and low-carbon industrial transformation".

The challenge was developed based on the original focus on low carbon, resource efficiency and circular industrial transition with the additional focus on hydrogen as a developing strength area within smart specialisation. The regional focus on sustainable production and advanced manufacturing was increasingly identifying hydrogen as a possible development area. The core challenge also encompassed societal challenges, so the working group agreed that it would be a good focus for Challenge Lab NMS.

Workshops:

PROCESS

The Challenge Lab NMS process was learning focused. Not the kind of learning where we only seek to do what we do better (conform), instead where we seek to do better things (reform) or even see the world in new ways (transform) (from the English anthropologist Gregory Bateson).

The task was to attract and engage participants around the shared challenge, joining together and creating a space to explore the questions rather than immediately searching for solutions. This meant that we needed to stay in a mode of inquiry, seeking to understand an issue from multiple perspectives and rationalise our principles of success. To do this, we designed and hosted a series of workshops, following a pattern to create security and psychological safety in the group, enabling an atmosphere suitable for sharing thoughts and ideas, trying out and testing new things and learning together.

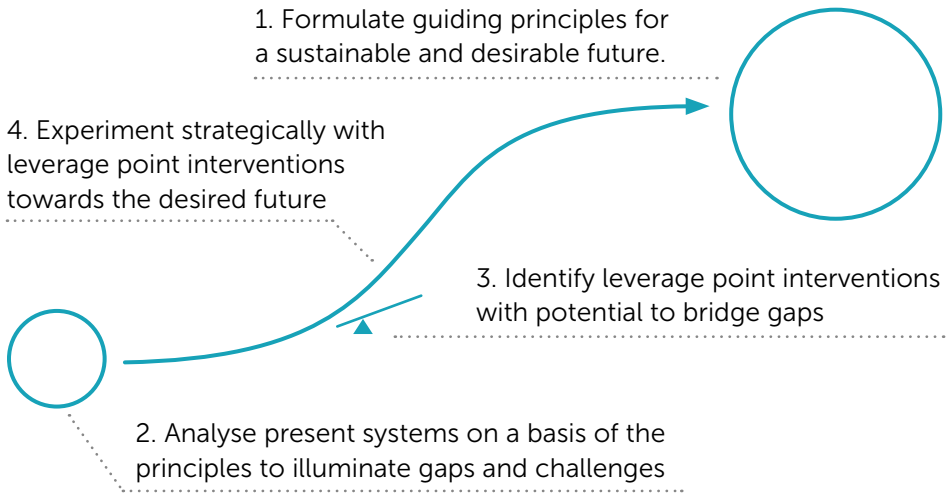


FIGURE 1 *Primary steps in a backcasting from principles methodology (from Holmberg (1998) and Holmberg and Larsson (2018)).*

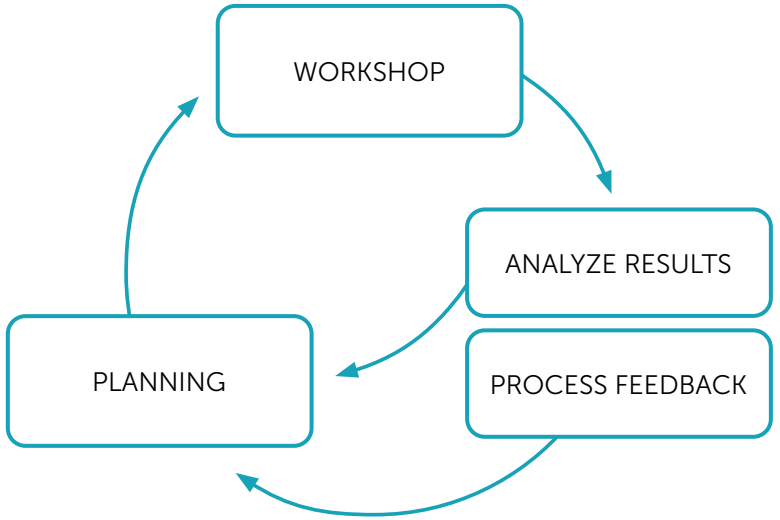


FIGURE 2 *Continuous evaluation & adjustment*

The backcasting methodology used seeks to open up for futures that are fundamentally different compared to what was before. The methodology builds on four primary steps, see figure below:

In moving through the four steps, it seeks to support us in thinking beyond what currently is – into what is truly important and should be; in thinking broader than we normally do in considering multiple perspectives and sustainability dimensions; in thinking behind/below symptoms and events into underlying causes and reasons; in thinking forward by encouraging purposeful action and in thinking together by creating a structure and 'scaffold' for the group as a shared reference.

Practically, our process consisted of four workshops with associated planning and evaluation work before, after and in between. The core team was made up of a design group, responsible for workshop structure and content, an evaluation group and facilitators. Our process was iterative, meaning that we continuously evaluated and analysed our progress and results in order to reflect, adjust and inform (Figure 2).

LEARNING & EVALUATION

As the Challenge Lab NMS (and Seed Fund) were part of a broader exploratory experiment to help provide insights on how regions can support sustainable systems transformation and entrepreneurial discovery beyond traditional product and service innovation, learning and evaluation was a core part. The evaluation activities were focused on learning (not checking) in order to provide insights about the process and how new capacity and knowledge gained is being applied to enable change that addresses the core challenge. The evaluation team was part of all workshops and led 'debrief' sessions for the design team after each workshop to illuminate key lessons on the process that could be directly applied in the design of future workshops. In addition, the team conducted a mid-term survey and follow-up talks, and a final set of interviews to establish overall learnings and insights.

Challenge Lab NMS: our exploration & discoveries

Workshop 1 – Establishing guiding principles

GOAL

The first workshop oriented around questions of what is truly important and why. The aim of this workshop was to identify our shared guiding principles for sustainability by establishing the frames for a desired future situation (rather than painting the picture in detail). A main reason to start with guiding principles is that the current situation tends to constrain our thinking into what is and has been, becoming a major obstacle when one seeks to develop radically different alternatives to the status quo. In other words, the guiding principles sought to support us in thinking beyond existing systems into what is truly important and desirable – providing the process with a motivating purpose, a shared sense of direction and personal meaning. The guiding principles were further used as a lens in the subsequent steps to support in directing attention towards the most important/problematic phenomena in the present, seeking to avoid falling into the trap of looking "under the light of the lamp" and a mere reacting to symptoms.

PROCESS

The first step was to get everyone on board. There was some uncertainty amongst everyone in Challenge Lab NMS as we set off. Looking out into uncharted waters has that effect! But we trusted the process and focused on getting ourselves into the mindset and the way of being. To do so we focused on introducing why we were on this journey and who we were being guided by. We then introduced some of the key concepts to the participants. The first is the concept of cruise ship versus the expedition mode. The normal business is done on the cruise ship- with known, predictable and safe processes and destinations. The expedition is the Challenge Lab, a space without a clear destination or targets, and with a higher risk tolerance and a brave and intrepid small group of people seeking out and learning together.

This initial onboarding then focused on trust building. We looked at personal values, sharing and listening in pairs, gaining deeper insights and daring to talk personally with someone new. This process used the digital break out rooms, enabling private conversations. These were not reported back to the whole group but reflections and some individual learnings were shared to the whole group.

Figure 3: The Sustainability Lighthouse model by Holmberg & Larsson (2018)

The main task in the first workshop was using the sustainability lighthouse model in Figure 2 to look forward into our future and understand what this would mean for our core challenge. We set a rough date of around 2050 which is beyond political and economic cycles but near enough to envision. The workshop used a 'world café' approach, with the same group moving between different questions with the facilitator remaining at the same table and helping to build up

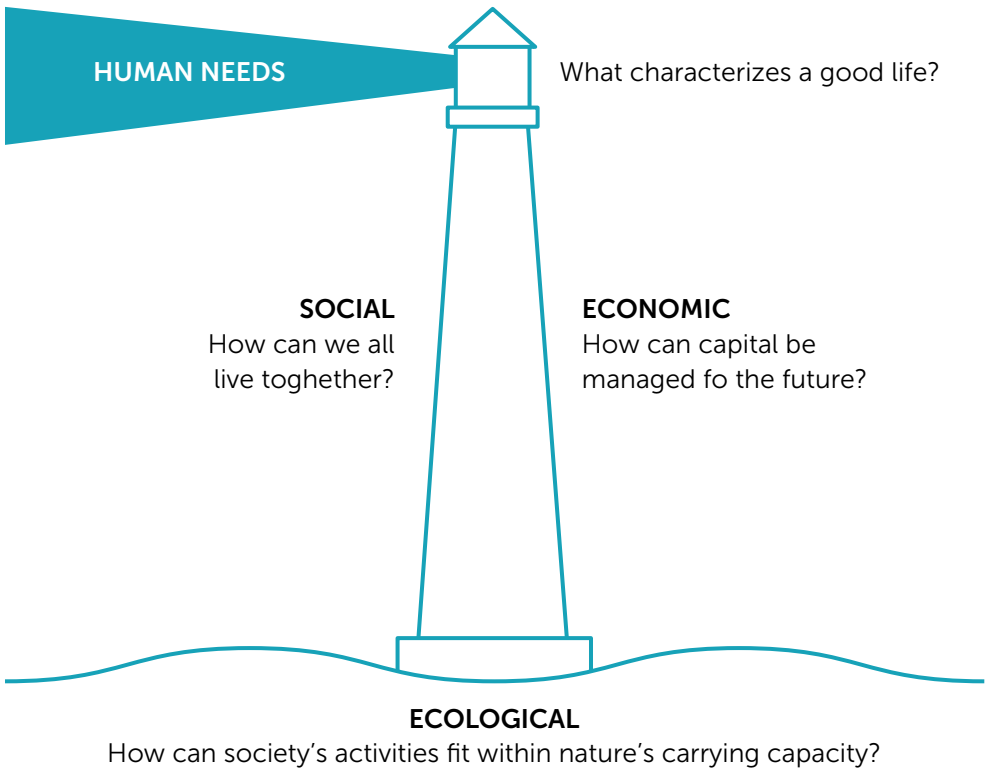


FIGURE 3 *The Sustainability Lighthouse, Holmberg & Larsson 2018*

a combined view from all of the groups. The focus was on four areas: human needs, social, economic and ecological sustainability.

The groups discussed how a desired future would be related to our core challenge. The discussions were wide ranging and also involved some sharing of different perspectives from the participants. Each topic had a designated facilitator who captured each discussion in the form of post it notes on a digital whiteboard and then showed the next group, building upon the previous group.

The future principles were reviewed and clustered by the facilitators and then the participants voted for what they thought most important. After the vote, we reviewed the results and had a second vote to give everyone a chance to highlight something they thought might have been missing in the first vote.

There was some discussion in the group about the most selected areas, and discussion of what each meant to the participants, including an important discussion about equity and inclusion from non Nordic participants and also what a future economic model would enable for environmental sustainability.

DISCOVERIES

The process led us to discover that there was a diverse group, quite aligned about a desired future for our core challenge. However there were divergent views on the role of economic growth and economic models between some of the academia participants (de-growth) and the industry participants (sustainable growth).

The process generated an identification of guiding principles for our expedition- setting a shared compass for our future course, but it required post working after the workshop and further adjustment in dialogue with the participants.

The agreed guiding principles also included some of the means for how to achieve our core challenge in North Middle Sweden. The group agreed that the areas we should aim towards were:

- Low emissions: we should have a mostly emissions free society in the future, including industry, energy, and transport
- Circular, renewable & resource efficient: resources should be kept in use and used effectively for maximum benefits and minimum impact.
- Equity & inclusion including rural & urban: the group felt strongly about equity and inclusion being a guiding principle, and specifically included the rural and urban perspective as well as gender, diversity and inclusion.
- New economic & political models: a means to achieve our core challenge is a new approach to the economic and political models of today, especially valuing nature and the environment that is currently excluded from today's economic approaches.
- Peaceful, happy, creative & open society: the group felt that our core challenge must include a focus on peace and security but also joy, creativity and creative expression.

These guiding principles were formed into lenses through which to view the rest of the Challenge Lab NMS process

Workshop 2 – Analysing the current situation and the gaps

GOAL

In the second workshop the focus shifted from the future to the current situation, addressing questions of what currently is and why. The guiding principles formulated in the first step were used as a lens to capture the most pressing/important sustainability challenges and their underlying causes. The aim was to identify a set of challenges (gaps) in the tension between the current situation and desirable future. In addition to identifying these main challenges, it was of interest to also identify larger societal trends and already ongoing initiatives that engage with or affect these challenges.

PROCESS

Opening the second workshop was about landing back in the space for exploration. This was done through a reflection on the first workshop, re-engaging the participants in our 'why' in terms of our desired future principles for the core challenge.

We invited the participants to reflect on their own perspective and share that with another participant. This aimed to increase awareness of how perspectives are different, and how seeking to look and take different perspectives can have a big effect upon what we find. The group engaged in the process and reported back some learnings and perspectives from their discussions.

We clarified and refined the lenses, particularly "economic models" and its importance for a sustainable future. We then looked into data (collected in advance) on the current situation in our region related to these lenses, asking "what is our current status and why is it so?"

The current status was then presented to the participants and the Multilevel perspective (MLP): a framework to understand systems innovation and transitions through has dynamically occurring across the interplay between technology and society with three nested levels; landscape, regime and niches.

This framework enabled a discussion about the dynamics of our current status. The workshop developed the MLP canvas focusing on specific systems, from the perspective of industry, transport, society and energy for the three levels in the MLP.

The groups discussed what is not working today in the current regime, and what gaps exist between where we are and where we want to be. The discussions then focused on how hydrogen plays a role in the gap between the current situation and the desired future.

The next step introduced the "iceberg model". This looks at surface effects of what is causing the current regime and then deeper into the underlying causes, from structures to mental models. Finally we looked at the gap between the current regime, the lenses and what causes could bridge the gap.

DISCOVERIES

The workshop generated a detailed multilevel perspective map of the landscape, regime and niches in NMS relating to hydrogen but with a focus heavily on Gävleborg. The landscape had least focus, and remained based upon the prevailing megatrends, decarbonisation, digitalisation, electrification and distributed and intermittent energy systems.

The regime or prevailing reality of how things are today focused significantly on economic and human factors of culture and norms. Key focus areas were the lack of an economic model valuing the environment and nature, and the prevalence of a cultures 'bruksmentalitet' which is a dominant cultural norm with conformist hierarchy dependant on the mill patron, and 'jantelagen', similar to 'tall poppy syndrome'. These were identified as dominant in the current reality and blocking innovation and transformation. The group agreed that there are many positive aspects of these cultures but that we need to be more aware of their impacts on the story we tell ourselves, and our agency in change and transformation.

There were many 'niches' or bubbling new ideas within all the systems (industry, transport and energy) related to hydrogen with embryonic projects, businesses and technologies identified. Hydrogen for fossil free steel processing, energy system services and applications for heavy transports were identified as the most relevant and concrete in the near term.

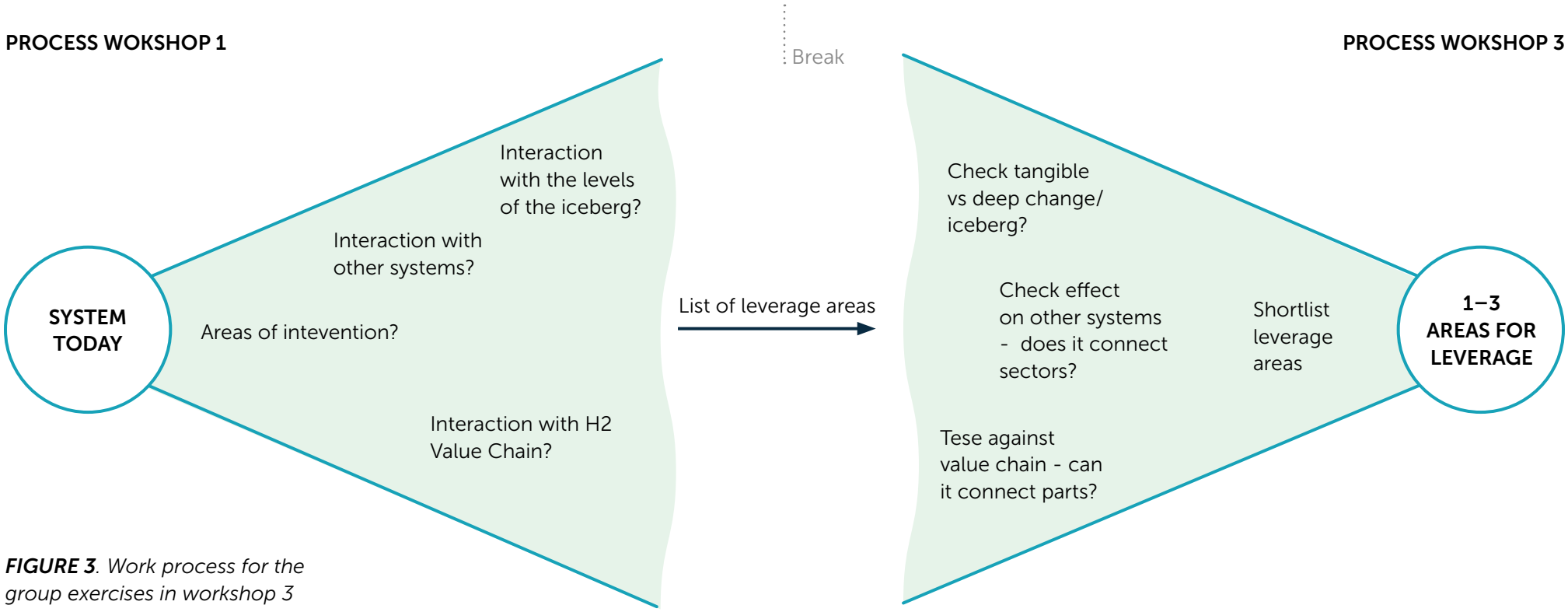


***FIGURE 3**. Work process for the group exercises in workshop 3*

Workshop 3 – Focusing on possibilities with the potential to bridge the gaps

GOAL

The third workshop oriented around questions of what could be different and where. The aim was to identify areas of intervention (not solutions) with leverage point potential, where smaller interventions can lead to bigger changes in directions towards sustainability. This means that immediate interventions should also provide good platforms for subsequent transformation steps. In other words, we sought to find the most relevant leverage points where possibility lie in closing the gap between where we are (workshop 2) and where we want to be (workshop 1). To arrive at a diversity of leverage point interventions with transformative potential, it is important to reflect upon and look into a system from many different angles and perspectives.

PROCESS

The workshop process began with a reflection on the previous workshop. The group reviewed the Multilevel Perspective (MLP) from workshop 2, which was represented in a new format for further development in this workshop. This was to help frame the current status in a way that could add more dynamics and identify transformation potential.

With the workshop focusing on where to create change, we did our check in exercise on our experiences of change processes. The discussion then included some of the challenges and discomfort participants had felt with change, but also some of the learnings and experiences gained. This framed our mindset for engaging with change and being open.

Before starting the group exercises we walked through the concept of leverage points and how different kinds of leverage points can impact change in the system. An example story was told to describe one of the participant's ideas for

a leverage point as inspiration to the process, about an opportunity to use heat produced as a by-product from industrial hydrogen production for a social enterprise.

We did two group exercises following a process to expand out and look at many opportunities (part 1) and then focus on specific leverage points (part 2), illustrated as an innovation diamond (Figure 4).

DISCOVERIES

Amongst many discoveries was that there were many ideas on where we could intervene in the system. Many new opportunities we identified with active engagement by all in the Challenge lab NMS. The process flowed well following from the check in and there was a lot of energy created in the discussions. Some of the areas identified in the different groups connected across the systems and industrial symbiosis and linking the systems and sectors came through the discussions strongly.

The second part of the workshop, to focus on and develop a few leverage points, was more complex to facilitate and led to less clear outcomes. The groups found the process harder and becoming concrete whilst still not focusing on a solution was a difficult task and the groups delivered a list of questions that helped to frame the preparation for workshop 4.

Workshop 4 – Identify priority actions and next steps

GOAL

The fourth workshop oriented around questions of what can be and how. The aim was to elaborate concrete suggestions and ideas for how to practically engage with the leverage point interventions identified/discovered in step 3. In such work, it is important to capture learning on what works and why in preparing for

TRANSPORT	INDUSTRY	ENERGY
Electrified transport networks & power systems	Multiple applications for hydrogen in industrial heating	Direct chain: Hydrogen production, distribution and use
Backup power and mobile systems	Waste product based hydrogen production opportunities	Hydrogen, storage and electricity
Local production systems & nodes	Meeting points for crossovers between industries and sectors	Synergies: sector coupling
	New collaborations and value chains	System development and locking
		Collaboration, coordination and engagement
		Learning from other sectors
		Civic engagement

upscaling of that which works and avoid that which does not. To enable such learning, it is important for participants to dare being vulnerable, sharing ideas and suggestions for ways forward in their early development to open up for feedback, iteration and new perspectives for further improving. Essential at this stage is also to think what can be consolidated and brought back into the participants' main organisations to improve and change how work is organised in terms of why, what and how things are done. As a learning process, this fourth step seeks to initiate scaling processes in transforming current systems in direction towards the guiding principles for sustainability.

PROCESS

To land in this last, forward looking space, we considered a time when we dared to try something new without having a defined or clear outcome in our paired check-in. We talked about how we shared our thoughts before making a decision and relating it to our experience of taking risks and venturing into the unknown. As in previous workshops, we connected back to the overall process and presented the discoveries from the previous workshop.

The group reviewed and complemented leverage areas from workshop 3 in a leverage point map. Then they selected a leverage point for development using a canvas to develop and explore different aspects in order to design experimental interventions with transformative capacity.

Towards the end of the workshop the group focused on the role of the coordinator of Mid Sweden Hydrogen Valley collaboration, to identify the most important tasks to move the network and the region forward in developing a hydrogen economy. This was a result of the clear identification of the Mid Sweden Hydrogen Valley as a key factor in the future of the hydrogen developments in the region.

DISCOVERIES

The groups used the leverage point canvas to experiment with their ideas, developing an intervention around a specific leverage point selected by the groups. 3 canvases were fully developed during the time and a fourth by one participant. These experimented with solutions based around the following leverage points.

1. H2 for steel heating, O2, transport & grid services with core focus on process heating of steel at high temperature though hydrogen and oxygen creating multiple spinoffs/ripple effects: for both environmental sustainability and economic viability
2. H2 containers for a pilot to provide H2 (and electricity) access to heavy machinery in remote areas without local hydrogen production
3. H2 industrial goods transport in collaboration with 1st industrial H2 refuelling & distribution routes

These interventions have developed with multiple perspectives based on the guiding principles for our core challenge. They also identified next steps and leading organisations to take the ideas forward after the workshop.

Challenge Lab NMS: what we learned

The continuous monitoring, reflection and learning approach throughout the lab process was complemented by deeper dives at the mid-term and after the 4th workshop to gather insights, experiences and "lessons learned" on the process. This focused on how and to what extent the lab was of value in enabling participants to connect, exchange perspectives and eventually ground and address the challenge, as well as tracing follow-up actions, activities and other results from the process.

The process

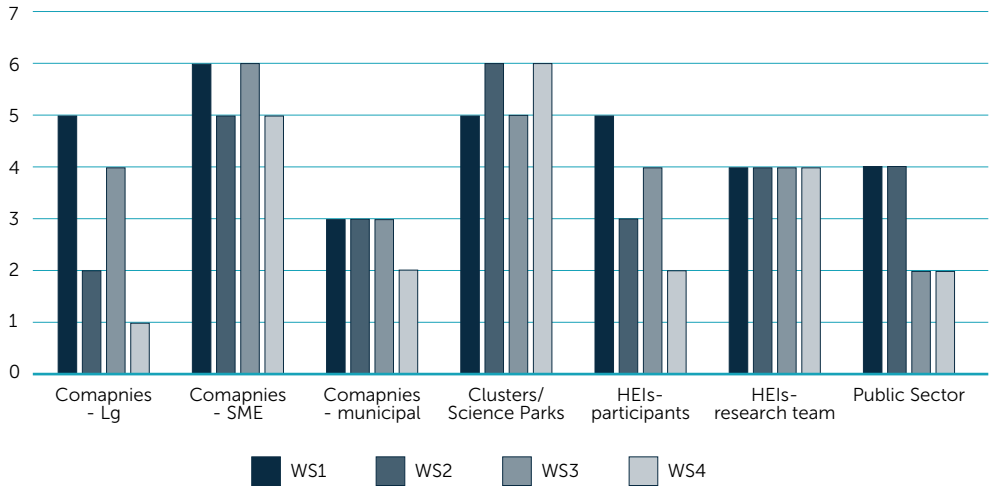
The objective of the lab (presented to participants in the invitation) was to establish a platform for challenge-driven innovation that will create dynamic growth by contributing to societal well-being and sustainability. The "exploration and discovery" process based on backcasting (in four workshops – described above) was designed to test new ways of thinking and doing related to the core challenge. So, how was this process experienced? And what did we learn? Why?

WHO PARTICIPATED AND WHY?

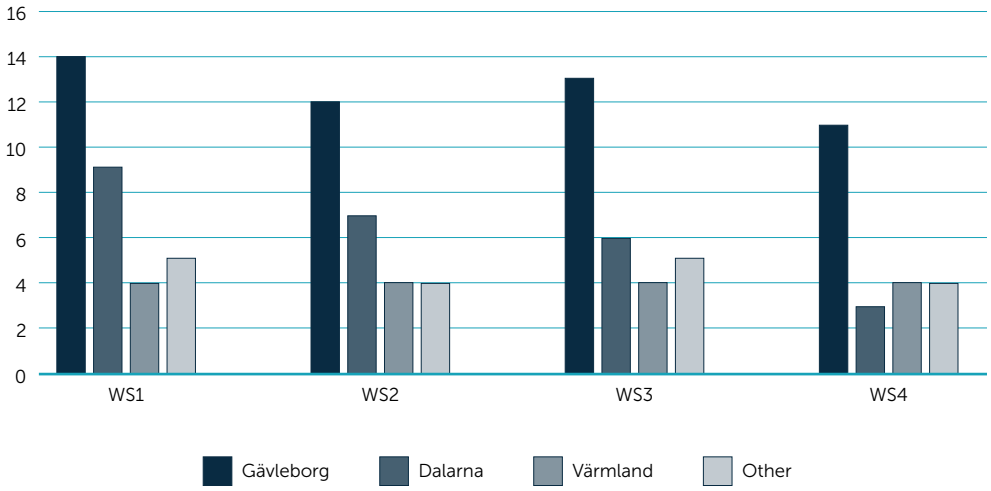
Excluding the external advisor, research/evaluation team and the project manager, there were between 17 and 27 participants in the challenge lab workshops (with most at WS1 and fewest at WS4). Unsurprisingly, company representatives (in particular those from large companies) had the most difficult time participating in all workshops. Companies represented around 40% of participants; clusters and science parks around 25%; HEIs (including the research/evaluation team) around 25%; and regional authorities around 10% (see figure below). On average, 46% of participants were from Gävleborg, 23% were from Dalarna, 15% were from Värmland and 17% were from outside North-Middle Sweden (see figure below). Around 75% of participants were male and 25% were female. 86% of participants were of Nordic origin; 14% were of non-Nordic origin. More than 50% of challenge lab participants engaged in mid-term[1] and final[2] learning and evaluation activities.

1. Mid-term survey had 63% response rate from WS2 participants; mid-term interview had 53% response rate.
2. Final interviews held with 14 individuals (52% of average WS participation).

Participation by Actor Group



Participation by County



Participants were personally invited to engage in Challenge Lab NMS, and a large majority had previous experience working with (hydrogen) energy transitions. In addition to "building on earlier conversations and relationships", participants chose to participate in the challenge lab because of the relevance and timeliness of the topic and because of their curiosity to learn more about the (backcasting) method, in order to apply in other contexts. Participants experienced that their main contribution to the process was being able to provide a different perspective: different actor group, different application area (energy, transport, manufacturing, etc.), technical or social system, niche or broad/holistic, or international. Participants felt that Challenge Lab NMS was designed so that everyone could contribute, and that having a diversity of perspectives was a key component to the success of the challenge lab. It was recommended that future lab processes include a stronger representation/ engagement of non-Nordic/international individuals and other age groups – in particular students/younger generation individuals.

EXPERIENCES FROM THE LAB/BACKCASTING PROCESS

Participants highlighted several aspects of the Challenge Lab NMS's backcasting process that were perceived as **valuable**:

BACKCASTING METHOD
– DRIVEN BY A TRANSFORMATIVE SUSTAINABILITY AMBITION

- The initial introduction to the Challenge Lab (as a method and process) was inspirational and awoke interest in being further engaged
- Taking on a long-term (20–30 year) future perspective and stimulating reflection on different aspects of a desired future highlighted a broader range of new opportunities and reinforced the relevance of various perspectives
- A structured approach, emphasis on establishing a common language and a focussed way of approaching and working with the challenge
- An interesting method – starting from "where you want to be" in a desired future rather than a problem in the present
  - The exercise in WS1 to transform values into guiding principles for sustainability raised awareness of additional perspectives/lenses that needed to be considered in the transition. Some participants highlighted that the principles-based approach put you in another mindset, and that it was important to do this exercise to realise that hydrogen is a means not an end in itself
  - Several participants mentioned they would take inspiration from or use backcasting and some tools in their own organizations, and some already had by the time of the final evaluation activity

MIX OF ACTORS/PERSPECTIVES

- The inclusion of various perspectives in all the discussions was experienced to bring understanding of other people and perspectives, as well as providing inspiration for taking action forward
  - Participants for example stressed that it was fun and energizing to work in a broad group with passionate people
  - Working with others who have different perspectives opens up new ideas/possibilities/inspiration

SAFE SPACE FOR EXPLORATION

- Many appreciated the check-in exercise, which provided the chance to establish a personal connection with another participant, helping to build a trusting atmosphere and to be more secure to open up and share perspectives and reflections in the group discussions
- These kind of connections are what sparks new perspectives, emotion (commitment) and action! It's so much about the setting, the people, and the openness/safe space that you create
- When joining break out room activities, it was good that we had a few minutes in silence to gather our thoughts and individually think on the task before immersing in discussion with others

Some elements were perceived as **not as valuable**:

- Generally good variation in participants/perspectives, but too little variation in age of participants (need young people as well!)
  - "Insight to realize that we weren't all there, we are missing people to make this more successful and make it happen more quickly" [emphasis added]
- The process introduced a number of new concepts (e.g. MLP, niche, regime) and models (iceberg model), as well as new digital tools (like mural) and perspectives (social, technical, etc.). The use of multiple tools and perspectives was challenging, and several suggestions were made in relation to this (mostly applicable to the digital Challenge Lab setting):
  - More time/clearer instructions on what should be discussed and desired results during the workshops (particularly in a digital setting)

  - Shorter sessions with less time in between the workshop sessions
  - Preparatory tasks to do in advance to build understanding of new concepts, etc. and to get everyone in the right mindset
  - Continuous recap of where the group is in the process, and why each step is being done
- Too little time for core tasks; sometimes felt as if didn't reach the bottom of discussions or realise the aims for the particular Workshop
  - Participants with much experience and knowledge on hydrogen-related issues found the knowledge base established in workshops as too basic
- Sometimes not clear on desired results from particular exercises; important to engage people in the method (and clear about the motivation to do various tasks); suggest to:
  - pedagogically review each step and how it fits with the purpose;
  - be clear about how the process fits together
- While the Challenge Lab was helpful to support a collective and long-term view (including identifying opportunities in the energy transition), there still needs to be enough actors/perspectives that are able to think of operational/concrete first steps that can be taken.
  - Were there too few companies?
  - Was there adequate coupling of the future-oriented discussion with "cruise ship" mechanisms to ensure legitimacy and relevance?
- The digital format made it difficult to realise the full benefit of the backcasting method (e.g. review and prioritisation of leverage points); could have needed more time (in person) to "assemble the troops", find common denominators for action, and clarify who can lead the way forward

Overall reflections/lessons on the backcasting process (as a tool/method):

- Quality of facilitation has implications on the quality of discussion (important to include/invite in all perspectives and provide equal access to the discussion space)
- Group's understanding of the 'task at hand' and time to "work through" the task is important to bring forward good results

HOW DID CHALLENGE LAB NMS DIFFER FROM OTHER COLLABORATION PROCESSES?

All participants have been engaged in collaborative multi-stakeholder innovation processes or projects previously. So what was experienced as different or special about the Challenge Lab?

Starting with a long-term sustainability ambition for the future – group reflection on values/why and setting the collective strategic purpose and direction on a level of principles

- "In many other processes, you start with the idea of what you will do together; which becomes much more focussed to quickly jump to action without thinking what it will lead to (further in the future)"
- "Valuable to really take the time to explore and 'define' the desired future"
- "Very interesting to think long-term and create consensus around a vision [values and guiding principles] for the future…enhances one's own picture"
- "If we agree on the larger vision, then we understand that it entails multiple levels of consequences on how different actors must change."

Focus on exploring and realising the relevance and value of various actors from several geographies and sectoral/thematic perspectives to achieve a common goal

- "Normally" each organisation commits to clear project goals/actions; can lead to fragmentation of efforts
- In other processes, can realise different perspectives and objectives during the process (and veer in different directions); this process focuses on exploring different perspectives from the start and helps to see how they can fit together
- This process is a way to mobilise a collective – to see how different actors (and ongoing actions) can gather together to achieve a bigger/broader whole
- "Many different actors meet…to go in the same direction."
- "Have not been working with hydrogen at all, not really taking any interest in it – not that I dislike it, but it was going under my radar. We [at our organization] need to embrace and start having in our system thinking to combine [hydrogen] with batteries and solar energy"
- It put NMS on the map. Previously I have thought the national level is most important, but this process has made me connect better with the regional level and it is an important level, and it weaves us together.

The imperative of considering broad perspectives (different lenses, sectors, time periods) – "forces" to think differently

- Including, for example, the social/societal lens (and other perspectives) on the energy transition; a more complex (and rich) discussion that opened up other ideas/possibilities
- "Think [social innovation] more important than technical innovation, can invent all we want but if no one embraces then just inventing for innovation's sake"

Embedding the big companies in the broader ecosystem – leveraging their efforts (and leadership) to mobilise others

- It was helpful to have large companies so engaged in the Challenge Lab; helped inform other actors of the necessity/relevance as well as the opportunities to act...to contribute or build onto existing activities

Rising to the challenge

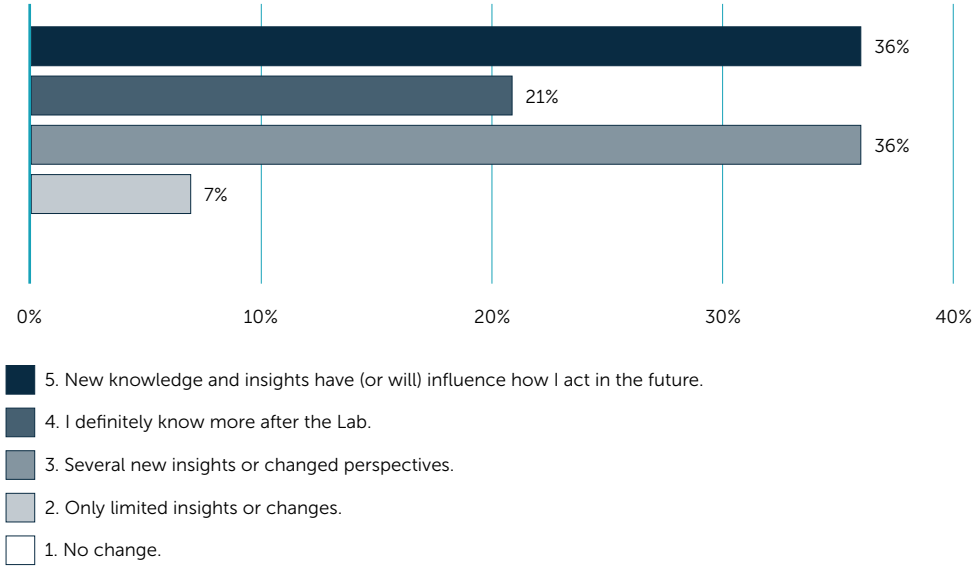
Participants were invited to join an expedition "to test a new way of thinking...to see from different perspectives, identify opportunities and think constructively" in addressing the challenge. How did the lab help participants gain new perspectives and strengthen confidence in their ability to contribute to addressing the challenge?

NEW KNOWLEDGE, INSIGHTS OR PERSPECTIVES ABOUT NMS ENERGY/HYDROGEN TRANSITION

Participants were 'hand-picked' and invited to the Challenge Lab. Thus, many had previous knowledge of the energy/hydrogen system transition challenge. Although many participants had previous (strong) knowledge of the challenge, they still perceived that they gained new insights and perspectives on the core challenge, with more than 55% of respondents perceiving that the challenge lab gave them (much) new knowledge and/or insights that will influence their future actions.

For the most part, participants felt that they gained a strengthened understanding of other actors' perspectives and insights how other players can contribute to the change process. The Challenge Lab also reinforced the relevance of the topic (and opportunities to act) from multiple industries and application areas – and in a longer term perspective. It is perceived that this reinforcement of relevance helps 'move' energy transition to become more of a central activity... linked more closely to core business.

To what extent has the Challenge Lab provided you with new knowledge, insights or perspectives about the energy/hydrogen system transition in NMS?



The process hasn't made it easier, but made it more clear how important it is to think and work with other perspectives (in relation to system transition). The ability to "see holistically" grew during the process.

I've been happy to learn that so many (different) actors have such commitment to energy transition. Confidence to act increases as one notices that more people (with different perspectives/in other organisations) think the same way and see the same opportunities.

Including other users in other parts of the value chain helps to see other opportunities. There are a lot of resources/strong assets that can be mobilised across NMS.

CONFIDENCE AND ABILITY TO CONTRIBUTE TO NMS ENERGY/HYDROGEN TRANSITION

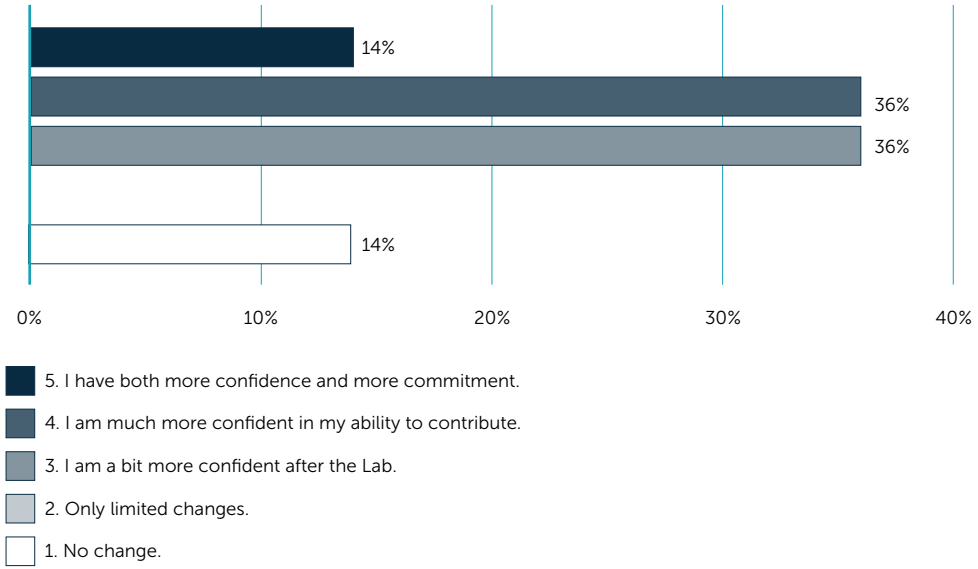
Given previous knowledge and engagement in the energy/hydrogen transition challenge, participants were already confident and committed to engage. The Challenge Lab provided additional knowledge about the impact on broader society (complementing existing knowledge about impact on environmental or economic aspects) and thus added perspectives and rationales to motivate action. This broadened perspective has catalysed interest, boosted confidence and reinforced participants' commitment to act – with 86% responding that the Challenge Lab contributed to their ability and commitment to contribute to the NMS energy transition.

I've gotten a broader and deeper picture of the question/system and am more informed...feel more capable to act!

I've understood that there are synergies and possibilities to collaborate with (clusters in other sectors and counties). The process has facilitated cross-sectoral connections. We are getting closer to each other.

The interaction with others has boosted confidence and a feeling of "backing"/ support. The Challenge Lab fills an important function – building a feeling of belonging and joint engagement.

To what extent has your confidence in your ability and commitment to contributed to the NMS energy transition changed since your participation in the Lab?



Results and ripple effects

At the start, the foreseen (potential) end result of the lab was "new ideas, solutions, pathways, projects or policy changes that can lead to transformation". These ideas could be supported financially by the Challenge Lab Seed Fund. So what types of direct results and initial ripples in the water did the challenge lab catalyse?

Participants in the Challenge Lab reported several **direct** results in terms of new or deepened connections, and in terms of new insights, ideas or opportunities to support energy transition in NMS. New connections help open doors with other organisations, leading to new possibilities.

I've made contact with a number of new individuals who will be important to maintain a dialogue with in the future. I've also developed deeper connections with several individuals.

I know many actors in NMS better as a result of the lab and think that it will help the innovation support system work better together.

It became clear to me how research and work in parallel with us in sales and vice versa: market establishment cannot happen without research and vice versa, it was clear, we need to work together even more.

The deeper connections helped provide new insights (on e.g. the relevance of social/societal aspects to energy transition, the possibilities with cross-sectoral connections) and highlight a broader range of motivations for and opportunities to act.

Challenge Lab has reinforced my views that the energy transition is not just about technical change, but also requires changed individual/societal behaviours and new business models.

Challenge Lab has strengthened insights on the need to be much better with cross-sectoral action (in energy production and energy applications in industrial production and transport). Currently, governmental departments and agencies have calls for one sector at a time – missing opportunities for SYSTEM transformation.

I think [Challenge Lab] has lowered the barriers and connected different actors within this area. It is we, they who can do something, if more people come together and want something, then things can happen.

Challenge Lab has increased our readiness to take upon challenges jointly across organisations. We managed to mobilise quickly on a separate funding opportunity for hydrogen infrastructure test-beds that we never would have been able to apply for had it not been for the connections made during Challenge Lab.

The Challenge Lab also provided insights on the challenges related to the energy transition, including large initial costs and risks, the need to think in terms of broader and longer-term system impact, and the need for new models for collaborative action.

Even with so many good ideas and reasons motivating action, it is still difficult to get an individual actor to take on initial costs and risks. One really needs to adopt a holistic "system thinking" and consider how the system can have a positive result (not necessarily each of the individual pieces).

Challenge Lab has pointed to the need for a new perspective and new approach to public-private partnership. With such big, expensive processes, we see industry/large companies invest...but need to have a different way for the public sector to act/invest as well. Have the impression that the public sector needs to be in closer partnership with industry (public-private) in such transformations.

Participants have begun sharing their ideas and insights with colleagues, as well as using ideas and insights (including the backcasting methodology itself) in their organisations and in their collaborative work. This leads to various types of **ripple effects.**

Dalarna has started a comparable process in relation to development of transport infrastructure. The region has applied the backcasting methodology and process in the strategy development process.

We got a funding opportunity on short notice and had no time to build a consortium, but we held three 90-minute workshops in three days and got lots of valuable inputs. It was more or less a light-version or rip-off of Challenge Lab.

Many new ideas have led to initiated action – either as proposed collaborative projects for the Challenge Lab seed fund, or as reinforced perspectives and activities within organisations' ongoing internal processes. Note that our interviews were conducted less than one month after the final Lab workshop. We anticipate further actions in the future.

I've used Challenge Lab tools to bring in new people/perspectives and bridge perspectives (within two ongoing research projects). By bringing in other actors in the system, the group is able to see with other lenses and gain additional "wins".

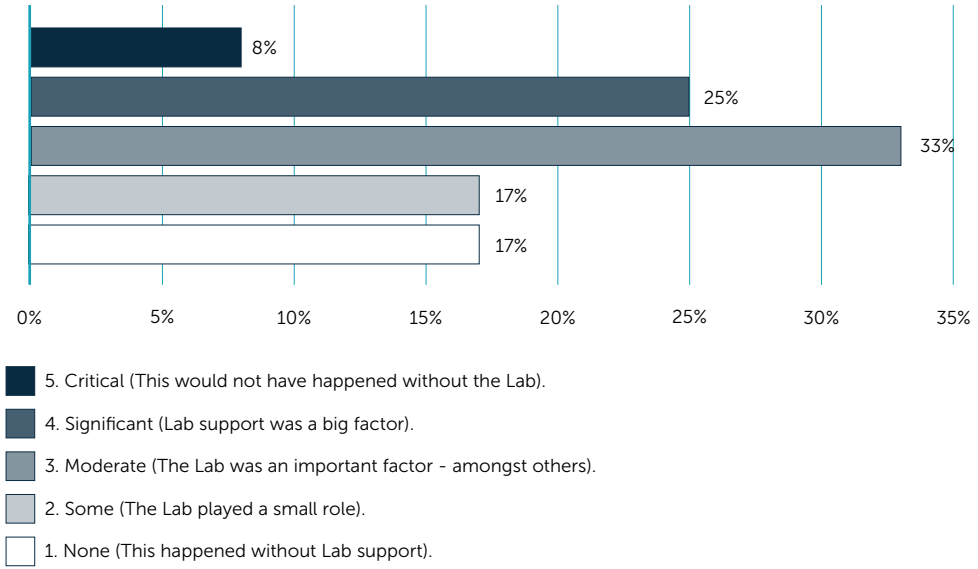
We've been a bit more driven in the actions we're (already) taking with the knowledge and confidence that it's worth the effort. At the same time, I think we'll be able to pick up contacts and ideas – and start new actions – in the longer-term.

Many participants were already believers. The value of the Challenge Lab is leveraging new contacts and perspectives to realise the overall vision. I think that participants will start initiating more 'local contacts' to start moving forward...that the mindset can initiate multiple experiments.

We've identified a number of possibilities to work across sectors (forestry and steel) and reinforce collaboration across counties in NMS. We are pursuing these possibilities in a number of pre-studies (financed through the Challenge Lab Seed Fund).

Many participants in the Challenge Lab had already been actively working with energy transition in various ways; yet 50% of respondents still perceived that the Lab contributed to reinforcing actions to some or a moderate degree. 33% of respondents perceived that the Challenge Lab contributed to new actions to a significant or critical degree. They viewed the Lab as a catalyst to broadening perspectives, identifying new/additional opportunities to act, and providing the opportunity to concretize and take first steps (through Seed Fund support).

In what ways did the Lab (or your participation in the Lab) contribute to these actions?



When asked what they thought the Challenge Lab's biggest contribution to supporting energy transition in NMS would be, participants applauded the process to bring together a variety of actors, providing them with the insight that they all are (can be) part of contributing to a transition, and enabling a way to take concrete next steps together. The Challenge Lab's backcasting process was viewed as a good method to work with transformation, and there was interest in having some kind of follow-up or continuing similar types of labs (with new/other individuals) going forward. While the Challenge Lab has introduced new perspectives and gotten the wheels turning, the actors need to start seeing benefits of engaging and acting in order to continue. This (long-term) process requires continual facilitation/pushing and proactive coordination.

To have brought together such a breadth of actors (from different sectors, application areas, and counties) who don't normally come in contact with each other is a big contribution! It required something attractive. The process got these actors together!

The more complex and "un-concrete" the area is, the more "drivers" and incentives are needed to take action on opportunities. I think we need to support transformative efforts a bit differently.

I see the rationale and benefits of having a "process thinking and approach" for driving societal development: establishing a common set of values and vision that includes and engages more actors; providing inspiration by highlighting new perspectives; reinforcing confidence to act/invest/take new steps by demonstrating relevance to a bigger picture.

It is easy to understand that if we are to transition and change direction [...] then it is difficult if we start from today and look into the future, for natural reasons then it will be an incremental change. [...] The backcasting method, to really set the goals and perspectives, to look far away and think what needs to be done to get there. The point was clear and for me it worked really well, that's a no brainer.

Challenge Lab NMS: next steps

Overall reflections and considerations for the future

NMS undertook this experiment with the Challenge Lab approach in order to explore how regional development and work with Smart Specialisation (S3, the regional innovation strategies) efforts can be directed towards system transformation for sustainability transition. As presented in the introduction, the expedition had various aims:

- **building capacity** on the backcasting/Challenge Lab approach in particular, and on addressing complex, sustainability challenges more generally
- **creating knowledge** on the challenge of hydrogen/energy transition in NMS
- **enabling change** through increased knowledge and awareness, increased agency, new networks and capacity, etc.
- **addressing the challenge** by identifying (and initiating action on) transformative interventions that could leverage hydrogen to support industrial transition and the good life in NMS

As elaborated in the previous sections, the Challenge Lab NMS has succeeded in delivering (initial steps) on all of these aims. Although this experiment involved a limited group of individuals working with the design and realisation of the lab, a limited group of participants within the lab process, and had (due to COVID-19) limitations on the timing and format for the process, the Challenge Lab NMS, and accompanying seed fund, have provided some important insights on working with complex, longer-term systemic change processes to address sustainability challenges.

Sustainability challenges require taking both a longer-term and broader, holistic view of the system and other constellations of actors (compared to existing collaborative innovation processes). Given natural tendencies to focus on the now and near term, and one's own "piece of the puzzle", system innovation requires proactive facilitation to mobilise and engage various actors (including large companies), broaden perspectives (different lenses, sectors and time periods), identify key leverage point interventions and set the wheels in motion, as well as continual 'nudging' and coordination to foster steps forward over time.

In order to truly influence change over the longer term, there is a need to explore new ways to engage the ecosystem of actors in different constellations. Small companies have limited capacity and resources to act alone. System change requires a more active involvement and leadership from larger companies. In turn, this requires new/other approaches for public sector engagement, including different types of longer-term support or different modes of public-private partnerships to address complex, longer-term industrial transition/transformation in responsible ways.

The longer-term nature of system change processes highlights the importance of continuity in the change process, maintaining continued momentum in "the

space for change", while also maintaining a strong anchoring and embeddedness in the context/system, ensuring regular "docking with the cruise ships". This includes, for instance, having ongoing coordination and connection with county/regional governments, engaging small and large companies in the activities, and communicating results to the broader ecosystem of actors.

Thus, the role of a proactive facilitator and coordinator is critical. This coordinator role includes a number of functions: inviting/engaging actors; identifying gaps and leverage points; looking for synergies; connecting to science, policy, other initiatives and broader society; external communication, etc; and requires a broad set of skills. To function as both an "expedition guide" and "docking mechanism", the coordinator needs to have a recognised mandate and support from within the system (the cruise ship). Support includes operational needs for the expedition: personnel/resources for mobilisation, communication, initiating activities, as well as ensuring that the expedition is regularly communicated and has a legitimate port (or set of ports) at which to dock and enable scaling-up over time.

The Challenge Lab/backcasting approach is a way to work with system innovation which is needed to address complex societal changes. The Challenge Lab expedition in NMS has demonstrated the value of the process as a mechanism for mobilisation and inclusion of various perspectives, for adopting a system and long-term perspective, and for developing alignment/common strategic direction on a complex issue. The Challenge Lab NMS has also highlighted a number of perceived benefits of the backcasting process (summarised above).

This experiment has provided some initial steps in building capacity for regional authorities and other actors on how to initiate and facilitate long-term system change processes. Yet more capacity building and method development is needed. Backcasting is considered as a valuable and relevant tool/process to use for addressing longer-term systemic challenges. There is a desire for continuing to develop understanding of system transformation, as well as alternative design(s) of backcasting processes that can be applied in various contexts.

It would be nice to have similar types of processes in "mini format" (gathering many actors working with different projects/perspectives) to have conversations, get an overview and new perspectives...and identify new opportunities to act collaboratively.

These overall reflections and insights provide "food for thought" to help inform and guide ongoing efforts to direct regional development/S3 towards transformation for sustainability transition. Based on these, some initial considerations for the future include:

- Continue to develop understanding and capacity for regional development teams to work with longer-term transformation/sustainability transitions - both conceptual understanding and methods/backcasting approaches in different forms
- Communicate with political leadership to anchor the relevance and need for different modes of operation for working with sustainability transition
- Build on the existing momentum and continue to host 'legitimate' spaces for change (in hydrogen/energy transition and other challenge areas)
- Develop and resource a "platform coordinator function" for hydrogen/energy transition in NMS

Opportunities for building on Challenge Lab NMS

To build on expeditions as a way of working (learning) and what is created in the expedition (results), there are different mechanisms to stimulate: replication, scaling up and transfer. Replication means that a basically similar expedition is performed "copy paste" on another issue and / or in another context. Upscaling means that the participants in the expedition focus on mobilizing resources to connect lessons and results to more people. Transfer means that the expedition transfers knowledge to the cruise; in such work, the steering and working groups become central.

We see initial signs of expedition transfer in the ongoing work to update Värmland's smart specialisation strategy, where there is a reformulation of regional smart specialisation towards sustainability, societal challenges and missions. And across the NMS counties, the backcasting approach (in different forms) is seen as a form of "entrepreneurial discovery process" for missions. NMS will explore possibilities for continued work on method development and capacity building - leveraging the experiences of the Challenge Lab design team and ongoing research efforts at Chalmers. Future capacity building actions could include other HEIs (researchers and students), as well as "train the trainers" modules for civil servants and other actors.

Seed fund – applications, areas and next steps

The Challenge Lab Seed Fund aimed to kick-start collaborative projects involving actors from across NMS that address shared complex systemic challenges related to low carbon and resource efficient industry and society. The Seed Fund was an initial support mechanism mainly, but not exclusively, for ideas generated during the Challenge Lab NMS. The Seed Fund was available for financing initiatives by groups of companies and other actors from the counties in NMS for RDI initiatives aimed at transformation for low-carbon and resource-efficient industry and society, up to 15,000 EURO per project. The fund was open from March to May 2021 and funded 10 projects.

There are several differences between the Seed Fund and 'normal' project funds. The Seed Fund:

- is based/relating to a challenge or mission oriented process
- purposefully engages with large companies rather than only SMEs
- aims to fund early stage, explorative ideas to address longer-term transformative change
- encourages cross-sector and cross-geography connections
- has a quick/agile and iterative funding decisions with more interactive dialogue with applicants

A review of the Seed Fund and projects will be completed at the end of 2021. The process has informed the focus and approach to the next ERDF regional programme, highlighting the interconnection between green and industrial transitions. The approach to the funding is also encouraging and being investigated as a possible future funding mechanism.

What about Hydrogen?

At the start of our journey the hydrogen agenda was bubbling away in some specific niche areas and geographies within the NMS region, but is now more widely on the agenda and collectively understood. The process enhanced knowledge, networks and capacity within the group, increasing the momentum for action and increasing the sense of agency and urgency for action. It also created curiosity for hydrogen technologies and their socio-economic applications for a good life, rural development, energy transition and wider societal benefits. Understanding intersections and interactions from a systems perspective has widened and deepened understanding of hydrogen and energy transition. The project has built capacity and created knowledge to enable change through increased knowledge and awareness, increased agency, new networks, and key pieces are in place to address the challenge.

An opportunity for systems transformation is the collaborative platform Mid Sweden Hydrogen Valley, where the transformative potential for a good life in our region could be realised with integration of the learnings from Challenge Lab NMS. World leading technologies and solutions are being developed in our region that can be expanded to drive societal transformation, to benefit us, here and now, as well as possibly many other regions and communities in the future.

Concluding insights

In conclusion, we would like to provide a few summarising insights for those primarily interested or involved in establishing conditions and designing challenge- and sustainability driven innovation processes on complex/systemic issues. In the above reporting, much focus has been on process-related experiences from a view of the participating actors, but there has also been an important groundwork in terms of establishing/holding the space and an associated leadership and facilitation quality.

- **Space:** expedition initiatives require embeddedness in a context where transitions are unfolding that can be linked up with, guided and accelerated, rather than seeking to create change from nothing. To bring together actors across perspectives and sectors where learning and the challenge is in the centre rather than a specific stakeholder or market need, the space needs to be free from ordinary organisational and institutional logics. Yet, the space needs to be connected with those in order to influence wider changes beyond the lab itself. It also needs to be inclusive and safe for people to come together to share experiences and perspectives in an open and trusting way.
- **Process:** backcasting can be understood as a structured process for entrepreneurial discovery with a mission-orientation, where a sustainability (challenge) becomes the driver for systems innovation into the future, rather than needs- and idea-driven innovation that typically lead to product and service innovation in the present. In other words, backcasting seeks to not only produce influence within existing systems and structures, but also challenge their very frames, boundaries and underlying logics. In working with backcasting as a process for expeditions, it is important to scaffold away unnecessary uncertainty and support thinking that moves us: beyond what currently is; broad, in considering multiple sustainability dimensions and system aspects; deep, in considering underlying causes and reasons; forward, in not only being an analytical endeavour; and together, in incorporating multiple perspectives and shared language. This approach to backcasting is not an ordinary visionary process that seeks to step-wise plan backwards from a desired future into the present, but learning-oriented and systemic.
- **Facilitation/leadership:** It is key for expedition initiatives to have an associated leadership and facilitation quality to make the desired features of the space and process come alive and become truly transformative experiences. This means we need to move beyond ideas of universal designs, blueprinting and plug-and-play methods and tools, into caring for underlying qualities and mechanisms of the engagement processes. This means one needs to adapt based on context and circumstance, listen in to participants needs and perspectives, select tools based on situation and be open to share assumptions and intents and change course when needed. Expeditions also establish capacities on the level of holding and facilitating these kind of processes, in addition to the knowledge generated on the particular challenge addressed.

Lastly, we would also like to stress that these kind of initiatives by design have to be open-ended, meaning that we cannot have all answers beforehand or know in detail what results may come out. The kind of transformative learning processes we are after cannot be controlled, but they can be enabled and supported. And, when space, process and facilitation/leadership come together, participants may feel that they have been part of something important and even unique, and experienced a possibility of meaningfully contributing to sustainability transformation processes.

Close & thanks

What we do now is up to all of us. Those that took part and those that have read, listened and learned from the process. With the help of the working and steering groups the Challenge Lab is intended to be linked back to the cruise ships with lessons learned exchanged. In our lab, the group is made up of region strategists and members of the industrial innovation support ecosystem, especially industrial clusters. All participants in the Challenge Lab are invited to reflect through the evaluation interviews and questionnaires, including a deeper reflection on what the participation has meant on a personal level from a learning perspective and from the results that have been created.

Those who in various ways have been involved in designing and facilitating the expedition, it will be important to gain an understanding of what worked and not, for whom, to what extent and why. Practical knowledge about such issues will be important for the further development of the working method and for spreading important lessons and experiences to others.

This difficult and exciting project was made possible by the support of many and varied organisations for which we are very grateful! Thanks and gratitude to you all.

- The project was financed thanks to the support of the European Commission and the pilot action for industrial transition.
- Additional financing of the development of the NMS strategy for industrial transition and additional work was funded by the Swedish Agency for Economic and Regional Growth (Tillväxtverket).
- The Challenge Lab NMS team including the regions, clusters, Science Parks and other organisations gave their time and energy to the process.

References & further reading

Holmberg, J., & Holmén, J. (2020). *Medskapande Omställningsarbete: Backcastingexpeditioner för Agenda 2030. Sveriges Kommuner och Regioner.*

Holmberg, J., & Larsson, J. (2018). *A Sustainability Lighthouse—Supporting Transition Leadership and Conversations on Desirable Futures. Sustainability, 10(11), 3842. https://doi.org/10.3390/su10113842*

Holmberg, J. (2019). *Oseglade vatten? – Då behövs expeditioner! In J. Algehed, E. Eneqvist, C. Jensen, & J. Lööf (Eds.), Innovation och Stadsutveckling: En forskningsantologi om organiseringsutmaningar för stad och kommun (p. 12).*

Holmberg, J. (1998) *Backcasting — a natural step when operationalising sustainable development. Greener Management International. — the Journal of Corporate Environmental Strategy and Practice. Issue 23: 30-51. (Autumn 1998)*

Holmberg, J., & Robèrt, K., (2000). *Backcasting - A framework for for strategic planning, The International Journal of Sustainable Development and World Ecology 7(4):291-308*

Additional reading

Elzen, B., & Wieczorek, A. (2005). *Transitions towards sustainability through system innovation. Technological Forecasting and Social Change, 72(6), 651–661. https://doi.org/10.1016/j.techfore.2005.04.002*

Holmberg, J., & Robèrt, K.-H. (2000). *Backcasting from non-overlapping sustainability principles—A framework for strategic planning. International Journal of Sustainable Development and World Ecology, 7, 291–308.*

Holmberg, J. & Holmen, J. (2021). *Backcasting Expeditions and Sustainability transformations. CIIST Working Paper Series [2021:1]*

Holmén, J. (2020). *Navigating Sustainability Transformations: Backcasting, transdisciplinarity and social learning [Thesis for the Degree of Doctor of Philosophy]. Chalmers University of Technology.*

Senge, P., Hamilton, H., & Kania, J. (2015). *The dawn of system leadership. Stanford Social Innovation Review Winter, 2015, 27–33.*

Williams, S., & Robinson, J. (2020). *Measuring sustainability: An evaluation framework for sustainability transition experiments. Environmental Science & Policy, 103, 58–66. https://doi.org/10.1016/j.envsci.2019.10.012*

Geels, F.W., (2011) *The multi-level perspective on sustainability transitions: Responses to seven criticisms, Environmental Innovation and Societal Transitions Volume 1, Issue 1, June 2011, Pages 24-40 https://www.sciencedirect.com/science/article/abs/pii/S2210422411000050*

Iceberg model & other tools www.donellameadows.org & http://www.donellameadows.org/wp-content/userfiles/iceberg-model.pdf

- https://www.innerdevelopmentgoals.org/
- https://sdgs.un.org/goals
- https://energyfutureslab.com/
- https://challengelab.chalmers.se/about/
- http://spaceforchange.se/
- https://xynteo.com/tools/wicked-problems-toolkit

CO-FINANCED BY