FAST EXPERT TEAMS

INVESTMENTS IN CLEAN ENERGY AND POWER-TO-X IN SOUTH-EAST FINLAND

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FINLAND NEEDS COOPERATION ACROSS SECTORS TO BENEFIT FROM THE ENERGY TRANSITION

Finland has excellent potential in the international clean energy and hydrogen economy PtX business, but the necessary investments will require open dialogue and shared understanding between the different parties.

> The energy transition is a systemic and interdependent entity that requires both short- and long-term cooperation.

There is global market potential for technological solutions to combat climate change. However, industrial-scale research and development of new technologies requires collaboration between companies and universities and investments in pilot environments.

The interdependence and systemic nature of energy transition requires both short- and long-term collaboration.

To take advantage of the opportunities of the energy transition, new business and networks need to be built. Innovative collaboration between different stakeholders is needed to overcome technological challenges and to design new profitable business models and related value chains.

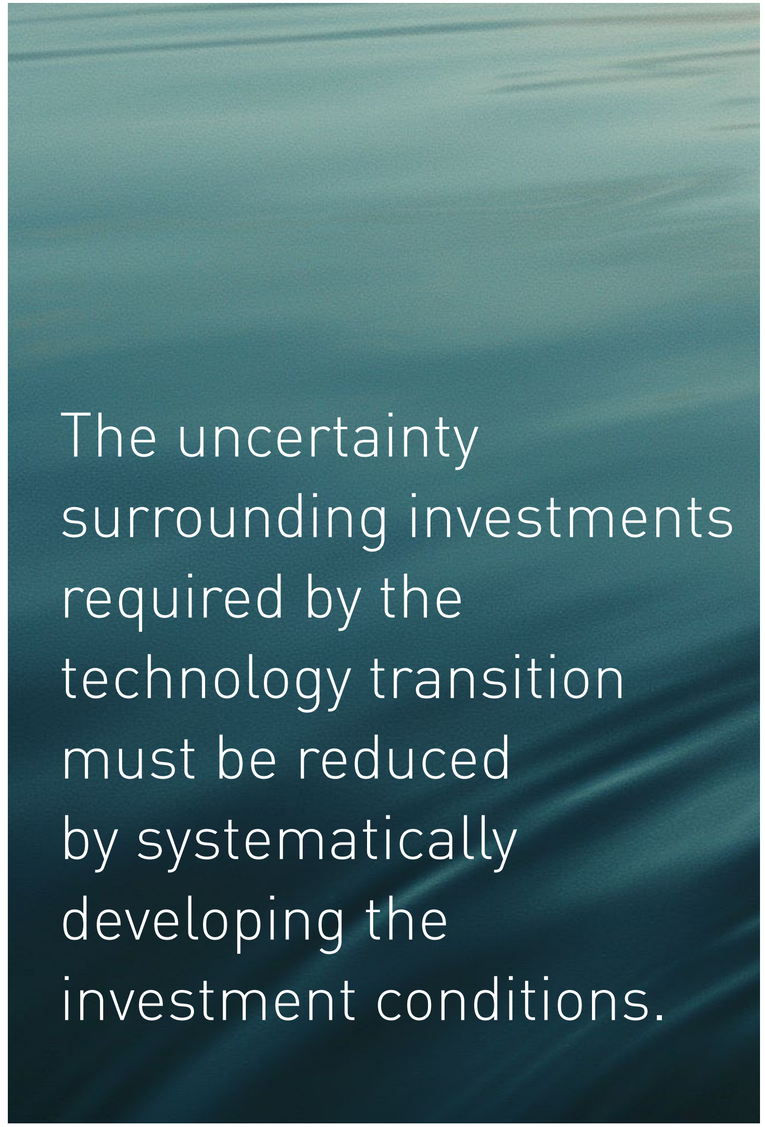
Different regions in Finland have different relative strengths and sources of competitive advantage. Eastern Finland produces a significant amount of Europe's biogenic carbon dioxide, and a significant share of Finland's energy transition research is carried out at the Lappeenranta–Lahti University of Technology LUT. LUT's researchers and students of nearly 100 nationalities offer an excellent talent pool.

The uncertainty surrounding investments required by the technology transition must be reduced by systematically developing the optimal conditions for investments.

The Fast Expert Teams collaboration model developed at LUT Business School was employed to assess the prevailing situation and create favorable investment conditions. Focusing on the role of South Karelia and South-East Finland in the energy transition, the Fast Expert Teams community included more than 60 energy experts from large companies, growth companies, universities, ministries, and the public sector.

Based on 80 background interviews, six expert teams were set up to tackle a systemic and complex problem: power generation and grids, industrial investment conditions in South-East Finland, CO_2 capture, research-based start-ups, PtX value chain modelling, and investments and financing. Experts in energy sector regulation and internationalization were invited to support the teams.

> Innovative collaboration is needed to overcome technology challenges and to design new profitable business models and related value chains.



AS A RESULT OF THIS WORK, THE FAST EXPERT TEAMS COMMUNITY PROPOSES

EIGHT CONCRETE ACTIONS:

1

Designing new profitable business models and related value chains.

2

Establishing a project development company to carry out industrial-scale pilot projects involving companies, universities, and cities.

3

Establishing an industrial-scale carbon capture, utilization, and storage (CCUS) research and technology centre in Eastern Finland as a national flagship project.

4

Increasing tenfold the number of research-based start-ups at LUT by improving the operating environment.

5

Setting up a seed venture fund to support the creation of energy start-ups by international and domestic students.

6

Making job offerings for international students in Eastern Finland a strategic goal.

7

Setting up an Invest In-network to get international investments and funding for the energy transition in Eastern Finland.

8

Inviting relevant stakeholders to solve the obstacles related to wind power in Eastern Finland.

ELECTRICITY GENERATION AND GRID

OBJECTIVE

Clean, affordable, and local energy production

> New industry investments in Eastern Finland require guaranteed affordable, sufficient, and clean energy.

Building energy production in Eastern Finland will have a positive impact on the region's economy and vitality.

In the 2020s and early 2030s, new green investments will require significant amounts of wind power. Wind power in Eastern Finland would also be important for Finland's overall electricity generation capacity.

Industrial-scale solar power can be deployed in the region even on short notice. In the future, also small modular reactors could be built in the region to replace combustion-based power generation.

Electricity grids can be expanded as electricity production and consumption develop.

> Solutions for the development of clean energy-based industry in Eastern Finland require political decisions.

Solutions for the development of clean energy-based industry in Eastern Finland require political decisions.

Political moves are needed without delay, as the time from investment decisions to the construction of productive investment plants is long – often 5–10 years.

Wind power investments require political will and guidance for the Finnish Defence Forces to find solutions for the problems related to the radar surveillance. Open dialogue is crucial not only on environmental and social impacts but on the fair distribution of economic benefits.

In addition to municipal decision-makers and officials, also local residents and non-governmental organizations (NGOs) need to participate in decision-making to secure wider acceptance and investments for clean energy.

The political decision-making processes and solution-oriented actions needed to ensure the vitality of Eastern Finland must be initiated immediately.

PROPOSALS FOR ACTION

- All parties involved should be invited to the same table as soon as possible. Open cooperation is a prerequisite for overcoming challenges related to 1) radar surveillance, 2) technological solutions, 3) funding models, and 4) social acceptance.
- The opportunities offered by the EU and NATO should be taken into account. Stakeholders include ministries, regions, municipalities, local residents, NGOs, transmission and distribution grid companies, the Defence Forces, the wind power industry, and the surveillance systems industry.
- Technological solutions should be tested on existing wind turbines with the aim of enhancing or at least maintaining the current intelligence and surveillance capabilities of the Defence Forces.
- A financing model should be created where wind farm developers can contribute to financing new capacity and enabling the Defence Forces to use the wind farm infrastructure. The Defence Forces must be guaranteed life-cycle funding for surveillance systems to ensure that new systems are operational.
- New wind turbine sites should be selected based on regional wind power studies, which take into account locations possible in terms of nature, population, and grid connections.
- Political decision-making and legislative work must be completed. At the same time, administrative processes at different levels of law implementation need to be streamlined: Nuclear Liability Act, zoning, and environmental licensing.

> The development of electricity generation requires shared understanding and open cooperation

CONDITIONS FOR INVESTMENT DECISIONS

Project = Political will + Techno-economic conditions

National political will → Decisions, support, societal infrastructure

Local political will → Zoning and other regional and local preparations

Interested project actor = Technology + Investors

CONDITIONS FOR INDUSTRIAL INVESTMENTS IN SOUTH-EAST FINLAND

OBJECTIVE

Creating favourable conditions for clean energy investments in South-East Finland

> The criteria for energy production and industrial investments apply to areas wider than individual municipalities: cooperation across municipal boundaries is essential for creating and communicating favourable conditions for investments.

Clean energy investments are not bound by municipal borders. Competition for energy investments between municipalities can even prevent investment projects from being realized. Considering communication with foreign investors, a nationwide collaboration network and presenting Finland's advantages would be beneficial.

Industrial investments in the green transition require a great deal of renewable energy. Therefore, it must be possible to increase the capacity of energy transmission grid. The benefits of investing in transmission networks are realized in the long-term – in 10 to 20 years. Investors are attracted by the competencies available at the region. Start-ups also have an important role to play here.

Prerequisites for investments include the availability of electricity, district heating, and gas grid as well as good logistical connections and locations.

In addition, a proactive and flexible approach to land use planning is a competitive asset. For example, hydrogen plants are required to have a zoning designation suitable for their operations. Land use planning and site allocation must pay particular attention to distances from vulnerable and sensitive sites such as residential areas, schools, and nurseries.

THE ASSETS OF COMPETITIVENESS IN SOUTH-EAST FINLAND:

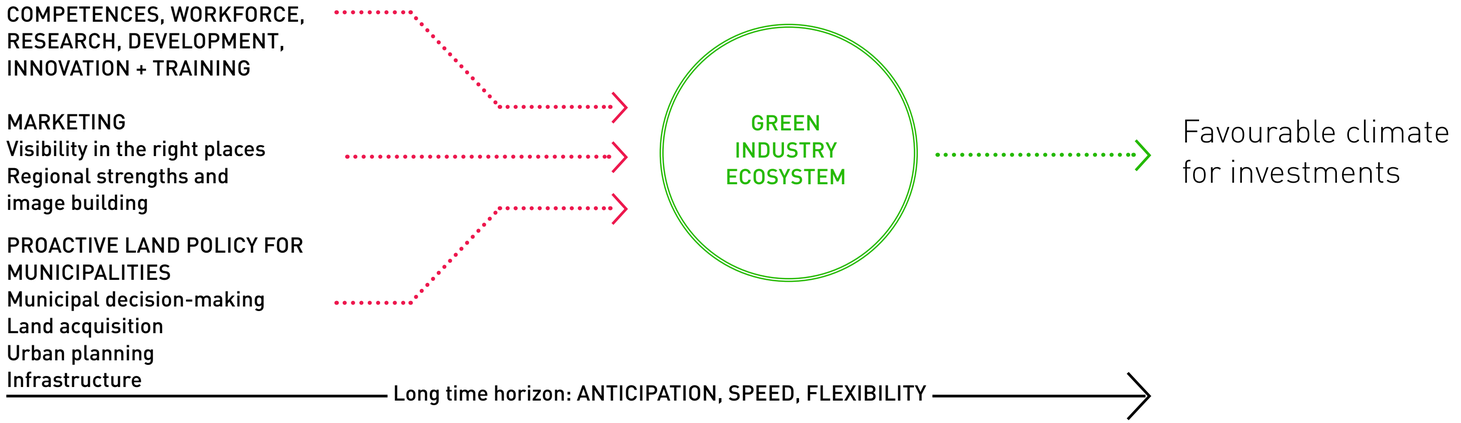
- Strong electricity grid and affordable electricity
- Availability of biogenic carbon dioxide
- Comprehensive district heating and gas grids
- Clean water
- Long tradition of large-scale industry
- Logistics and transport connections (rail, road, waterways, airports)
- Strong university research, education, and talent

Prerequisites for investments include the availability of electricity, district heating, and gas grid as well as good logistical connections and locations.

PROPOSALS FOR ACTION:

- Identifying and preparing suitable sites for industrial investments.
- Planning and implementing joint investor marketing in South-East Finland in cooperation with regional councils, municipalities, cities, Business Finland, etc.
- Ensuring smooth and proactive municipal zoning and permit processes.
- Developing a common regional land use plan to secure the development of the infrastructure in Eastern Finland.
- Supporting local decision-making with an information package provided by project developers, including calculations of the direct, indirect, and multiplier effects of energy production (e.g., employment and tax revenue).
- Solving the radar surveillance problem in Eastern Finland to increase wind power alongside solar power as a source of renewable energy.

GREEN INDUSTRY INVESTMENT PATHWAY



CO_2: CAPTURE AND USE

OBJECTIVE

Promoting the capture, storage, use, and research of biogenic carbon dioxide (CO_2) in Finland.

On the European scale, Eastern Finland produces a very significant amount of biogenic carbon dioxide, which is a valuable raw material for the hydrogen economy and new industrial applications.

In addition to biogenic carbon dioxide, the region has a sufficient supply of clean water and strong expertise in energy technology and chemistry.

The market uncertainty and current cost structure in the carbon capture value chain make profitable business challenging.

Major CO_2 point source capture projects are still awaiting investment decisions. However, by starting CO_2 capture from small point sources and promoting logistics and beneficial use solutions, progress can already be made.

Scaling up distributed utilization and storage solutions for small and later large point sources is advantageous for Finland, as the possibilities for economic geological storage, for example, are very limited compared to our competitors.

The logistics solutions required by the CCUS value chain can also promote new export opportunities for Finland.

An industrial-scale carbon capture, utilization, and storage (CCUS) research and technology centre should be established in Eastern Finland.

The centre would be designated as a strategic, national flagship project. Its aim would be to accelerate Finland's competitive advantage in the field of biogenic carbon dioxide and to facilitate industrial investments and technology exports.

The research and technology centre would serve as a pilot platform for companies and research, increase know-how, and build a solid foundation for new business opportunities in the carbon capture, utilization, and storage value chain in Finland.

It is also important to revise Finland's energy policy targets to better match the available resources, especially for biogenic carbon dioxide. Finland should promote EU regulation that encourages the capture, storage, and utilization of biogenic carbon dioxide.

Finland must develop a clear and stable regulatory framework that supports the capture, storage, and use of biogenic carbon dioxide. This will increase the predictability and stability of investments. There must be economic benefits from the use of renewable electricity that act as an incentive to adopt green energy solutions.

Establishing a biogenic carbon capture, storage, and utilization demands public incentives and funding, which include targeted subsidies for different parts of the CCS value chain, such as technology development, infrastructure, and market creation.

PROPOSALS FOR ACTION

- Establishing an industrial-scale carbon capture, utilization, and storage (CCUS) research and technology centre in Eastern Finland.
- Revising Finland's energy policy targets to better match available resources, especially for biogenic carbon dioxide.
- Increasing public incentives and funding to trigger the capture, storage, and use of biogenic carbon dioxide.
- Providing targeted support for different parts of the carbon capture, storage, and utilization value chain, such as technology development, infrastructure, and market creation.
- Developing a clear and stable regulatory framework in Finland that supports the capture, storage, and use of biogenic carbon dioxide. This will increase the predictability and stability of investments.
- Promoting EU regulation that encourages the capture, storage, and utilization of biogenic carbon dioxide and increasing the cost of emission permits to make carbon capture economically viable.

CONCEPTS: WHAT IS CCUS?

CCUS — Carbon capture, utilization, and storage, incl. CDR / technical carbon sinks

CDR — Carbon dioxide removal / technical carbon sink

CCS — Carbon capture and storage = Emission reduction if fossil CO_2 source

CCU — Carbon capture and utilization

BCR — Biochar carbon removal

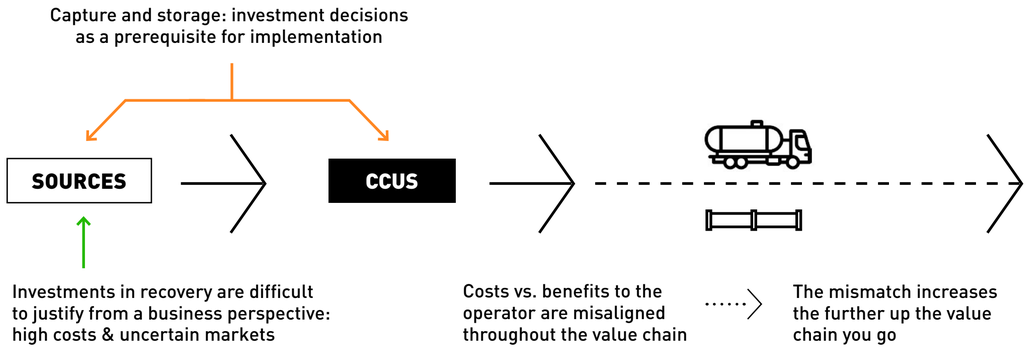
BECCU — Bioenergy with CCS; i.e., bioenergy and CO_2 capture and use

BECCS — Bioenergy with CCS; i.e., bioenergy and CO_2 capture and storage

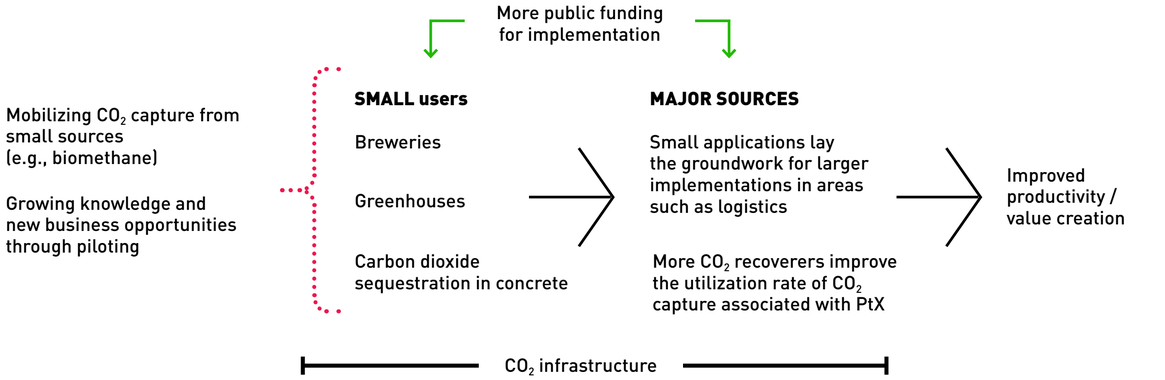
BioCCU — Biogenic CCS from pulp/paper; i.e., the capture and use of biogenic CO_2

BioCCS — Biogenic CCS from pulp/paper; i.e., biogenic CO_2 capture and storage

THE UPSTREAM END OF THE CARBON CAPTURE VALUE CHAIN IN FINLAND: CHALLENGES



UPSTREAM CARBON CAPTURE VALUE CHAIN IN FINLAND: SOLUTIONS



FROM RESEARCH TO START-UPS

OBJECTIVE

A tenfold increase in the number of research-based start-ups in South-East Finland.

> At LUT University, world-class research is carried out by top teams, but only one or two research-based start-ups are created each year.

A viable start-up community requires a sufficient number of potential customers, investors, and mentors. It is essential to remove bottlenecks in the research-to-business process by involving the different stakeholders already in the idea creation process.

Credible start-ups need an idea with global business potential and the best possible team. Team-building can be enhanced by forming a start-up community with physical and virtual meeting places.

Supporting researchers and students in building research-driven start-ups through a strategic development programme.

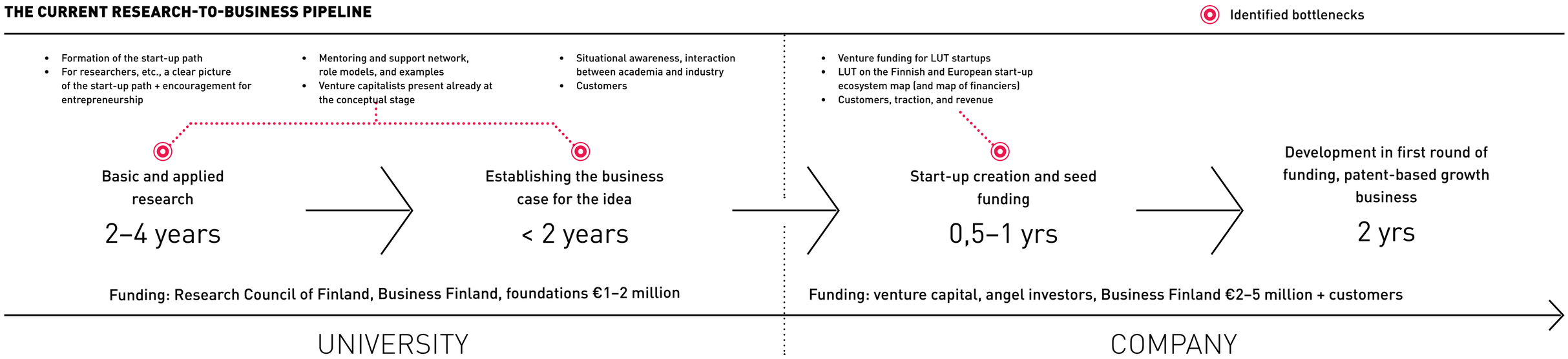
Making business ideas stemming from LUT's research visible as part of the start-up ecosystem map of Finland and Europe.

> Supporting researchers and students in building research-driven start-ups through a strategic development programme.

PROPOSALS FOR ACTION

- Launching a strategic development programme to increase the number of research-based start-ups tenfold in five years.
- Establishing a seed venture fund to support the creation of energy start-ups by international and domestic students.
- Creating a process to turn early-stage research ideas and innovations into business ideas.
- Identifying and putting together teams with the competences that best support business ideas and building on them.
- In addition to academic and industrial careers, creating a clear entrepreneurial path and discussing it in career development meetings as an alternative career path for researchers and students.
- Adding a course on "from research to entrepreneurship" as a compulsory part of doctoral studies for all doctoral students.
- Connecting the university's talent, donors, and customers by creating physical and virtual meeting places.
- Providing role models and examples by, for example, setting up an LUT residency programme for experienced entrepreneurs.
- Developing start-up incubator activities.

THE CURRENT RESEARCH-TO-BUSINESS PIPELINE



PROJECT DEVELOPMENT COMPANY FOR THE PtX VALUE CHAIN

OBJECTIVE

Implementing an industrial-scale PtX value chain in South Karelia

Slowing down climate change requires the use of renewable electricity and its downstream hydrogen (H2) through Power-to-X (PtX) technologies. However, the promotion of PtX technologies still requires industry-scale trials.

The technology needed to produce renewable hydrogen is not yet scalable or profitable. In addition, the lack of market development and the uncertain regulatory situation are major constraints on the necessary investments and development.

Finland has an excellent opportunity to lead the way and build internationally competitive PtX technology and manufacturing expertise. However, this requires efforts to develop the technologies and develop the market.

Scaling up the necessary PtX technologies and profitable production require the development of the whole value chain.

However, the uncertainty and risks are still too great for individual companies in the value chain. The solution is open and close collaboration between the actors in the value chain and a value chain analysis of risks and returns.

A project development company could be established to build a complete PtX value chain in South Karelia.

A project development company can be used to engage the required actors in the development of the value chain. By working together, it is possible to analyse and share the risks of new business and to learn and develop critical areas.

A value chain of key elements can initially be established, allowing each individual actor in the value chain to collaborate with others to develop the profitability of their business.

The project company would initially target a market where replacing fossil energy and reducing CO_2 emissions is challenging. A possible target market could be, for example, the maritime transport sector.

The size of the project development company's demonstration plant is 50–60 MW of electrolysis. The value chain includes carbon capture, pure hydrogen production, and methanol synthesis. Electricity will initially be purchased from the grid, while a long-term contract with a clean energy park will be explored.

The piloting of the whole value chain will provide the basis for multidisciplinary research and development, taking into account efficient technology solutions, overall economy, environmental impact, safety, standards, and legislation. Management, as well as risk and benefit sharing among participants need to be considered for the entire value chain.

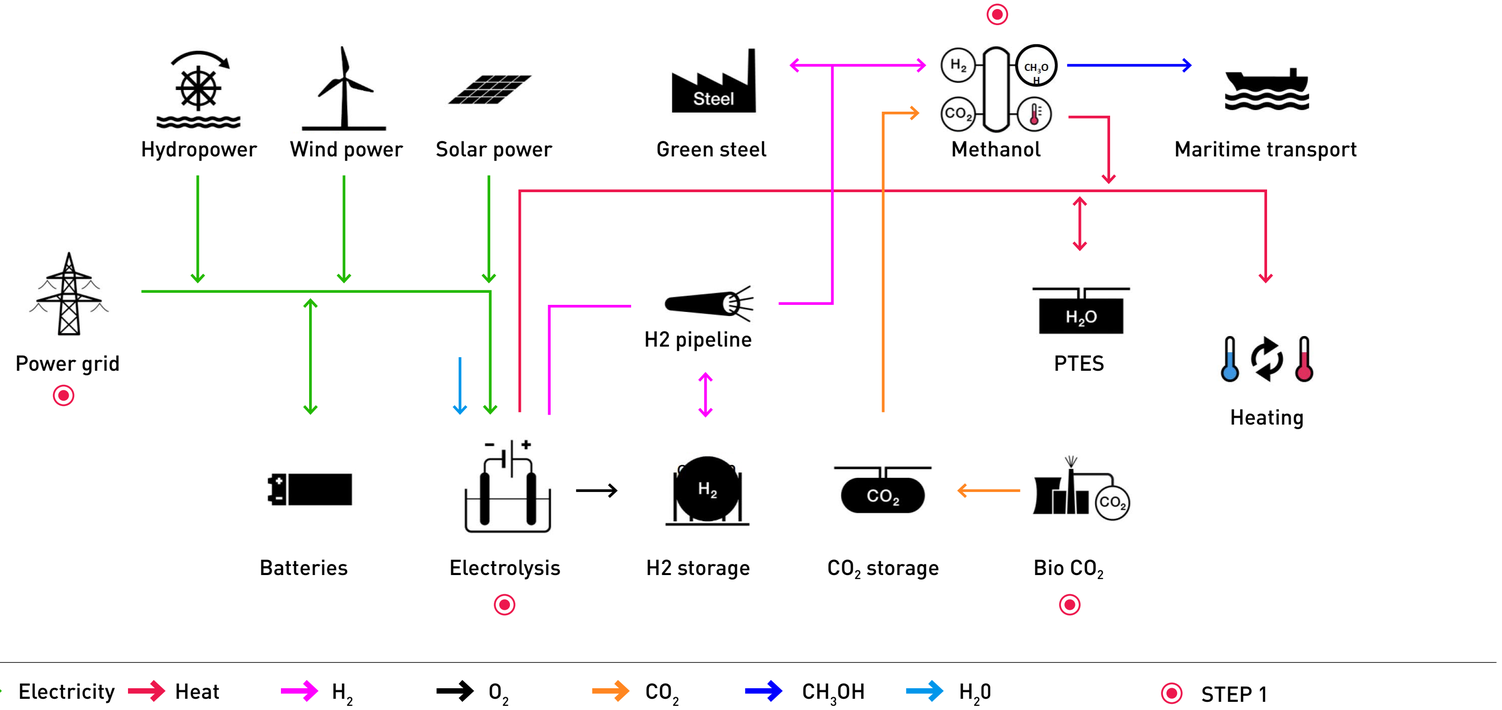
> Scaling up the necessary PtX technologies and profitable production requires the development of the entire value chain.

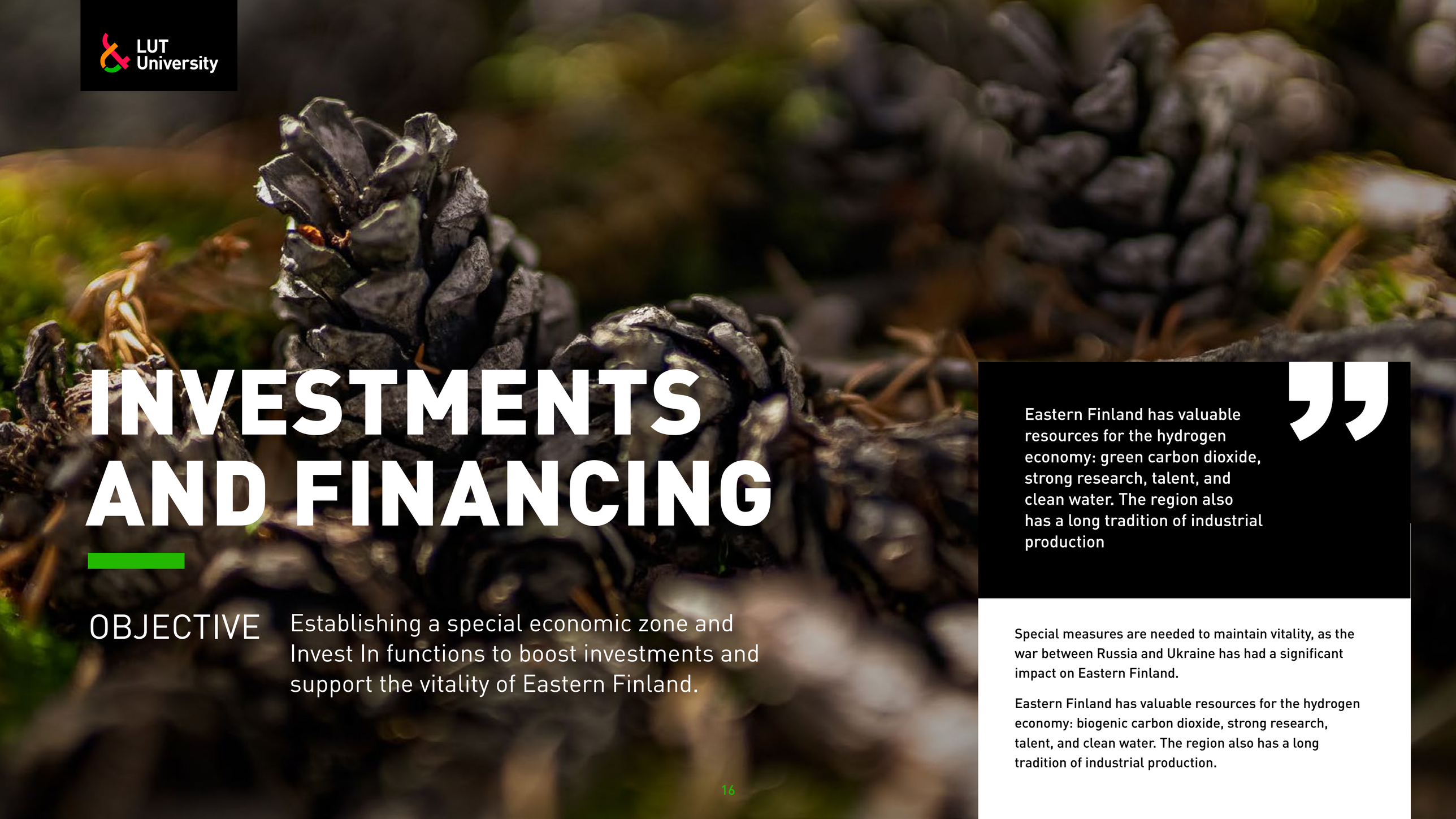
> Establishing a project company to build a complete PtX value chain in South Karelia.

PROPOSALS FOR ACTION

- Conducting a feasibility study on the project development company.
- Securing national and regional support and funding.
- Ensuring a fast authorization process by public authorities.
- Clarifying the boundary conditions for regulation.
- Launching a 50–60 MW demonstration plant.

INDUSTRIAL PILOT IN SOUTH KARELIA





INVESTMENTS AND FINANCING

OBJECTIVE

Establishing a special economic zone and Invest In functions to boost investments and support the vitality of Eastern Finland.

> Eastern Finland has valuable resources for the hydrogen economy: green carbon dioxide, strong research, talent, and clean water. The region also has a long tradition of industrial production

Special measures are needed to maintain vitality, as the war between Russia and Ukraine has had a significant impact on Eastern Finland.

Eastern Finland has valuable resources for the hydrogen economy: biogenic carbon dioxide, strong research, talent, and clean water. The region also has a long tradition of industrial production.

LUT is one of Finland's leading universities in electrical engineering and energy technology research, and one third of all Finnish graduates in those fields come from LUT. Most of Finland's PtX research is also carried out at LUT. About half of the research funding comes from industry.

Career opportunities for international students in Finnish companies should be strongly promoted. At present, too many talented people have to leave Finland.

LUT's strong expertise in electrical engineering, energy technology, business, and social sciences creates excellent conditions for clean energy growth companies and for attracting domestic and international investments.

Clean energy investment decisions are the result of 5–10 years of work. Investors first assess the attractiveness of the operating environment. In addition to land use, acceptability, and smooth permitting processes, a skilled workforce and research and development expertise are key.

> LUT University's strong expertise in electrical engineering, energy technology, business, and social sciences creates excellent conditions for clean energy growth companies and for attracting domestic and international investments.

> To support international investments in Eastern Finland, a skilled Invest In Network of experts is needed.

To support international investments in Eastern Finland, a skilled Invest In Network of experts is needed.

The business community supports green technology and process development, but public sector backing is also needed, as PtX investments are not yet profitable. Technology and process development requires close cooperation between industry and universities.

Industrial-scale demonstration facilities are essential in developing scalable processes and equipment and in commercializing research results. Special economic zone status would increase the attractiveness of Eastern Finland and raise the region's profile in the eyes of investors.

Specific measures to improve the business environment will pave the way for greater industrial investments in the region.

PROPOSALS FOR ACTION

- Applying for special economic zone status for Eastern Finland.
- Organizing the special economic zone and Invest In activities.
- Establishing a strategic programme to promote the employment of international students in companies or as start-up entrepreneurs in Eastern Finland.

EXPERTS INVOLVED IN THE WORK

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Fast Expert Teams is a collaboration model developed to address complex societal challenges. It is based on building a temporary expert community that collaborates on a digital platform. Experts are called together to share their specialized know-how and solve complex problems in designated teams. The outcomes of the expert collaboration are documented and shared with relevant decision-makers.

LUT University

→ FAST EXPERT TEAMS GUIDEBOOK

The Fast Expert Teams collaboration model was designed at LUT Business School to solve complex challenges and seize opportunities. More information: Professor Kirsimarja Blomqvist, kirsimarja.blomqvist@lut.fi, 040 755 1693.