

STRATEGIC RESEARCH AGENDA FOR FINNISH HYDROGEN RESEARCH

- INSIGHTS FROM THE HYDROGEN RESEARCH FORUM
FINLAND

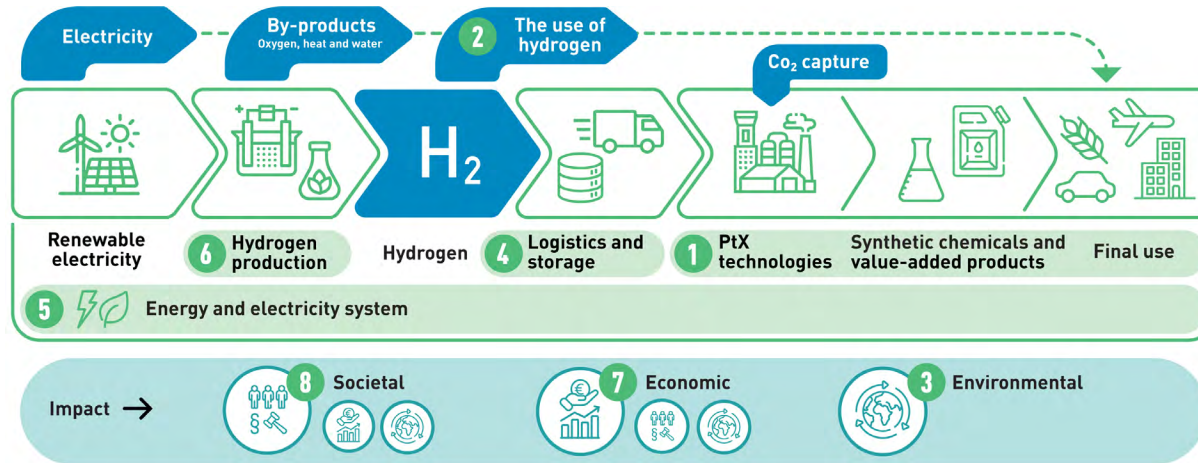


Hydrogen drives a clean industrial breakthrough

The goal of the Paris Agreement is to limit the temperature increase due to climate change to 1.5 °C. This calls for a drastic reductions in fossil fuel emissions, primarily through the use of clean electricity in transportation, heating and industry. Clean hydrogen is a key element here, as it can replace fossil fuels and promote emissions on sectors where the direct use of electricity is challenging.

Other additional factors in the energy transition are the self-sufficiency of energy, security of supply and safety, all of which contribute to a stable and sustainable society. In recent years, the production costs of clean electricity have come down to a level that is competitive with fossil electricity production. This accelerates the transition to clean electricity production, enabling the use of hydrogen for energy storage and distribution in areas where direct electrification is difficult. Finland's potential for renewable energy (onshore wind, offshore wind, and solar power) exceeds our domestic consumption tenfold. Finland also has a significant amount of biogenic carbon dioxide at a European scale, giving Finland a unique position to reinforce its role within the EU's energy system.

Key research areas pertaining to hydrogen economy



1 Synthetic value-added products of hydrogen, carbon dioxide and their use

e-methanol	e-ammonia	Sustainable aviation fuel (SAF)
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2 The use of hydrogen

Using hydrogen to produce clean steel	Fuel cells and X-to-Power (X2P) cycles, including RESOC	The use of hydrogen in maritime transport
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3 The environment and sustainability

Evaluating the environmental impacts of the green transition and hydrogen economy	Resources and critical raw materials	Life cycle analysis in hydrogen economy	Monitoring, advancing and supporting industrial changes in the green transition and hydrogen economy
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4 Storage and distribution of energy and hydrogen

Hydrogen storage	Comparing hydrogen pipeline distribution to other alternatives	Materials research on hydrogen components
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5 Energy and electricity system

Storage and flexibility of electricity and energy	Utilization of by-products from hydrogen production	Flexibility of electricity and energy consumption and demand
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6 Production of clean hydrogen

Finding efficient and/or alternative electrolysis materials	Improving the energy efficiency of electrolysis materials (alkaline and PEM)	Removing production limitations of electrolysis technologies (alkaline and PEM)
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7 The markets and society

Monitoring the development of business models and supporting them through the green transition and in hydrogen economy.	Monitoring and supporting Finnish macro economy and competitiveness through the green transition
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8 EU regulations and politics

Evaluating the effects of key EU regulations to promote Finland's green transition and hydrogen economy	Geopolitics and security of supply	Forming an overview of the EU regulation framework and promoting its effectiveness
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Research needs are divided into short-term, medium-term and long-term goals.

1-3 years	SHORT-TERM
3-5 years	MEDIUM-TERM
5-10 years	LONG-TERM

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PtX technologies transform renewable electricity into various fuels and chemicals, often utilizing carbon dioxide and hydrogen. They are key technologies in electrification that can replace fossil fuels and derivative products. The value chain of hydrogen economy consists of the production, storage and direct use of hydrogen. Boosting the efficiency of hydrogen production requires clean primary energy production and water resources, which will be essential to the energy system in the future.

Research Time Frames and Needs

The research needs are categorized into short-term (1–3 years), medium-term (3–5 years), and long-term (5–10 years) goals. Short-term goals center around overcoming industrial bottlenecks. Medium-term goals focus on improving the cost-competitiveness of technologies and the long-term goals center around developing breakthrough technologies and evaluating sustainability.

Key research areas

- **Clean hydrogen production:** Development and commercialization of more effective electrolysis systems.
- **Storage and distribution of energy and hydrogen:** Researching optimal distribution and storage methods.
- **Use of hydrogen:** Development of hydrogen fuel cells and manufacture of clean steel.
- **Synthetic value-added products of hydrogen, carbon dioxide and their use:** Development of synthetic fuels and chemicals out of hydrogen.
- **The energy and electricity system:** Adaptability of the energy system to renewable energy sources and flexible solutions.
- **Markets and society**
- **EU regulations and politics**
- **Environment and sustainability**

Method and results

The Finnish Strategic Hydrogen involved 12 Finnish universities and research institutes, including Aalto University, University of Helsinki, University of Jyväskylä, Natural

Resources Institute Finland, LUT University, University of Oulu, Tampere University, University of Turku, University of Eastern Finland, University of Vaasa, VTT Technical Research Centre of Finland and Åbo Akademi. The collaboration collected and evaluated 83 research topics, which were narrowed down into 24 of the most important ones that are crucial for Finnish competitiveness.

“The synthetic value-added products of hydrogen, carbon dioxide and their use” ranked as the most important category. The second most important was “The use of hydrogen” and the third one “The environment and sustainability”. Other important categories included “Storage and distribution of energy and hydrogen”, “The energy and electricity system”, and “Manufacture of clean hydrogen”. The lowest-scoring categories were “The markets and society” and “EU regulations and politics”. From the perspective of the most important research category, “Synthetic value-added products of hydrogen, carbon dioxide, and their use,” it is essential to study the entire hydrogen value chain and its various components. Understanding the changes in the value chain and their impacts is crucial for implementing these changes as efficiently as possible.

Summary

Hydrogen and PtX technologies are key factors as Finland moves towards a more sustainable and self-sufficient energy system. The goal of the Finnish Strategic Hydrogen Study is to reinforce Finland’s position as a pioneer of hydrogen economy and to make use of the country’s unique renewable electricity resources and biogenic carbon dioxide. This calls for extensive research and development cooperation and significant investments. Cooperation between Finnish universities and research institutes is crucial for realizing this strategy.

Further information:

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