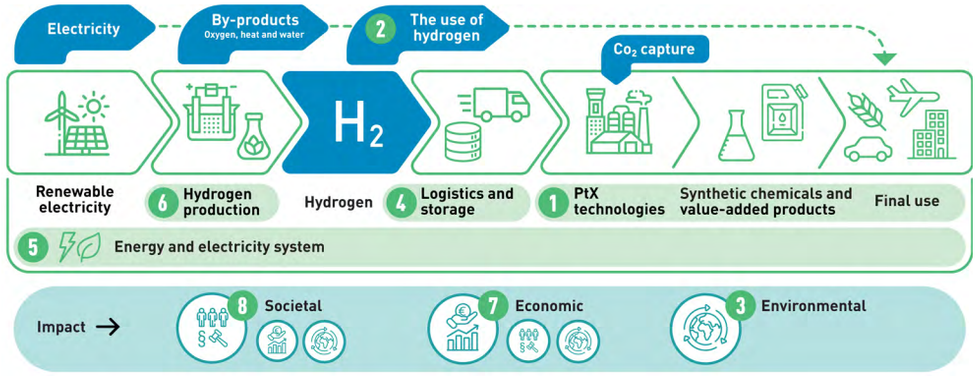
STRATEGIC RESEARCH AGENDA FOR FINNISH HYDROGEN RESEARCH

- COMPARISON OF RESEARCH NEEDS IN FINLAND'S HYDROGEN ECONOMY FROM THE PERSPECTIVES OF INDUSTRY AND ACADEMIA

HYDROGEN RESEARCH FORUM FINLAND

Key research areas pertaining to hydrogen economy



To understand the needs for research from the Finnish economy's viewpoint, one should also examine the industry's needs for research. The industrial viewpoint emphasizes practical solutions that support the rapid commercialization of hydrogen economy and strengthen competitiveness. Conversely, research organizations' focuses are more widely related to sustainability, innovations and long-term impacts. Combining these viewpoints creates a comprehensive and balanced understanding of what kind of research is needed to support both technological development and national economy goals in advancing the hydrogen economy.

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

	Industry-specific research needs	Shared views of industry and academia on the research needs of Finland's hydrogen economy	Research needs by academia
1 Synthetic value-added products of hydrogen, carbon dioxide, and their use	–	e-methanol Sustainable aviation fuel (SAF) Carbon dioxide separation technologies	e-ammonia
2 The use of hydrogen	Infrastructure required for hydrogen use	Using hydrogen to produce clean steel Fuel cells and X-to-Power (X2P) cycles, including RESOC Using hydrogen in engines and turbines	The use of hydrogen in maritime transport
3 The environment and sustainability	–	Evaluating the environmental impacts of the green transition and hydrogen economy Resources and critical raw materials Life cycle analysis of various green transition and hydrogen economy scenarios	Monitoring, advancing and supporting industrial changes within hydrogen economy
4 Energy and hydrogen storage and distribution	–	Hydrogen storage Hydrogen's role as an energy storage Materials research for hydrogen components Safety of hydrogen pipeline distribution	Comparison of hydrogen pipeline distribution to other alternatives
5 Energy and the electricity system	–	Storage and flexibility of electricity and energy Utilization of by-products from hydrogen production Flexibility of energy and electricity consumption and demand	–
6 Clean hydrogen production	Development of electrolysis technologies (alkaline/PEM) Development of electrolysis technologies (SOEC/AEM)	Finding efficient and/or alternative electrolysis technologies Improving the energy-efficiency of electrolysis technologies (alkaline and PEM)	Removing production limitations of electrolysis technologies (alkaline and PEM)
7 The markets and society	Monitoring and supporting Finnish macro economy and competitiveness through the green transition	–	Monitoring the development of business models and supporting them through the green transition and in hydrogen economy.
8 EU regulations and politics	Assessment of the EU regulatory framework and influencing it	Evaluating the effects of key EU regulations and the options to impact them to promote Finland's green transition and hydrogen economy	Geopolitics and security of supply

HYDROGEN RESEARCH FORUM FINLAND

STRATEGIC RESEARCH AGENDA FOR FINNISH HYDROGEN RESEARCH

- COMPARISON OF RESEARCH NEEDS IN FINLAND'S HYDROGEN ECONOMY FROM THE PERSPECTIVES OF INDUSTRY AND ACADEMIA

PtX technologies transform renewable energy 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 essentials 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 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 industry's views on the research needs of Finnish hydrogen economy were surveyed with a questionnaire. The questionnaire was based on research topics surveyed from Finnish universities and research organizations. The same questionnaire was sent to both universities and companies. A total of 23 representatives from Finnish companies responded to the survey. Based on the questionnaire, the highest averages – and thus the highest emphasis in terms of companies' research priorities – were related to the synthetic value-added products of hydrogen, carbon dioxide, and the manufacture of clean hydrogen. The next most important research categories were the use of hydrogen, storage and distribution of energy and hydrogen, and the energy and overall electricity systems. Companies were less likely to emphasize the evaluation of the markets and society, or environmental considerations in improving hydrogen economy and sustainability. Questions related to EU regulations and politics were the least important to companies from a research perspective.

Both companies and academia prioritized the category synthetic value-added products of hydrogen, carbon dioxide and their use as the most important research area Both sectors also considered the direct use of hydrogen important. Energy and hydrogen storage and distribution, and the energy and electricity system ranked fourth and fifth, respectively, for both groups.

Major differences could be seen within the categories of clean hydrogen production, and the environment and sustainability. For industry, the production of clean hydrogen was ranked as the second most important while academia ranked it only sixth. In contrast, universities ranked the environment and sustainability the third most important, while companies considered it among the two least important categories.

Summary

In conclusion, even though the views of industrial companies, universities and research institutes emphasize the significance of hydrogen economy for building a sustainable and self-sufficient energy system, they emphasized different focuses in terms of research. Industrial operators emphasize immediate and practical applications, such as clean hydrogen production and the development of synthetic value-added products. Universities on the other hand emphasize sustainability and environmental impacts in a larger context, thus reflecting the longevity and multidisciplinary nature of research.

Further information:
Pertti Kauranen, Professor, LUT University,
Chairman of Hydrogen Research Forum Finland, email: pertti.kauranen@lut.fi
Petteri Laaksonen, PhD, Research director, LUT University, email: petteri.laaksonen@lut.fi
Eeva Lähdesmäki, MSc, Project manager, LUT University, email: eeva.lahdesmaki@lut.fi
Teemu Tuomisalo, PhD, Researcher, LUT University, email: teemu.tuomisalo@lut.fi

UNIVERSITY OF OULU
PIRKANMAA COUNCIL OF TAMPERE REGION
LUT University
innocities
Co-funded by the European Union