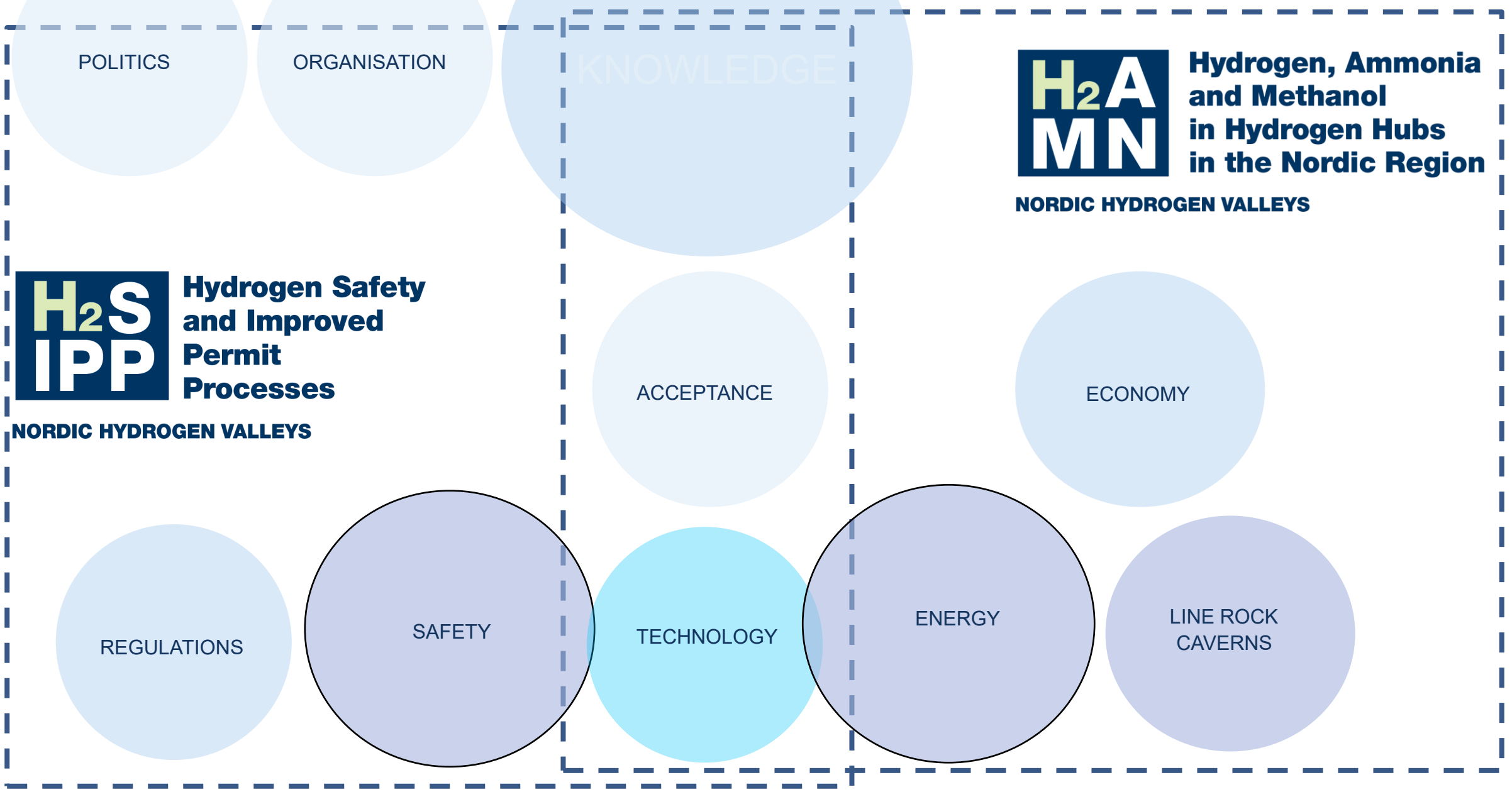
Hydrogen, Ammonia and Methanol in hydrogen hubs in the Nordic region (H2AMN)

Cecilia Wallmark
Luleå University of Technology

Nordic Energy Research


POLITICS
ORGANISATION
KNOWLEDGE
H2A MN
Hydrogen, Ammonia and Methanol in Hydrogen Hubs in the Nordic Region
NORDIC HYDROGEN VALLEYS
H2S IPP
Hydrogen Safety and Improved Permit Processes
NORDIC HYDROGEN VALLEYS
ACCEPTANCE
ECONOMY
REGULATIONS
SAFETY
TECHNOLOGY
ENERGY
LINE ROCK CAVERNS

Nordic
Hydrogen Valleys
as Energy Hubs

Hydrogen, Ammonia and Methanol in hydrogen hubs in the Nordic region

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Cecilia Wallmark
20260428

Nordic Hydrogen Valleys as Energy Hubs

In summary:

“Clear political leadership and reliable policies enabling long-term decisions and investments”

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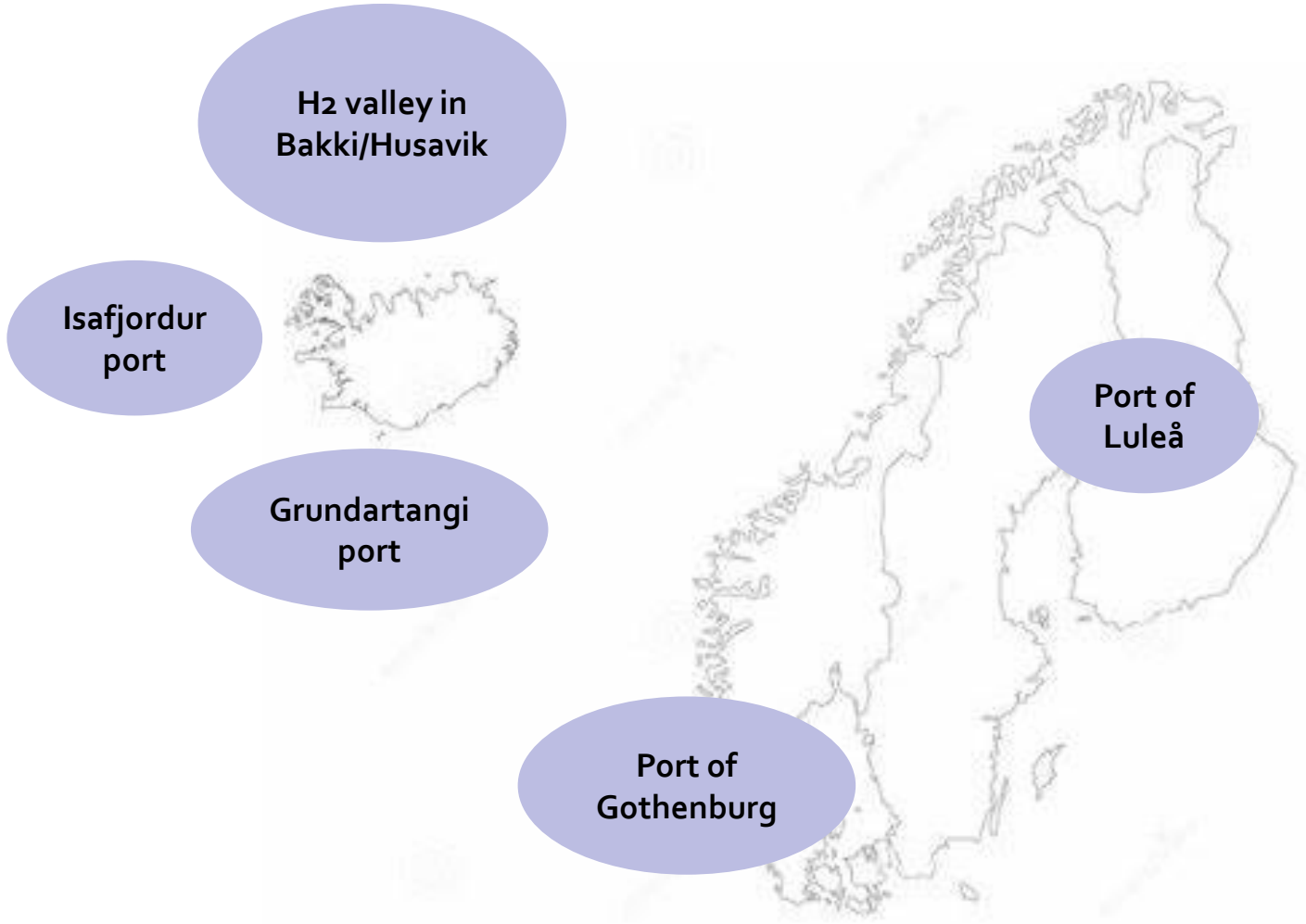
Nordic
Hydrogen Valleys
as Energy Hubs
H2A MN
In summary:
"Clear political leadership and reliable policies enabling long-term decisions and investments"
Nordic Energy Research
ARCTIC CIRCLE
ARCTIC CIRCLE

10 project partners

Five case studies in two countries



Tools and methods

- Mathematical linear programming
- Numerical modeling (LRC)
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- Interviews
- Stakeholder workshops
- Scenario analysis
- Literature reviews

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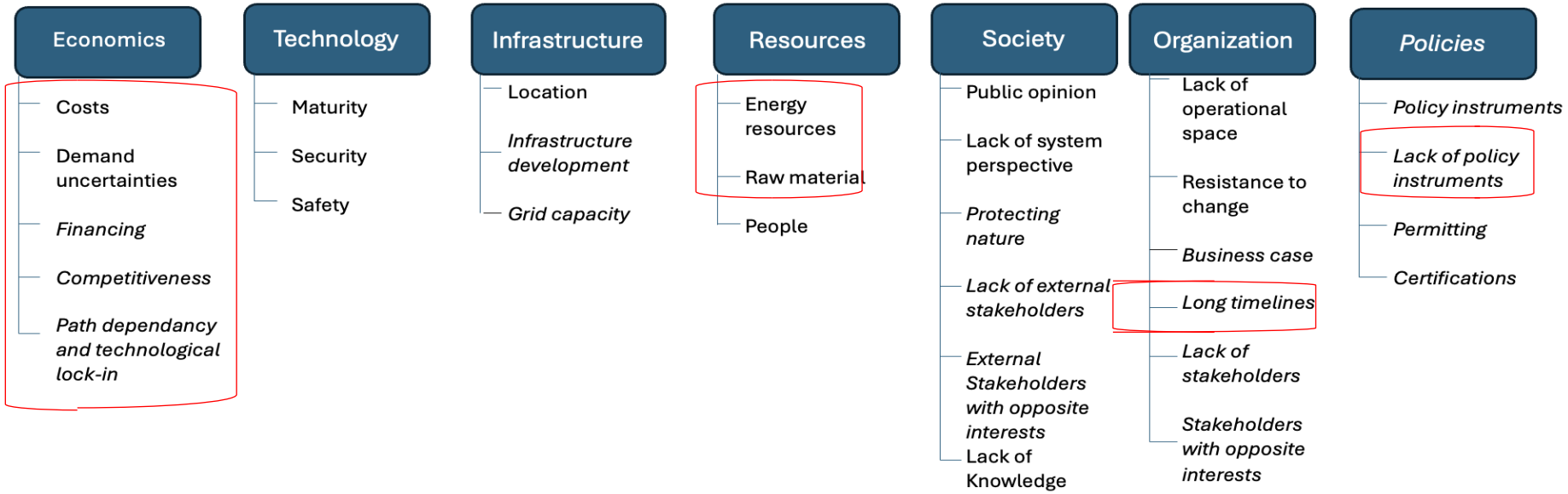
Nordic Hydrogen Valleys as Energy Hubs

Barriers / Iceland



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H2AMN Hydrogen, Ammonia and Methanol in Hydrogen Hubs in the Nordic Region

NORDIC HYDROGEN VALLEYS

Development

- Energy resources
- Raw material
- Public opinion (Ammonia specific)
- Safety and security
- Financing and demand uncertainties
- Ísafjörður faces barriers regarding energy, grid capacity, physical space and security

Deployment

- Financing, costs, competitiveness, path dependency and technological lock-in
- Only barriers specific to ammonia
- Resistance to change
- Lack of policy instruments

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The Nordic Hydrogen Valleys Conference
The hydrogen economy: Regulations and best practices
Nordic Energy Research
How to bridge the gap: policy needs to break the deadlock
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Holistic strategic thinking
Coordination of climate and energy goals including the hydrogen roadmap
Coordinated and inclusive action plans
Coordination of timelines
Prioritization of energy resources and building of infrastructure
Transparent implementation of Fit for 55
Regulatory instruments
Standards and certification
Bans and mandates e.g. blending standards
Economic incentives
Carbon pricing
Risk mitigation and risk sharing as technologies mature
Subsidies for Capex
Development
Infrastructure
Deployment
Innovative support to finan
Demonstration projects
Stakeholder engagement
Public acceptance
H2A MN
“The government's role is to set ambitious (but realistic) targets and to create the enabling conditions needed to reach set target.”
Brynhildur Davidsdottir, HI
Luleå Jan 2025

Breaking the deadlock

Drivers and barriers of Iceland

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H2AMN Hydrogen, Ammonia and Methanol in Hydrogen Hubs in the Nordic Region

NORDIC HYDROGEN VALLEYS

Scan for full article
Cary Corcoran et al.

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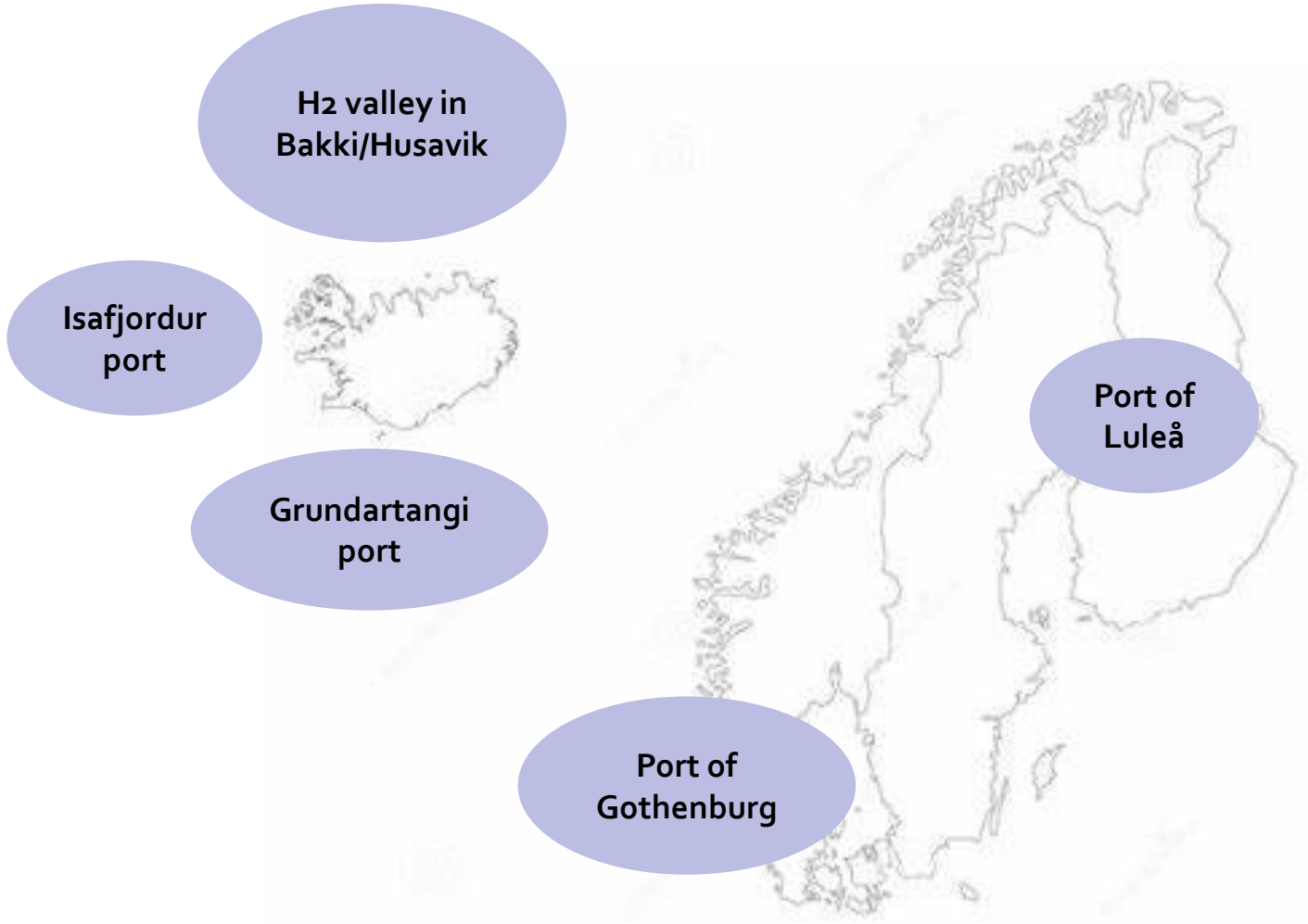
Five case studies in two countries



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North Sweden

740 MW installed at Stegra in Boden

Hybrit in Luleå

Worlds first hydrogen-based fossil-free steel production.

&

Worlds first hydrogen lined rock cavern.

Ping Zhang
Prof. in Rock Mechanics at LTU

H2AMN

Oil storage caverns for hydrogen storage?

Maximum allowable gas pressure increases with burial depth and rock mass quality (GSI).

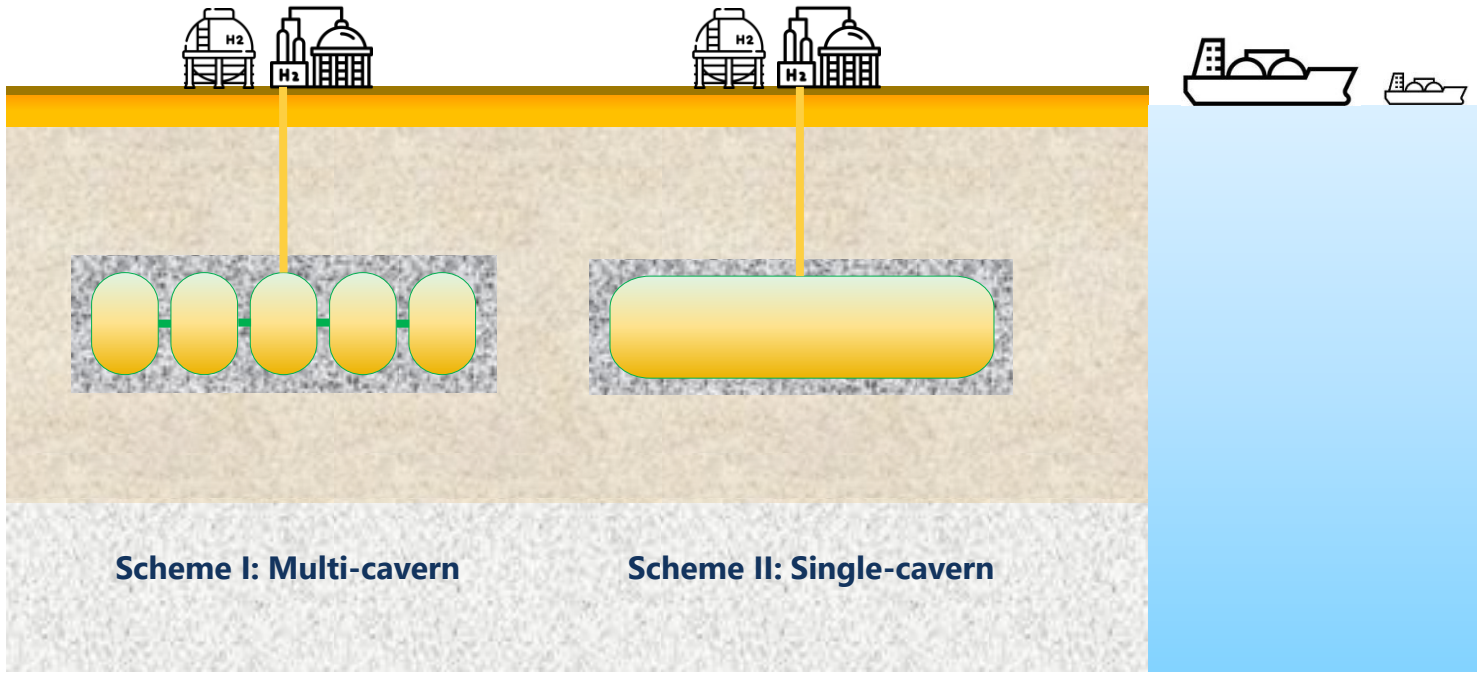
Rock mass quality and in-situ stress conditions dominate overall cavern behavior:

- Steel liner stress is mainly controlled by GSI

The Multi-caverns scheme demonstrates better structural stability, with lower steel liner stress and smaller plastic zones compared to the long Single-cavern scheme.

Cost is strongly governed by operating pressure:

- Higher pressure ⟶ lower unit storage cost (nonlinear relationship)
- The Single-cavern scheme is more cost-efficient, while the Multi-caverns scheme incurs higher costs due to reduced capacity and additional concrete



RQs:

1. Can existing oil storage caverns be effectively repurposed for hydrogen storage using Lined Rock Cavern (LRC) technology?
2. What technical guidelines are required to support the adaptation of LRC-based storage technology to repurposed oil caverns under varying geological, geometrical, and operational conditions?

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Joakim Lundgren

Prof. In Energy Engineering, LTU

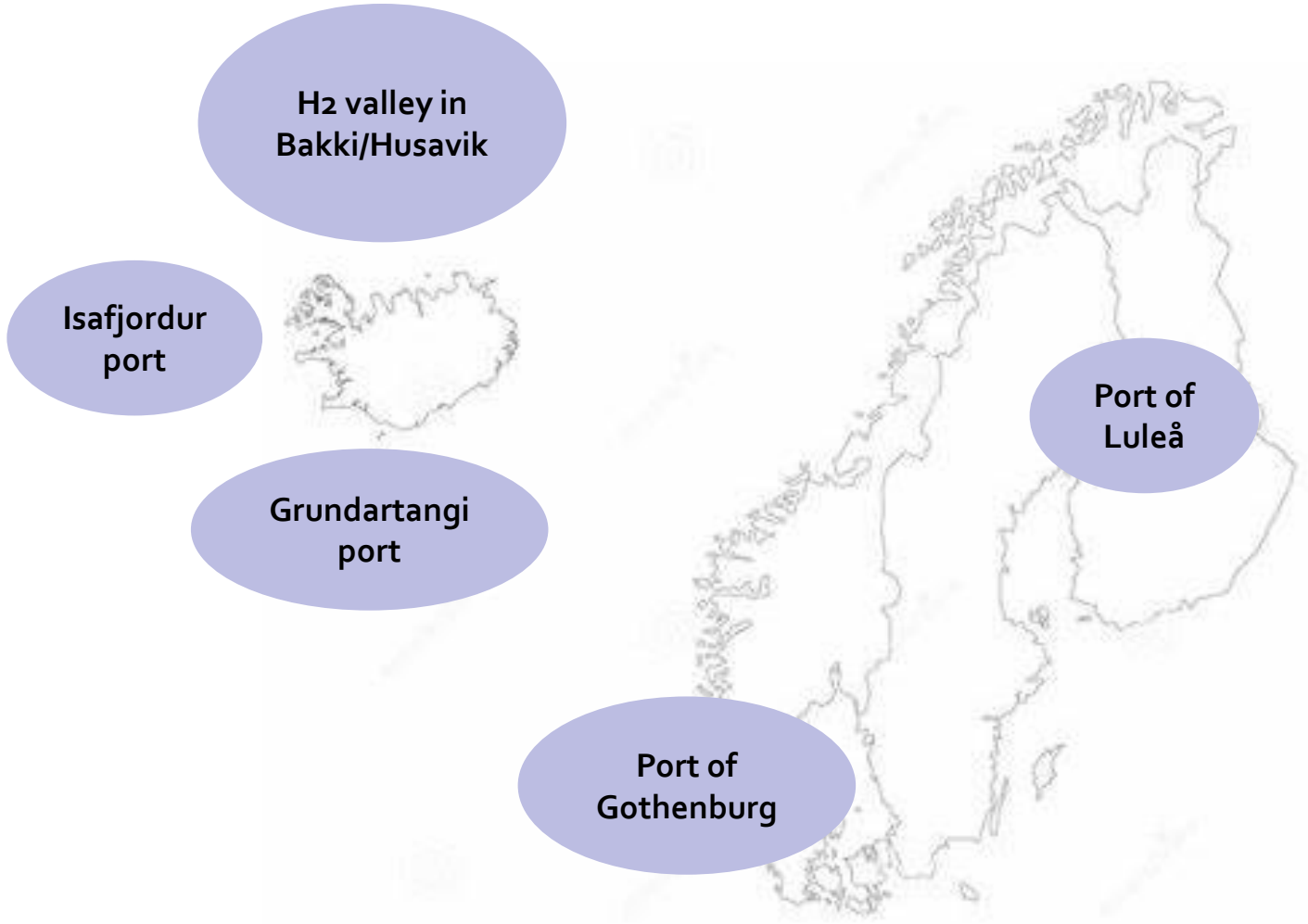
- Hydrogen & methanol: strong regional potential
- Biomass-based H_2: overlooked opportunity
- Limited potential for large-scale energy exports

Linda Wårell

Associate Professor in Economics at LTU

- From an economic perspective, stronger carbon taxation and increased funding for hydrogen-based fuel projects are needed.
- On the societal side, greater collaboration across stakeholders is essential and a lack of system perspective identified

Five case studies in two countries



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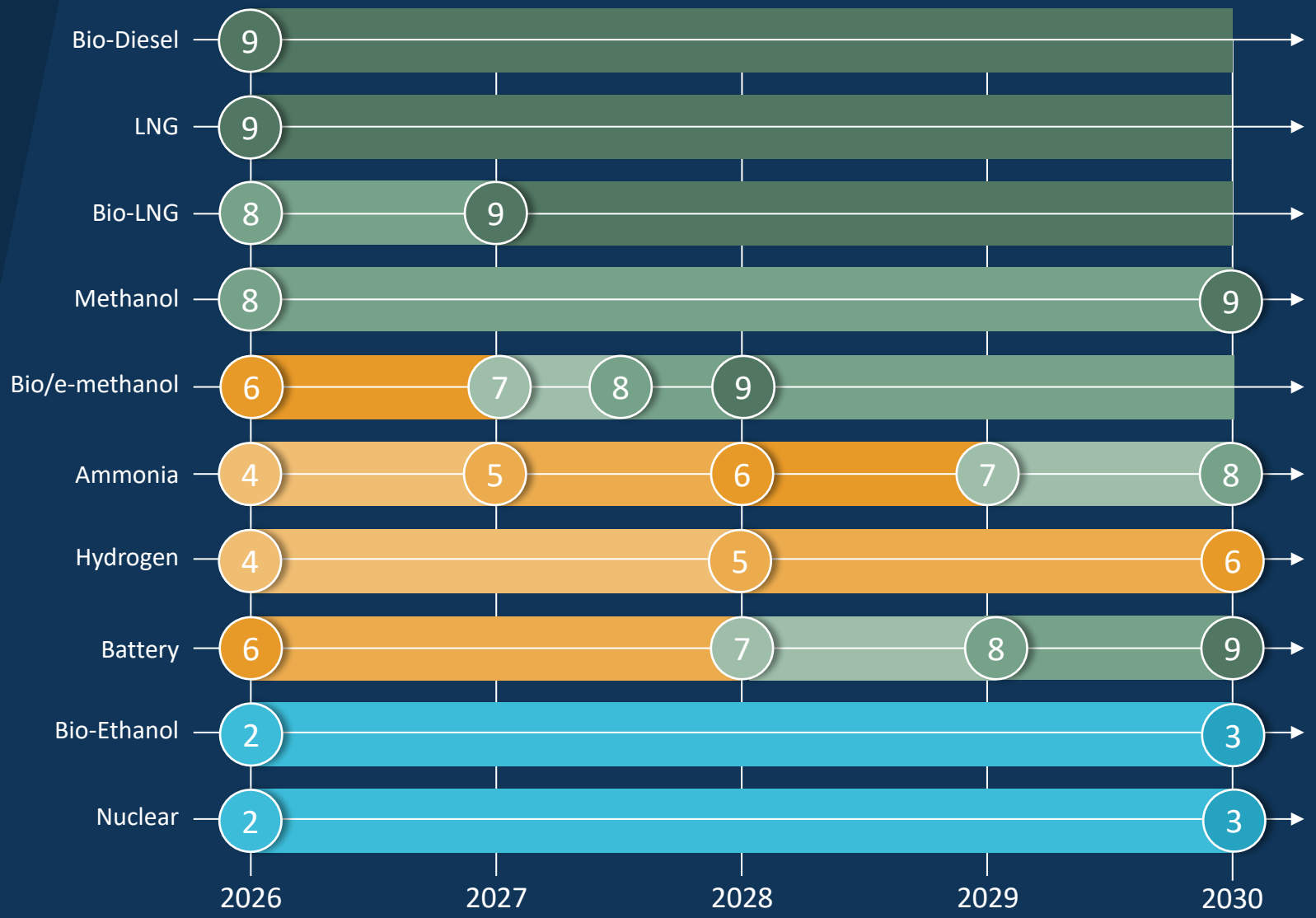
Nordic Hydrogen Valleys as Energy Hubs

PORT OF GOTHENBURG
TAKING YOU FURTHER

Port Readiness Level for Marine Fuels

- assessment framework developed by IAPH

In this phase, the port assesses whether the fuel is relevant. It identifies knowledge gaps, weighs pros and cons, and gauges interest among port stakeholders.	1	RESEARCH
	2	
	3	
Here, strategic decisions are made on how to implement the fuel. Guidelines are developed based on assessments and testing, and a pilot project is carried out.	4	DEVELOPMENT
	5	
	6	
In this final phase, operations are scaled up, moving from individual projects to becoming an integrated and regular part of the port's operations.	7	DEPLOYMENT
	8	
	9	

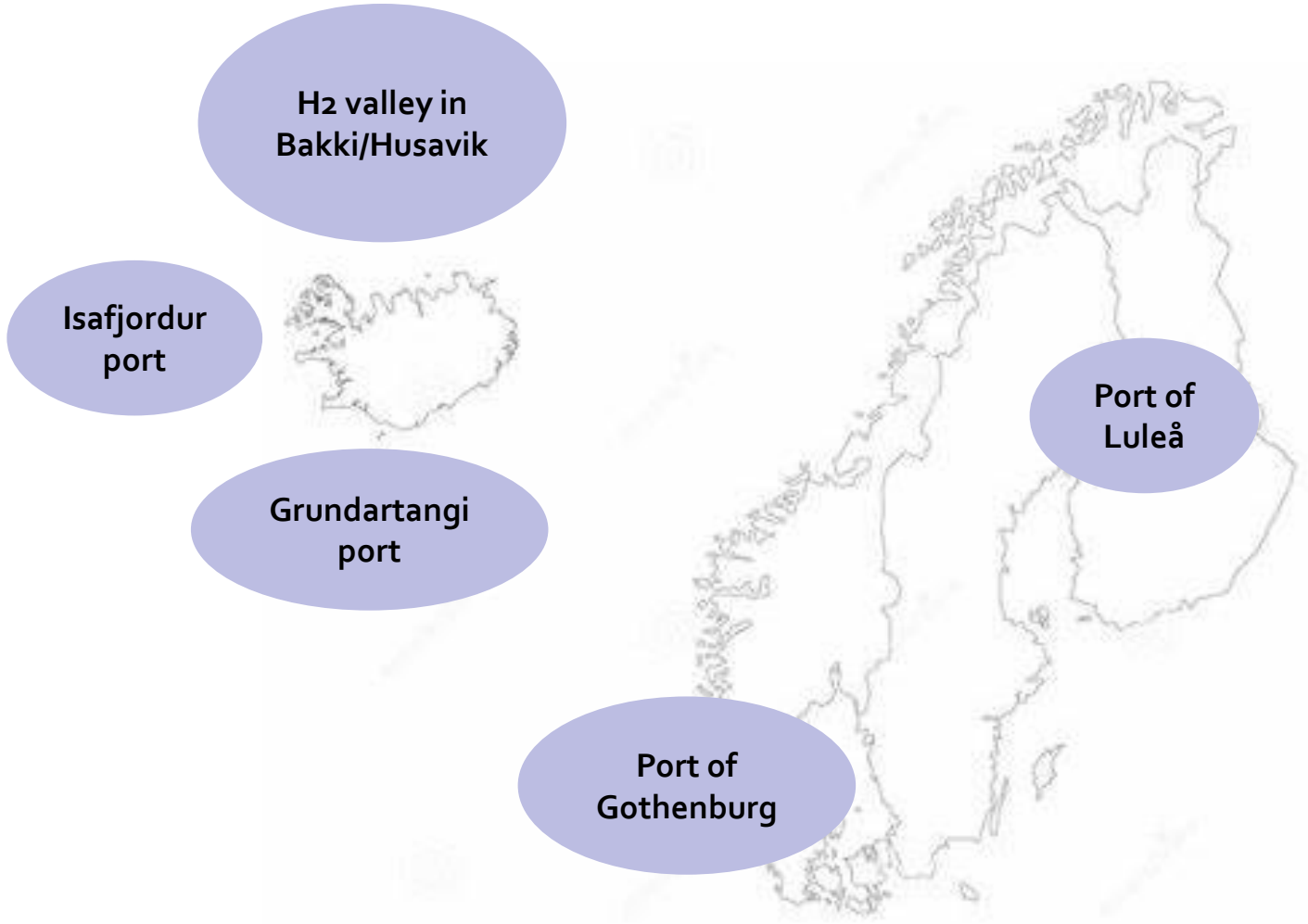


Julia Hansson

IVL The Swedish Environmental Institute

“Many actors see hydrogen-based fuels as economically beneficial in the long term, but today the higher cost compared to fossil fuels remains the main barrier.”

Five case studies in two countries



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Nordic Hydrogen Valleys as Energy Hubs

Main message

Policy an enabler for H_2-based fuels

Difficult to break the **hydrogen deadlock** with current signals and global situation

Cost most important driver and barrier:

Clear political leadership and **reliable policies** enabling long-term decisions/investments needed

- **Strengthen** current **policy** framework and **realize** holisitic **strategic roadmap**: high CO_2 taxes, fund pilot projects and R&D programs, support demand (early mover incentives)
- Increased coordination needed on **energy resource** availability and **grid capacity**

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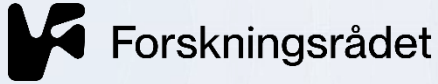
Swedish
Energy Agency


Innovation Fund Denmark


Forskningsrådet

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Hydrogen Safety and Improved Permit Processes

Nordic Energy Research

Cecilia Wallmark
20260428

Results by H2SIPP

- ✓ Essential **to improve regulatory clarity and efficiency, while maintaining environmental protection**, to enable large-scale hydrogen deployment and support the green transition.
- ✓ New knowledge implies up to **40 % reduction in safety distances**
- ✓ **Air humidity** reduces thermal radiation, directly influencing risk during close exposure

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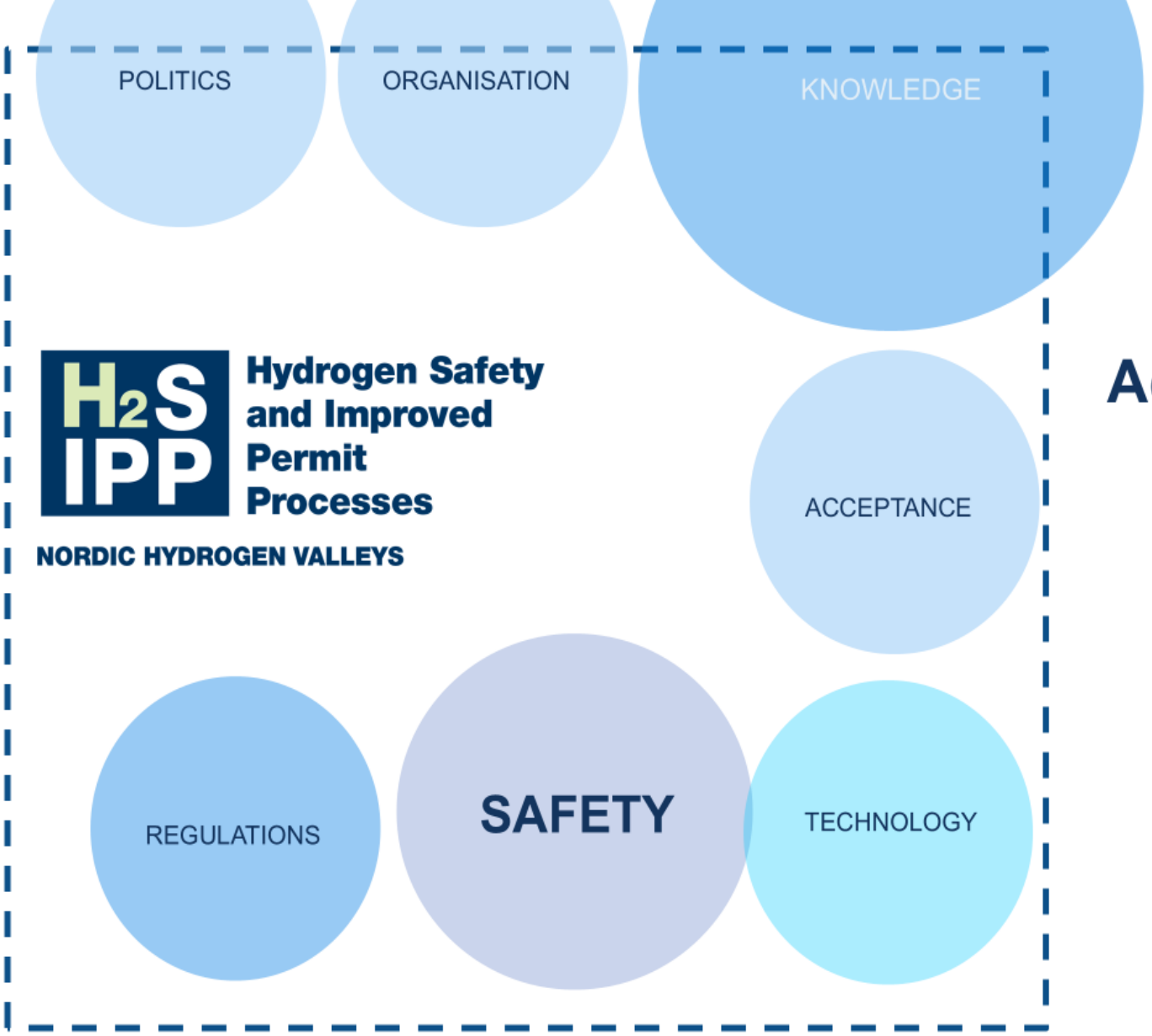
For Nordic Hydrogen Valley
2026



Addressing major barriers

Hydrogen Safety and Improved Permit Processes

NORDIC HYDROGEN VALLEYS

Pathways to 2030 and 2040

We will develop strategies to delimit key barriers identified in recent work for the implementation of hydrogen in the Nordic countries:

1) permit processes
2) safety distance determination
3) social acceptance

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Nordic Hydrogen Valleys as Energy Hubs

LUND UNIVERSITY

Aalto University

NTNU
Norwegian University of Science and Technology

A project team within hydrogen industry, local hydrogen energy systems, pipelines, refuelling stations, including NGOs, public partners and four universities.

H2S IPP

AFRY ÅF PÖYRY

NORDION ENERGI

hydri

GÄLLIVARE

BODENS KOMMUN

SSAB

SKOOGS Bränsle AB

GEN-H Hydrogen energy solutions

ENERGIGAS SVERIGE

ZELK

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Nordic Hydrogen Valleys as Energy Hubs

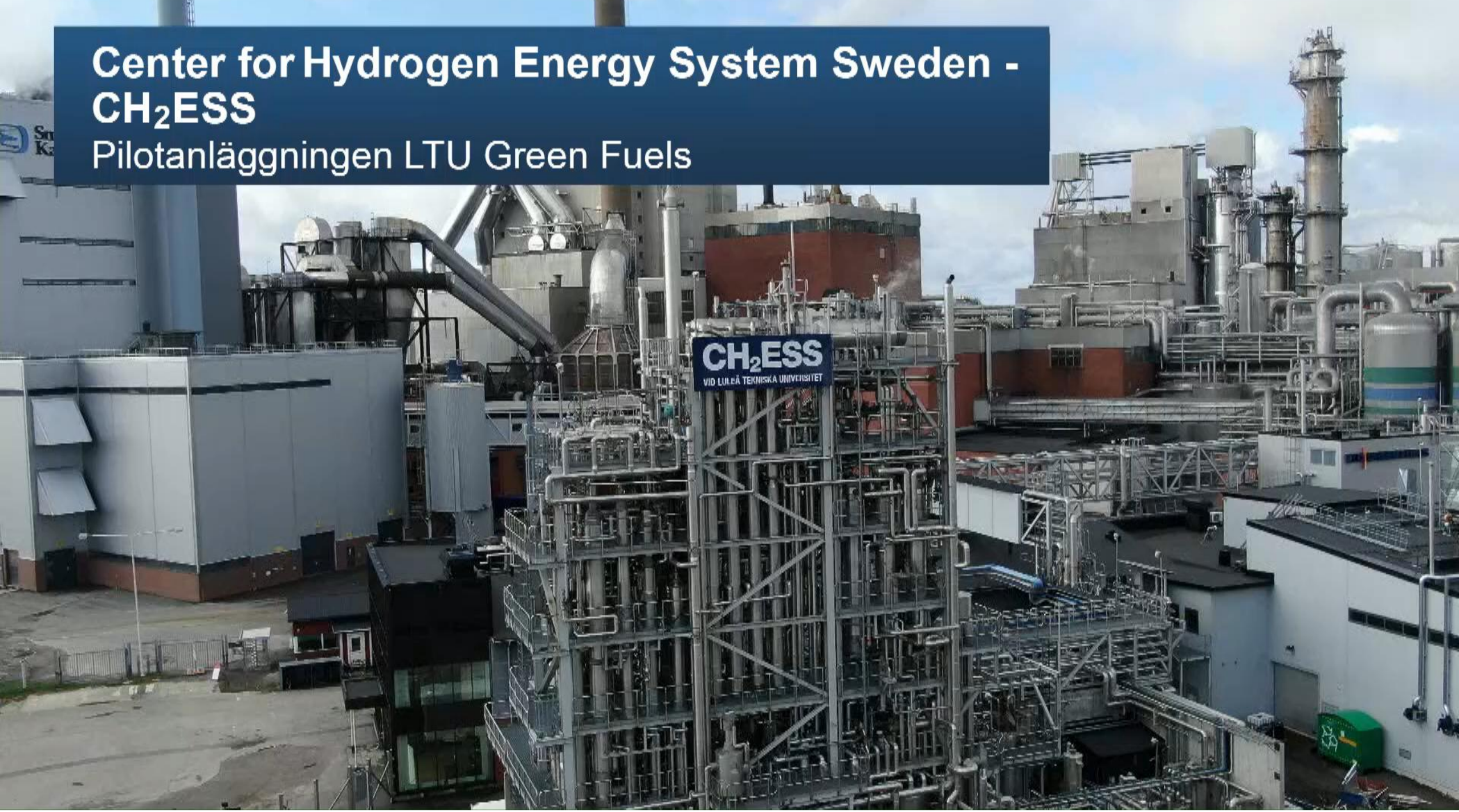
LUND UNIVERSITY

Aalto University

NTNU Norwegian University of Science and Technology

Center for Hydrogen Energy System Sweden - CH_2ESS

Pilotanläggningen LTU Green Fuels



Regulative frameworks lagging

Oskar Johansson, Researcher, Maria Pettersson, Professor in Law, LTU

- ✓ **Regulatory frameworks lag behind** technological development, creating a “pacing problem”.
  - Technology moves fast
  - Regulation moves slower
  - Result → Regulations lag behind, creating gaps, uncertainty, or outdated rules.

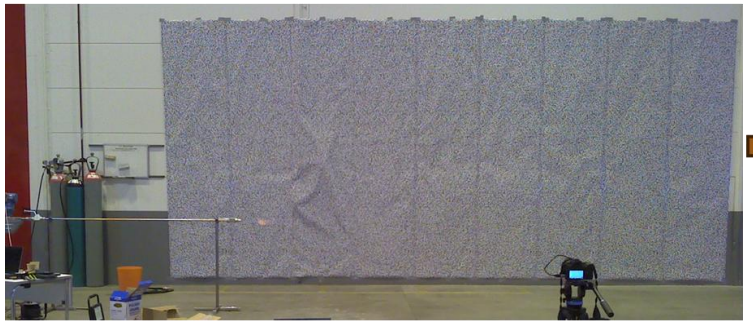
- ✓ **Stakeholders strongly call for clearer guidelines,** technical standards, and more harmonized regulations at both national and EU levels
  - Emphasis on guidelines and technical standards

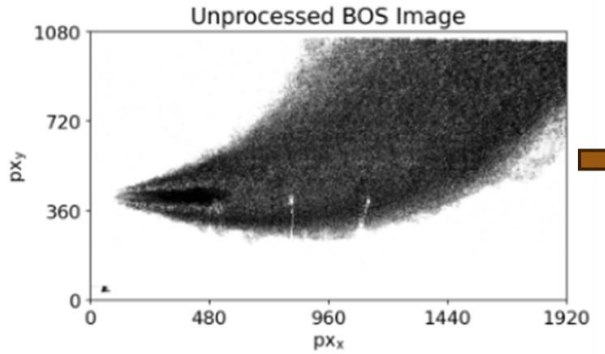
- ✓ **Improving regulatory clarity and efficiency, while maintaining environmental protection**, is essential to enable large-scale hydrogen deployment and support the green transition.

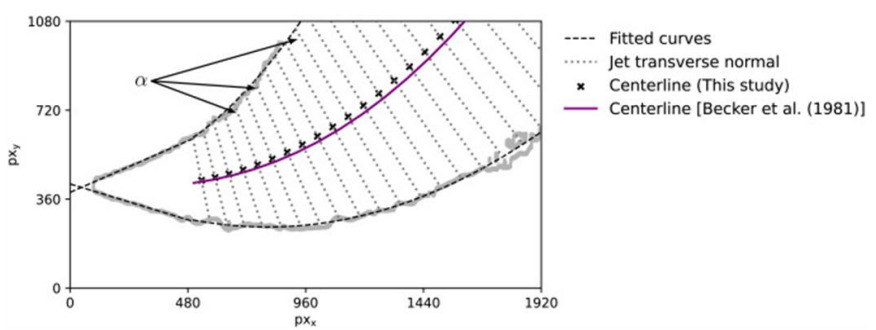
Project partners from Gällivare, Boden and Nordion Energi

Buoyancy of Combustion Products

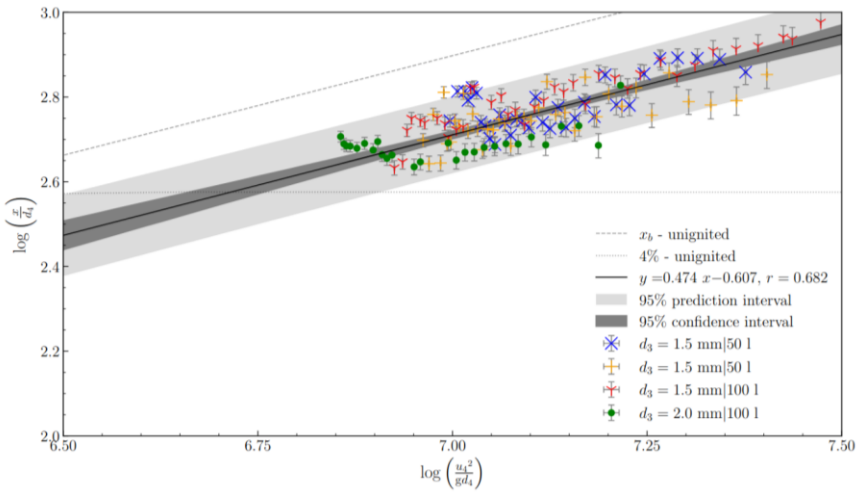
Marcus Runefors, Associate Professor in Fire Safety Engineering, Lund University







Result:



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Nordic Hydrogen Valleys as Energy Hubs

Lund University

Up to 40 % reduction in safety distances!

H2S IPP

Marcus Runefors
Associate Professor in Fire Safety Engineering,
Lund University

Nordic Energy Research

Nordic Hydrogen Valleys as Energy Hubs

LUND UNIVERSITY

Andrea Correa

PhD Student in Fire Technology, LTU

“Air humidity reduces thermal radiation, directly influencing risk during close exposure.”

This insight supports safer system design, and future integration into CFD models could improve predictions for large-scale hydrogen scenarios.

Rhoda Afriyie Mensah

Associate Senior Lecturer in Fire Technology, LTU

Knowledge: There is low knowledge of hydrogen in most target/stakeholder groups. More targeted education is needed.

Standards: There are a wide range of existing standards. Critical gaps remain in areas like large-scale storage, pipeline repurposing, and system integration.

Permitting: The system is fragmented and complex. Digitalization and AI could help to improve efficiency and reduce delays.

Next: Sustainable hydrogen value chains, 7.5 ECTS

Welcome to Luleå!

25-29 May 2026

Study visits to Hybrit and Stegra

Examiner: Joakim Lundgren

Centre for Hydrogen Energy Systems Sweden
AT LULEÅ UNIVERSITY OF TECHNOLOGY

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Hydrogen Valleys as Energy Hubs

The Nordic Offer

Let's investigate a common
Nordic Hydrogen Offer!

- Analyse to strengthen the Nordic energy market with a common market for hydrogen and its derivates
- Identify matching products and services for the global market
- Develop a Nordic Safety Standard!?

Welcome to discuss collaborations for the next phase

Hydrogen SIC! – The Swedish Innovation Cluster for Excellence along and across the Value Chains

Dr. Cecilia Wallmark, Hydrogen SIC! Project manager
Associate Professor in Energy Engineering, LTU
Director of Centre for Hydrogen Energy Systems Sweden (CH2ESS),
at Luleå University of Technology (cecilia.wallmark@ltu.se)

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Nordic Hydrogen Valleys as Energy Hubs

Hydrogen SIC!

Sweden: 250 companies,
500 researchers within hydrogen

Dr. Cecilia Wallmark

Associate Professor

cecilia.wallmark@ltu.se

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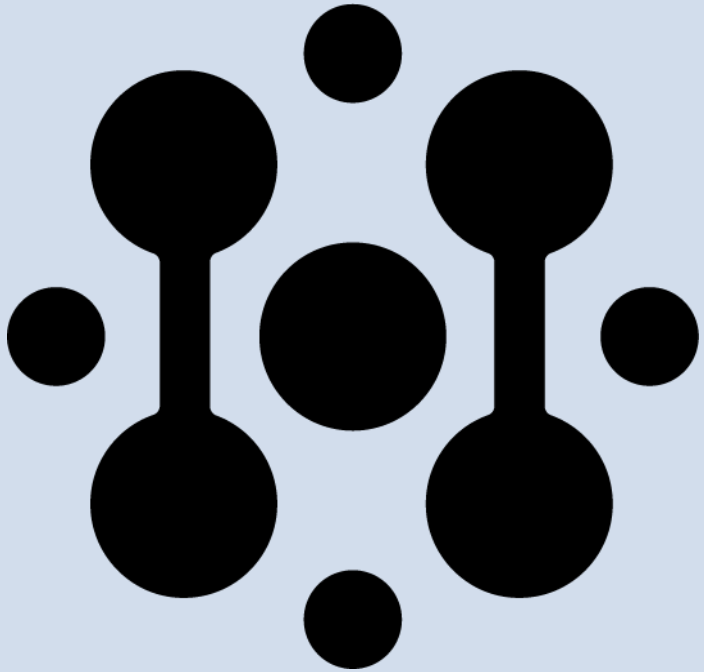
Luleå University of Technology
CH2ESS

nordicenergy.org

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BUSINESS
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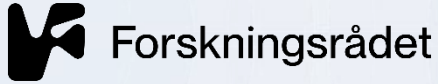
Energy Agency


Innovation Fund Denmark


Forskningsrådet

This project is part of the

Nordic Hydrogen Valleys as Energy Hubs Programme

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Nordic Hydrogen Valleys as Energy Hubs


LULEÅ
UNIVERSITY
OF TECHNOLOGY

Matchmaking event: Thanks to the Nordic Energy Research Equality

AFRY ÅF PÖYRY

Stegra

Skellefteå Kraft

CH2 ESS Centre for Hydrogen Energy Systems Sweden AT LULEÅ UNIVERSITY OF TECHNOLOGY

An appreciated hydrogen-dedicated event to make foreign students and regional companies matchmaking.

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