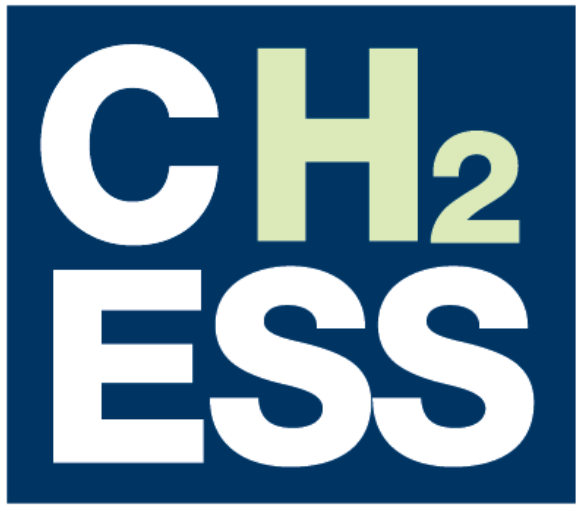
Vätgasens nyttor och infrastruktur

Dr. Cecilia Wallmark,
Verksamhetsledare CH2ESS
Inom vätgas sedan 1999



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Frågeställningar för dagen

- Varför är vätgas intressant för industri, transporter och energisystemet?
- Vad är aktuellt inom vätgas i Sverige och globalt?
- Vilken infrastruktur behövs för användning av vätgas?
- Hur kan vätgas produceras?

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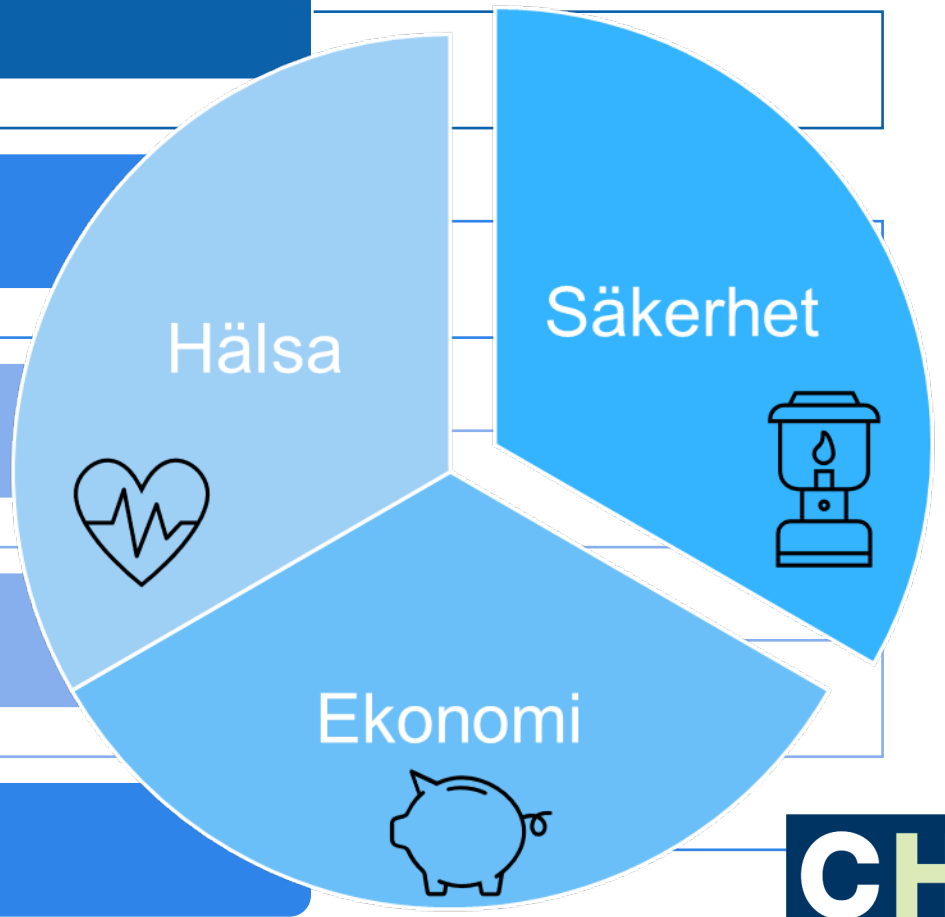
1) Utbildning

2) Forskning

3) Stöd för implementering av vätgas i samhället

Drivkrafter för vätgas

- Klimatnytta
  Minskade emissioner
- Industriell insatsråvara, grund för elektrobränslen, drivmedel
- Fossilfria produkter, affärer och export
- Lokal produktion
  Energilagring
- Försörjningstrygghet



Vätgas – en energibärare & unik insatsråvara

1

En energibärare

2

Utgör en emissionsfri del av värdekedjan

3

Flexibel

4

Vanlig gas i industrin
Ny användning

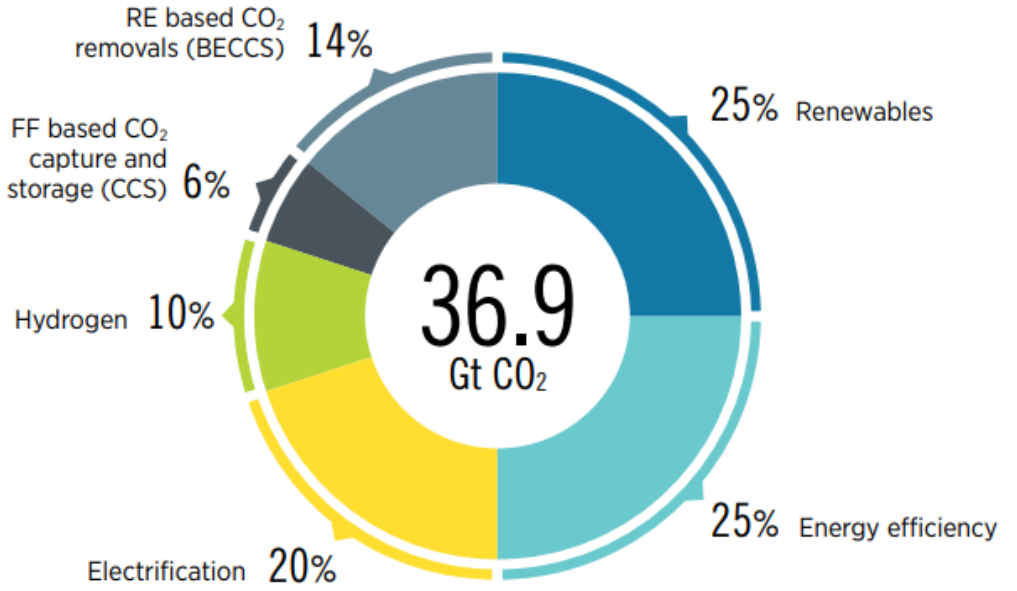
Varför är vätgas intressant för industri, transporter och energisystemet?

Vätgas för klimatet

- I storleksordningen 10 % reduktion av växthusgasutsläpp möjliga med hjälp av vätgas till 2050.
- Världens stålindustri står för 7 % av världens utsläpp,

WORLD ENERGY
TRANSITIONS OUTLOOK

FIGURE 1.1 Reducing emissions by 2050 through six technological avenues



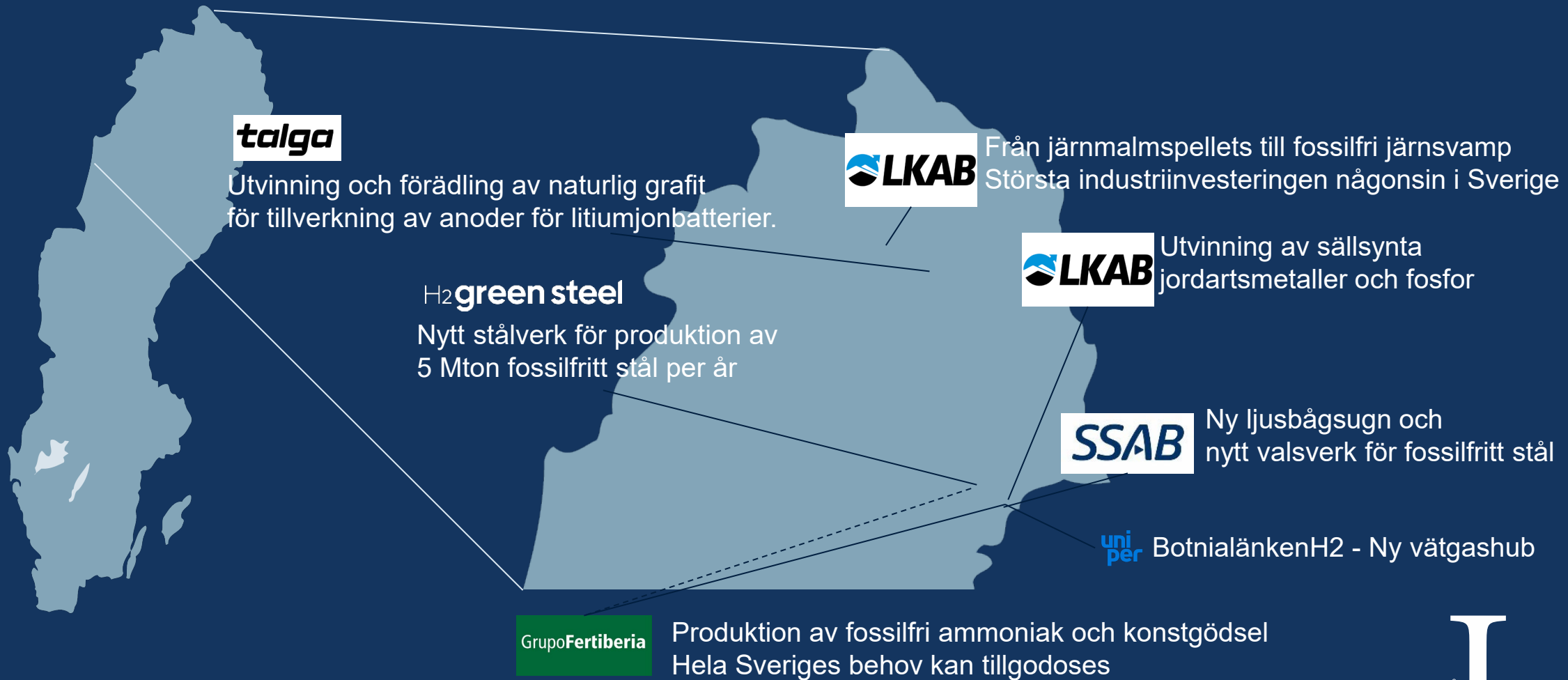
Note: Abatement estimates include energy and process-related CO_2 emissions along with emissions from non-ene
use. Renewables include renewable electricity generation sources and direct use of renewable heat and biom
Energy efficiency includes measures related to reduced demand and efficiency improvements. Structural chan
(*e.g.* relocation of steel production with direct reduced iron) and circular economy practices are part of ene
efficiency. Electrification includes direct use of clean electricity in transport and heat applications. Hydrogen
its derivatives include synthetic fuels and feedstocks. CCS describes carbon capture and storage from point-sou
fossil fuel-based and other emitting processes, mainly in industry. BECCS and other carbon removal measures incl
bioenergy coupled with CCS in electricity, heat generation and industry.

CCS = carbon capture and storage; BECCS = bioenergy with carbon capture and storage; RE = renewab
FF = fossil fuel; $GtCO_2$ = gigatonnes of carbon dioxide.

Hybrit in Luleå

Stegra in Boden

Investeringar för mer än 1 000 miljarder kr



Ref. LKAB, SSAB, H2GS, Grupo Fertiberia, Uniper, Talga, 2022/2023

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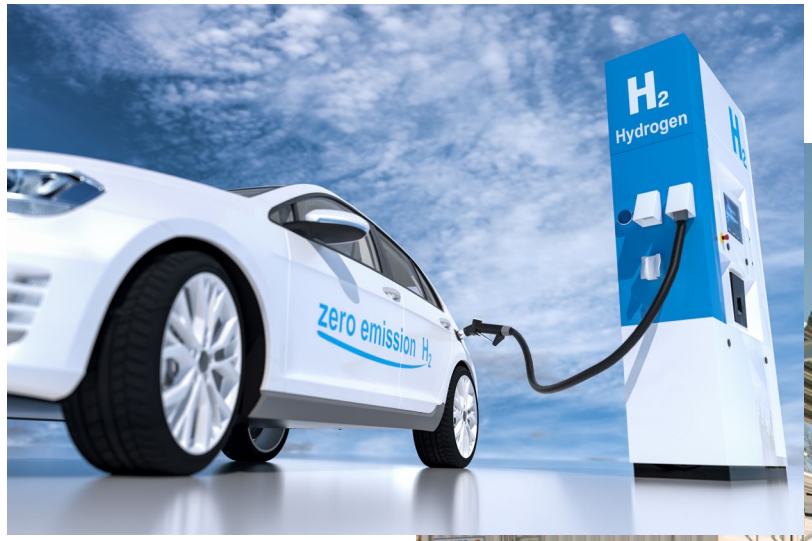
Tanka vätgas – för tunga transporter



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Världens första dumper med bränsleceller Volvo HX04 – juni 2022,

”ett resultat av forskning i Sverige” [Energimyndigheten]

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Vad är aktuellt inom vätgas i Sverige och globalt?

Sweden as a frontrunner in hydrogen

[Vätgaskonferensen 2023, CH2ESS @ LTU]

Green power, biomass, distr heating, green CO_2, H_2O, capital

Active stakeholders along the full value chain, geografical spread, applications and systems

Major component suppliers
- ABB
- Hitachi
- SKF
- Alfa Laval
- …

Early network of HRS
>60 stations accepted for public financial support

High quality heavy-duty FCV
- Volvo
- Scania

Front runners in fossil-free green iron and steel etc
- SSAB
- LKAB
- H2 Green Steel
- Ovako
- Power2Earth

Hydrogen based fuel production
- Liquid Wind
- St1
- Vattenfall
- Uniper
- …

World class fuel cell material, components, stacks and systems
- PowerCell
- Alleima
- Cellimpact
- Permascand…

Energy system innovations and research with multiple stakeholders and sector coupling

Marine applications
- Gotland
- …

Strong innovation, SME

E.g for flights with FC, GT, hydrogen storage

First movers

World class hydrogen research
- KTH
- Umeå
- Chalmers
- Lund
- Uppsala
- LTU
- RISE

World leading steel and metallurgy research
- LTU
- KTH
- Swerim

Stakeholders active in hydrogen and fuel cell research and development, all TRL

Investeringar och produkter

Aktiviteter över hela Sverige längs hela värdekedjan från produktion, distribution, lagring och användning i **industri, energi och transport**.

Fossilfritt stål, elektrobränslen, forskning, produkter…

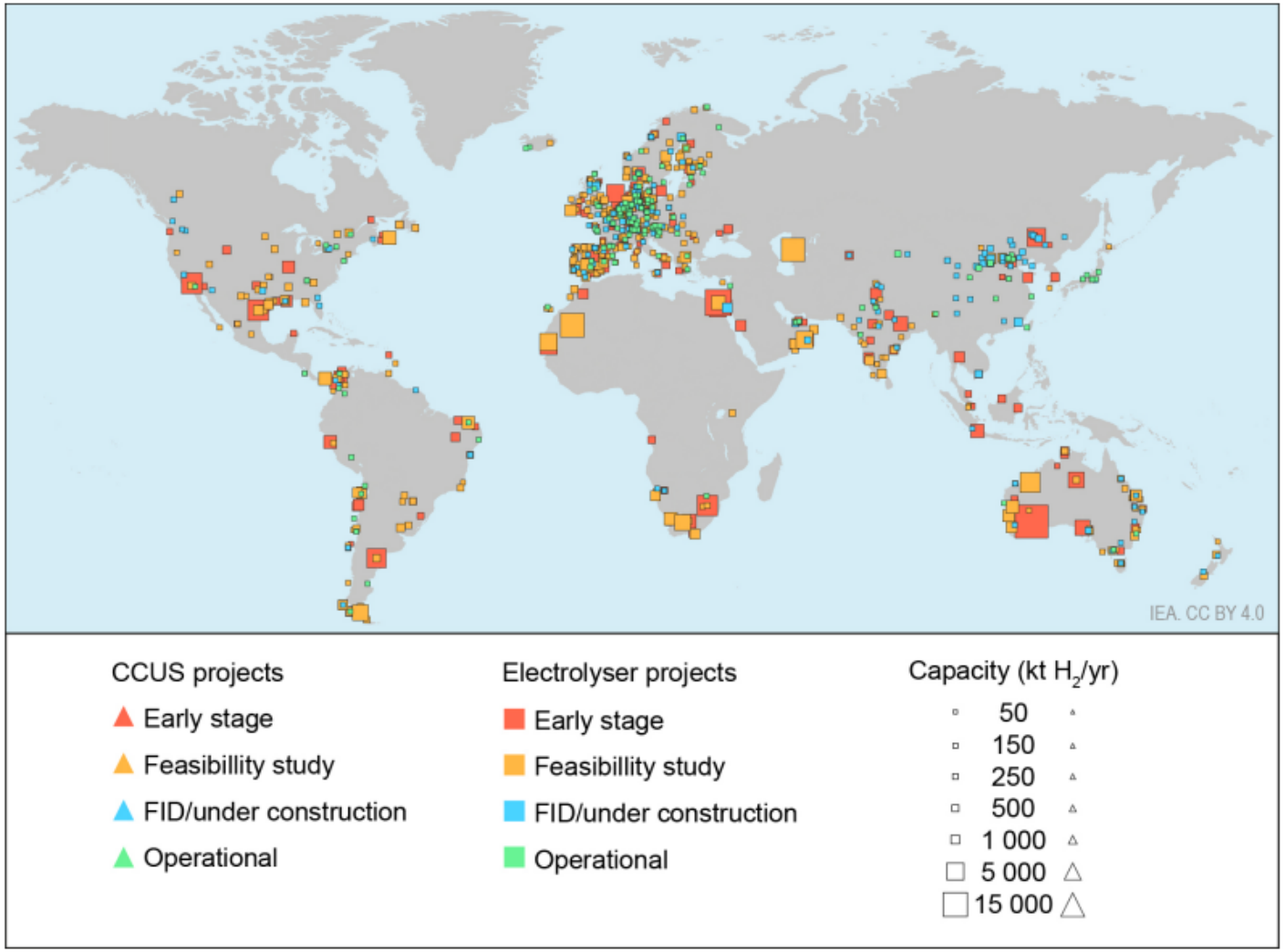
Karta med underlag insamlade under Vätgaskonferensen december 2023 samt 2024
Vätgaskartan 2024

- Anläggning i drift
- Första spadtaget
- Projektering
- Förstudie
- Övrigt

Vätgas ses som en nyckel för omställningen, och nya affärer, i stora regioner globalt

Bild:
Global Hydrogen Review 2023

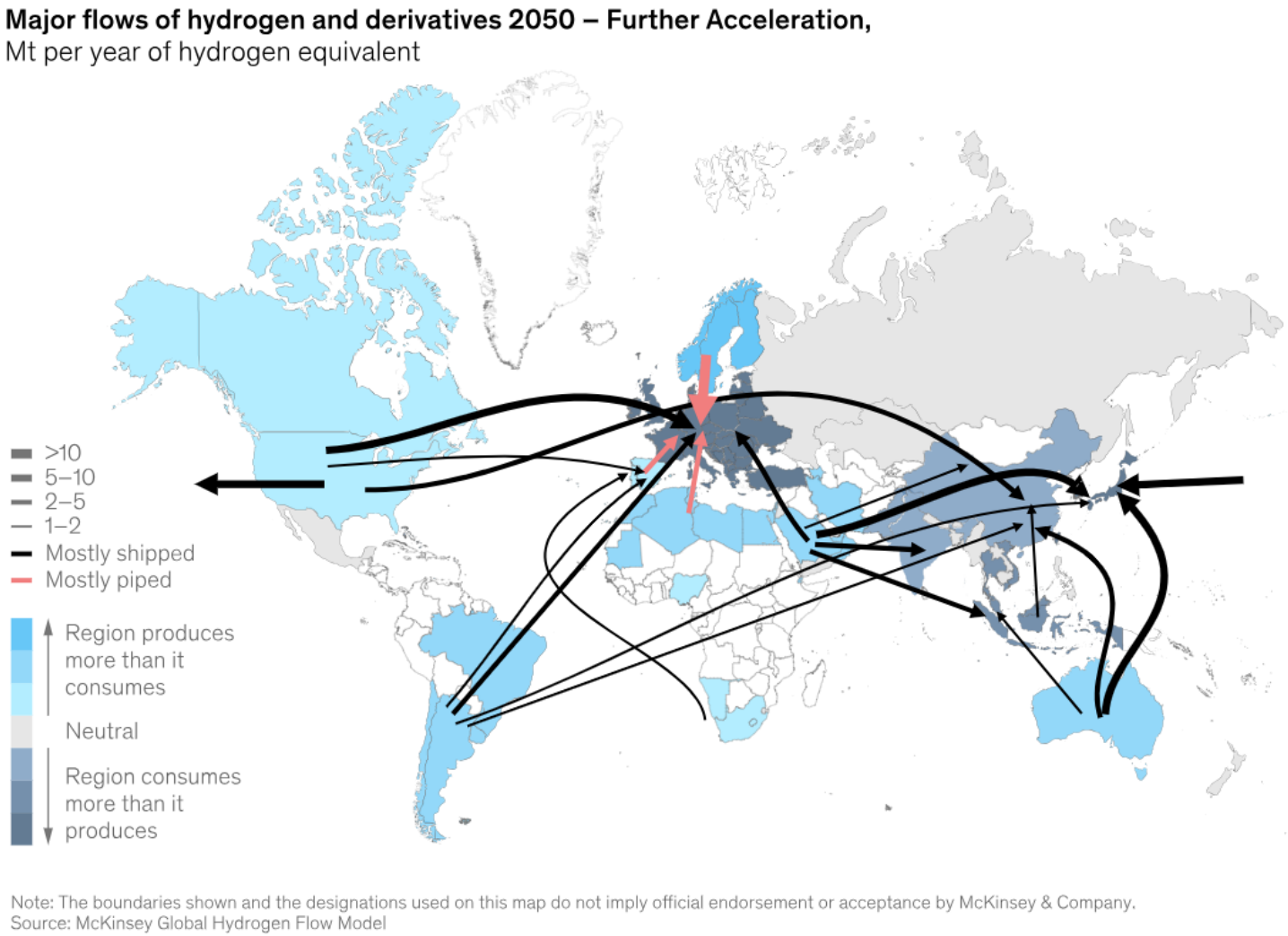
Figure 3.4 Map of announced low-emission hydrogen production projects



Note: Map also includes announced projects starting after 2030.
Source: IEA Hydrogen Projects, (Database, October 2023 release).

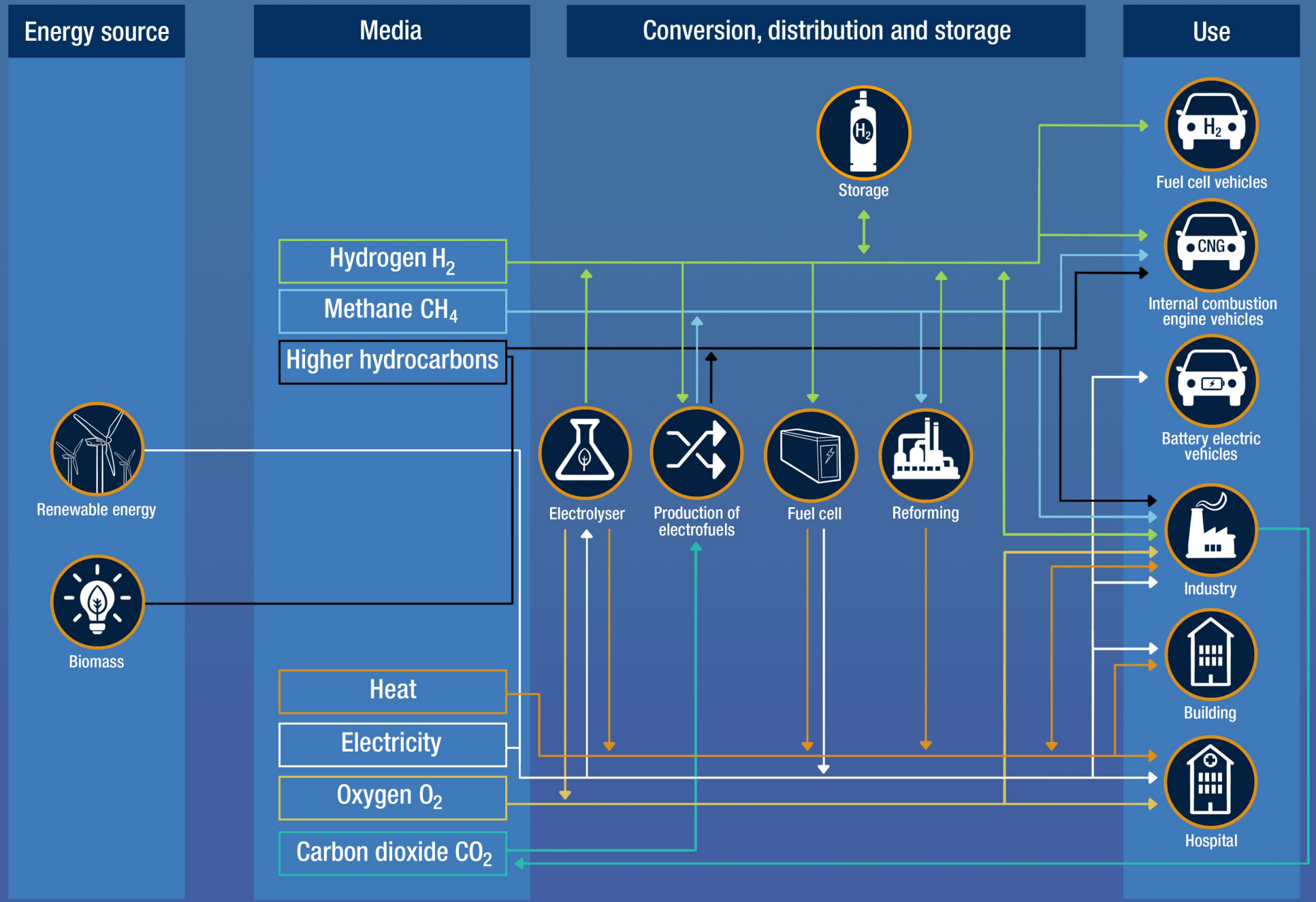
Announced projects are so far concentrated in Europe and Australia, but a growing number are planned in Africa, China, India, Latin America and the United States.

Betydelsen av geografisk strategi och prioritet



Källa: Global Energy Perspective 2023: Hydrogen outlook

Hur kan vätgas produceras?


Energy source
Media
Conversion, distribution and storage
Use
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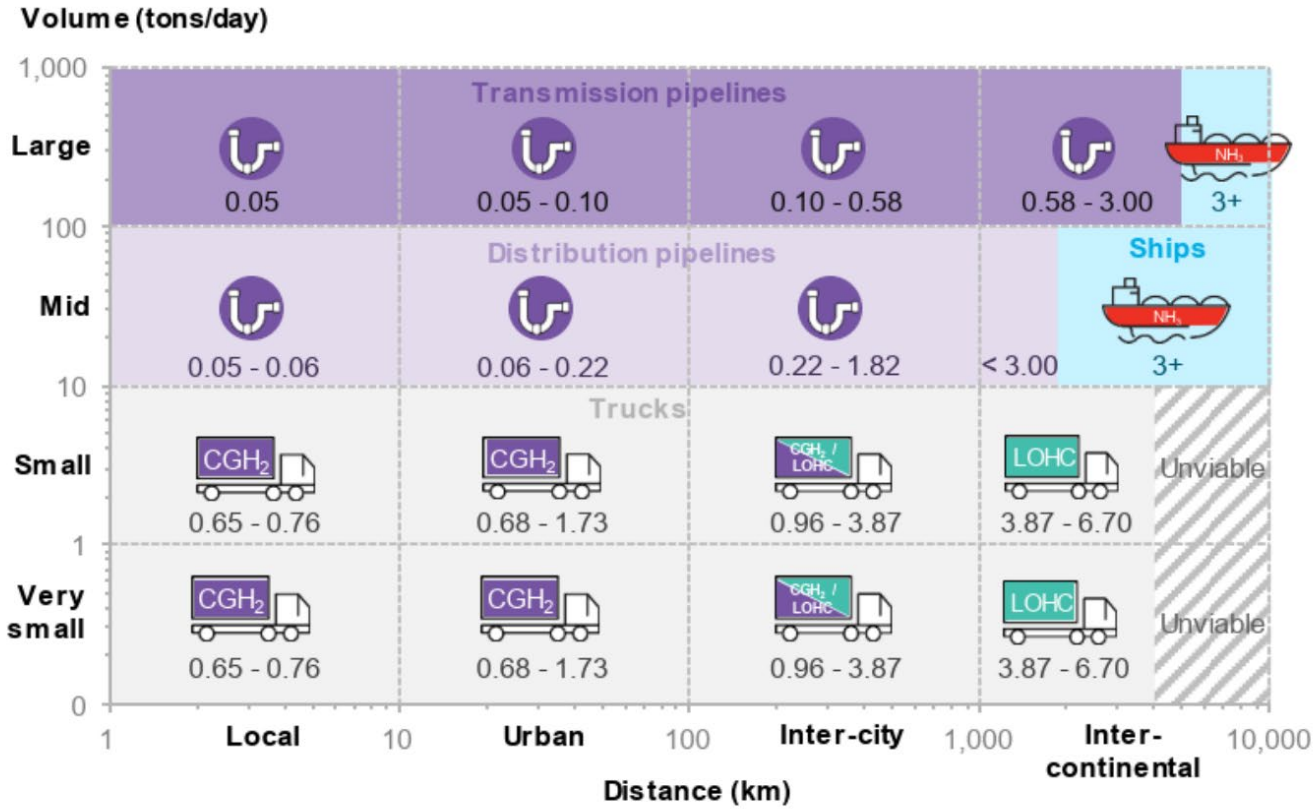
Storage
Hydrogen H_2
Methane CH_4
Higher hydrocarbons
Renewable energy
Biomass
Electrolyser
Production of electrofuels
Fuel cell
Reforming
Heat
Electricity
Oxygen O_2
Carbon dioxide CO_2
Fuel cell vehicles
Internal combustion engine vehicles
Battery electric vehicles
Industry
Building
Hospital

Vilken infrastruktur behövs för användning av vätgas?

On hydrogen distribution



Legend: *Compressed H_2* *Liquid H_2* *Ammonia* *Liquid Organic Hydrogen Carriers*

Source: BloombergNEF. Note: figures include the cost of movement, compression and associated storage (20% assumed for pipelines in a salt cavern). Ammonia assumed unsuitable at small scale due to its toxicity. While LOHC is cheaper than LH_2 for long distance trucking, it is less likely to be used than the more commercially developed LH_2.

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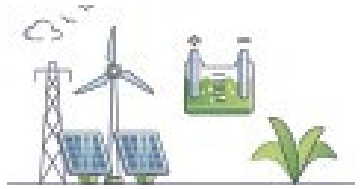
1) Utbildning

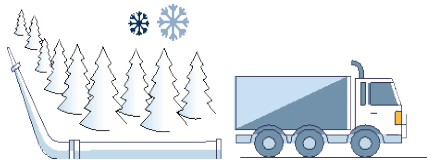
2) Forskning

3) Stöd för implementering av vätgas i samhället

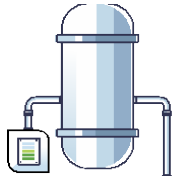
The CH2ESS growing research portfolio (May 2024)



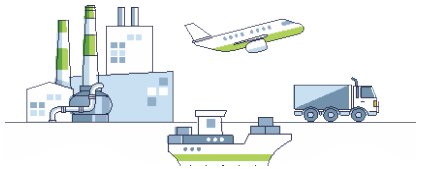
Production



Distribution



Storage



Usage

Energy & Fluid mechanics

Electrocatalytic production of liquid organic hydrogen carriers (LOHC) and chemicals from lignin

Power grid connections

Hydrogen from biomass

1 MW electrolyser (H2LABS)

Formic acid as hydrogen carrier

Pipeline flows x2

Methanol as a storage

Oxygen in iron oxide process

Carbon capture, storage and use

Green Fuels

Material & Safety

Condition monitoring - pipelines

Polymer for H2 tanks

Lined rock caverns

Ammonia – storage materials

Laser welding for stationary storage

Safety, permits & acceptance (H2SIPP)

Industrial symbiosis, energy & storage in rock caverns (H2AMN)

Bearing performance

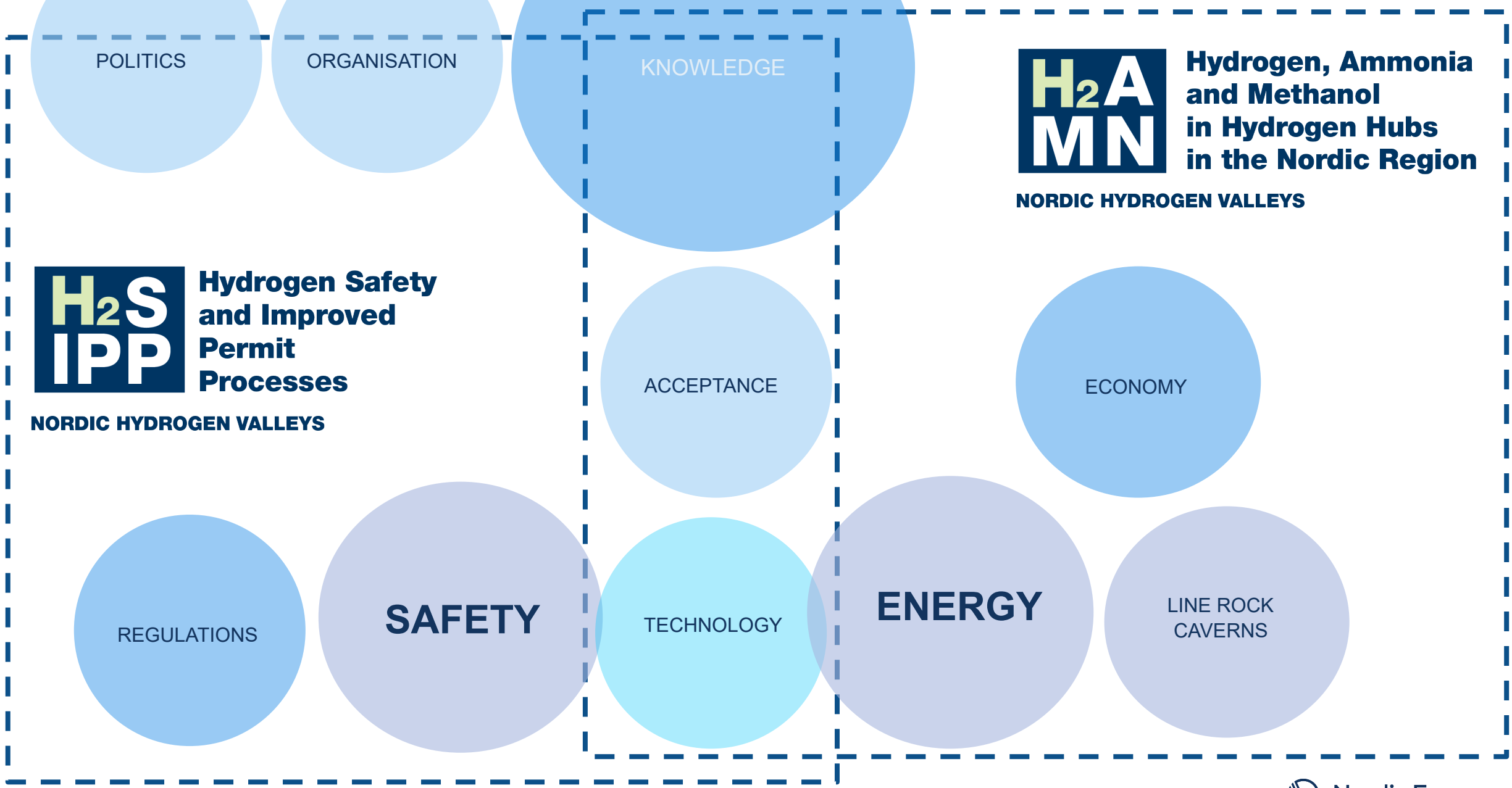
Fossil-free steel (FINAST)

Law & Economics

Heavy duty vehicles

Socio-technical challenges, stakeholders

*CH2ESS seed project color

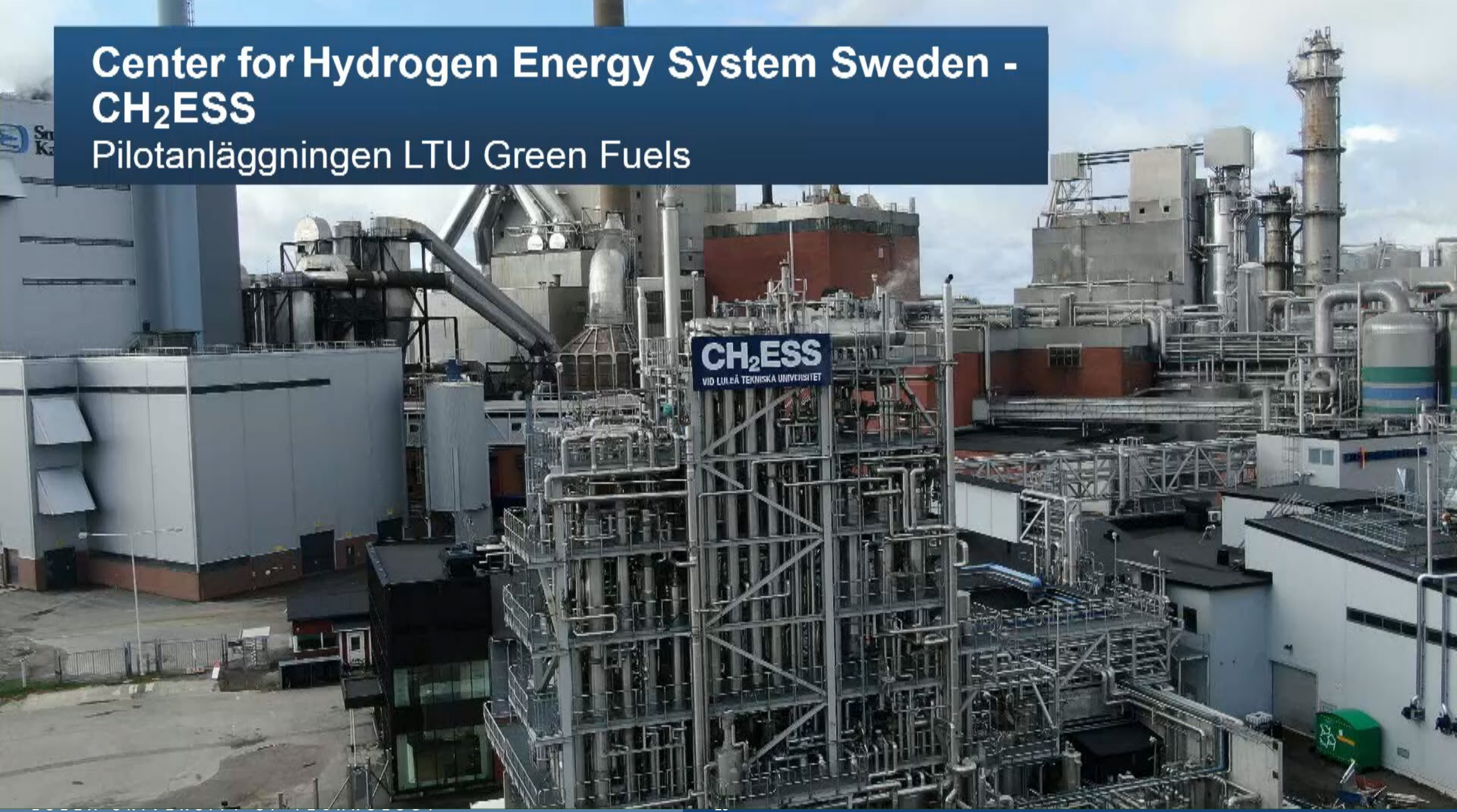


Addressing major barriers

Nordic Energy Research

Center for Hydrogen Energy System Sweden - CH_2ESS

Pilotanläggningen LTU Green Fuels



Hydrogen academy – Aimed at the public, professionals, and undergraduate/graduate students

1. Hydrogen for sustainable solutions – Introduction to the hydrogen value chain
Massive Online Open Course MOOC (Swedish and English), 12 hours, 14 lectures > 500 deltagare

2. Courses in undergraduate programs and for graduate students

- Master thesis
- Project courses
- Separate lessions and tasks

3. Education on demand, for companies and stakeholders

Vätgassäkerhet!

LTU.se/centres/CH2ESS/Utbildning

Sustainable hydrogen value chains, PhD course, 5-9 May 2025
7.5 ECTS

LTU CH2ESS Research Day 27-28/8

Presentationer
Poster session

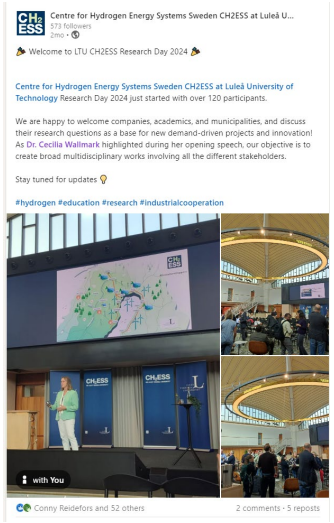
Ta med er forskningsfråga!

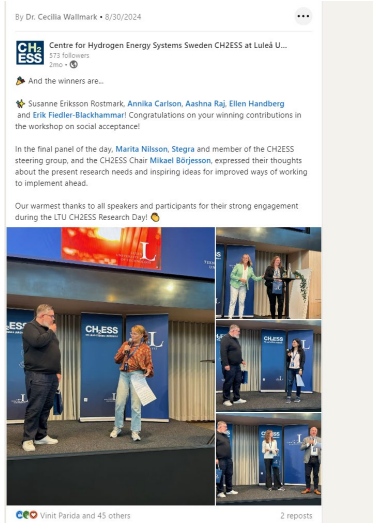
Frågor?

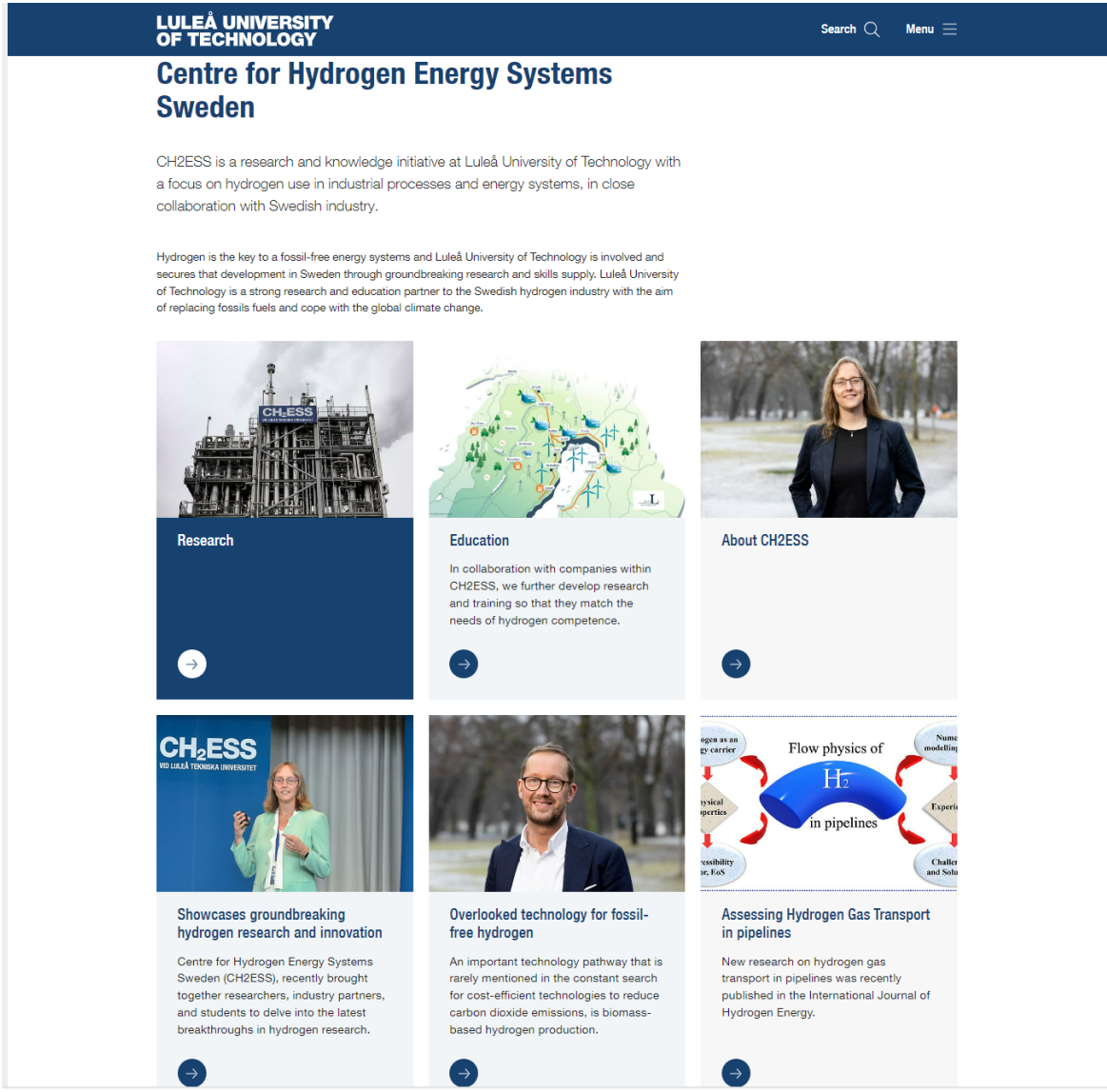
cecilia.wallmark@ltu.se
070-549 20 76

Kommunikation, web 2024

- [Centre for Hydrogen Energy Systems Sweden | Luleå tekniska universitet (ltu.se)]
- [Activities | Luleå tekniska universitet (ltu.se)]
- [Research projects on Centre for Hydrogen Energy Systems Sweden | Luleå tekniska universitet (ltu.se)]
- [Education on Centre for Hydrogen Energy Systems Sweden | Luleå tekniska universitet (ltu.se)]
- [CH2ESS on LinkedIN]







CH_2ESS Styrgrupp, aug 2024

VATTENFALL

Skellefteå Kraft

Stegra

Luleå Energi

REGION NORRBOTTEN

region västerbotten

BODENS KOMMUN

Skellefteå kommun

TITAN KONSTRUKTION

Piteå kommun

GÄLLIVARE NÄRINGSLIV

LULEÅ KOMMUN

LULEÅ TEKNISKA UNIVERSITET

Centre for Hydrogen Energy Systems Sweden

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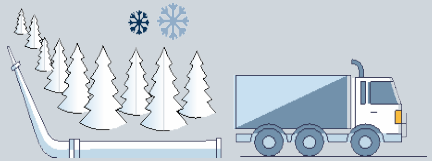
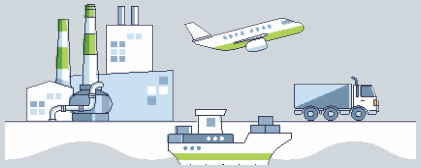
Production



Distribution

Storage



Usage

Energy & Fluid mechanics

Material & Safety

Law & Economics

Policy

Environment, Health & Society

IT & Digitalization

Forskning, utveckling och utbildning inom vätgas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