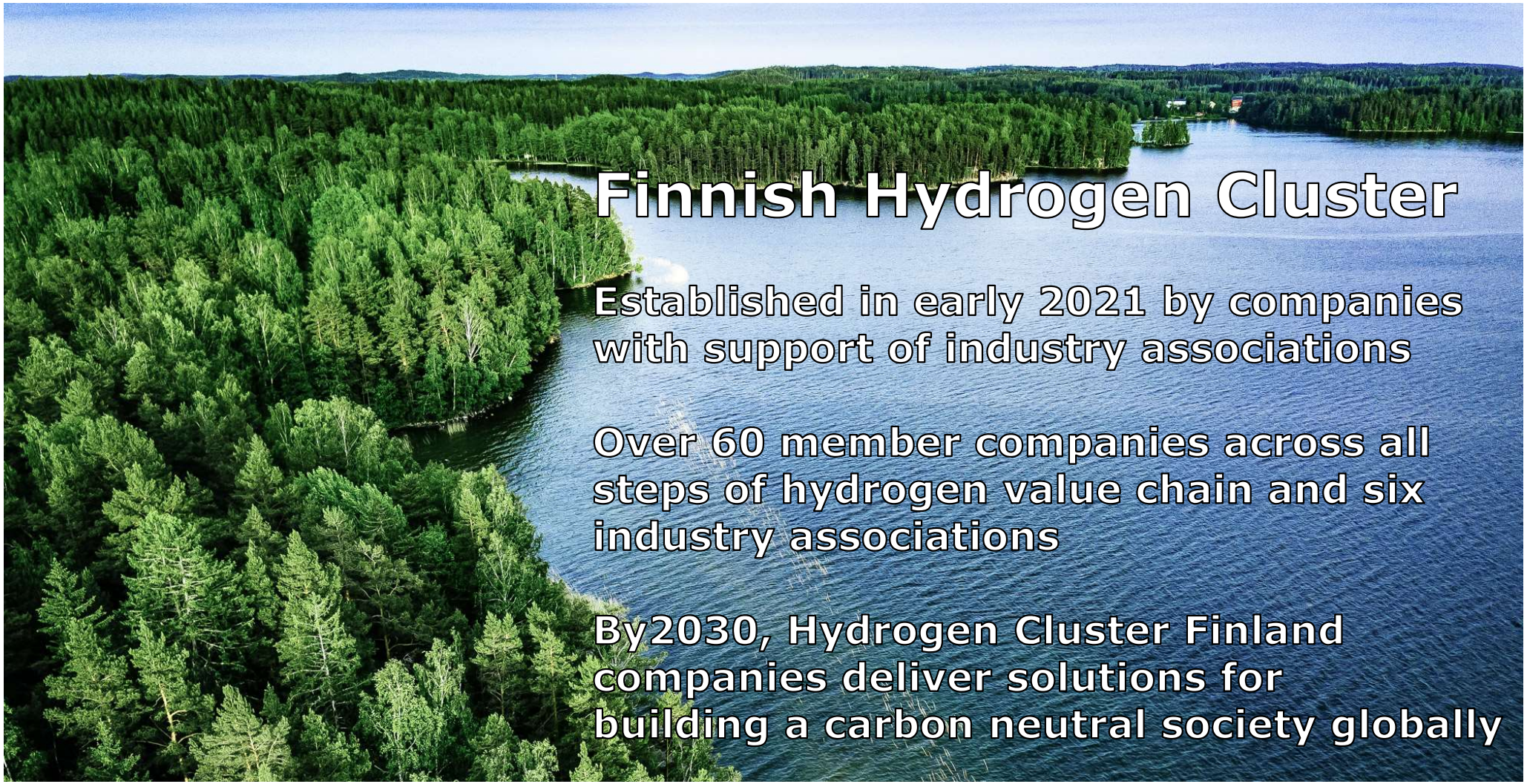
Hydrogen Cluster Finland (HCF)
The Finnish Hydrogen Value Network

New technology, business potential and climate impact in every segment



H2 cluster FINLAND

www.h2cluster.fi

Meet our 60+ active members throughout the value-chain

www.h2cluster.fi

Operating Model and Working Groups 2022

Steering Group– Chair Outi Ervasti, Neste

Cluster meetings –Over 60 companies and 6 industry associations

Common interests, focus areas, working groups, financials
Stakeholder group – and collaboration meetings

WG1: Comphetitive Hydrogen Economy - How will Finland differentiate	WG2: Education, Knowledge and RDI	WG3: International collaboration and Networking	WG4: Operating environment and regulation	WG5: Safety and Security	WG6:Hydrogen Projects and Hubs
Chair Simo Säynevirta, ABB	Chair Mikael Wideskog, Wärtsilä	Chair Matti Malkamäki, Aurelia Turbines	Chair Marko Janhunen, UPM	Chair Mikko Muoniovaara, Fortum	Chair Heidi Bergman, Neste
• System level energy efficiency optimisation • Competitive solutions and capabilities • Value networks, collaborations, IPCEI • White Paper	• Promote Hydrogen related education in Finland • Identify companies' RDI needs • Promote that the number of piloting and demonstration cases increase • Identify funding possibilities - Recovery Package	• Clean Hydrogen Alliance Roundtables • Hydrogen IPCEI preparations at EU-level • BothH_2nia - project • EU-affairs and information sharing, organise international events	• Combined view from the cluster company • Evaluation on impacts of the coming regulation and taxation • Cluster statements • Position Paper	• Safety issues in every value chain sector • Collaboration with Tukes, National Emergency Supply Agency and Rescue Department • Cyber Security	• Collect all the Hydrogen projects in Finland in a map • Follow the progression of the projects • Hydrogen Valleys

Coordination

Finnish Strengths in Hydrogen economy

A robust and clean electricity system as a basis for clean hydrogen expansion

- Massive growth potential for cost competitive land based wind power expansion
  - Shallow off-shore waters extend opportunity further
  - Strong, intelligent and digitalized electricity transmission and distribution networks enable rapid scaling
- Pragmatic energy policy offers additional flexibility for generation of clean electricity (e.g. use of nuclear in the mix)

High-tech, stable society with unique competencies basis for ecosystems

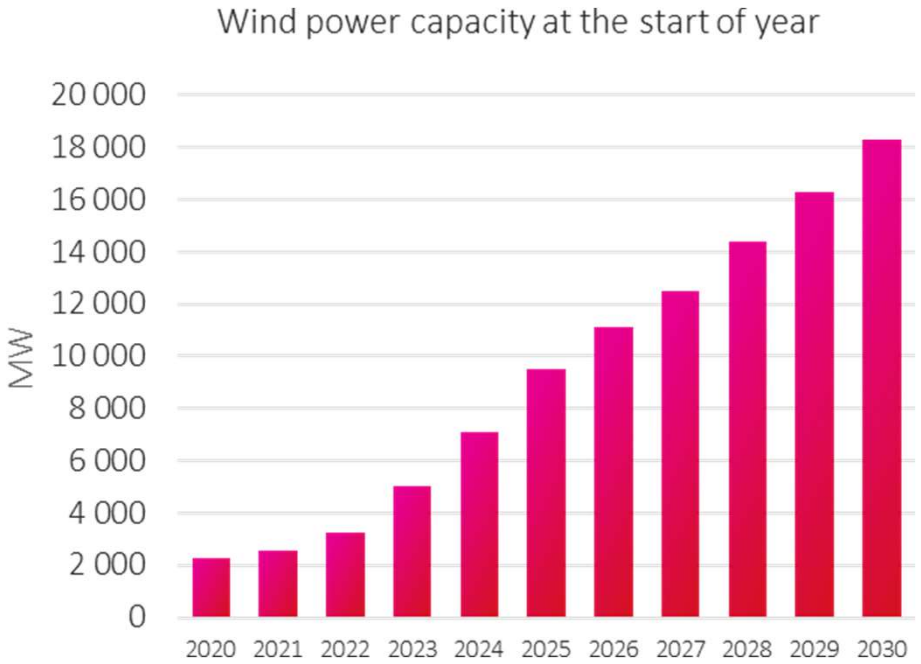
- Electrical engineering, process systems, ICT, cyber security…
- Effective public-private collaboration
- Low risk investment environment

Extensive sector coupling opportunities to integrate hydrogen across industries and energy sectors from maximum value add

- District heating networks, CHP, energy intensive process industries, (bio) CO2 sources, clean water, marine cluster…

The production potential of clean hydrogen in Finland is significant – and competitive

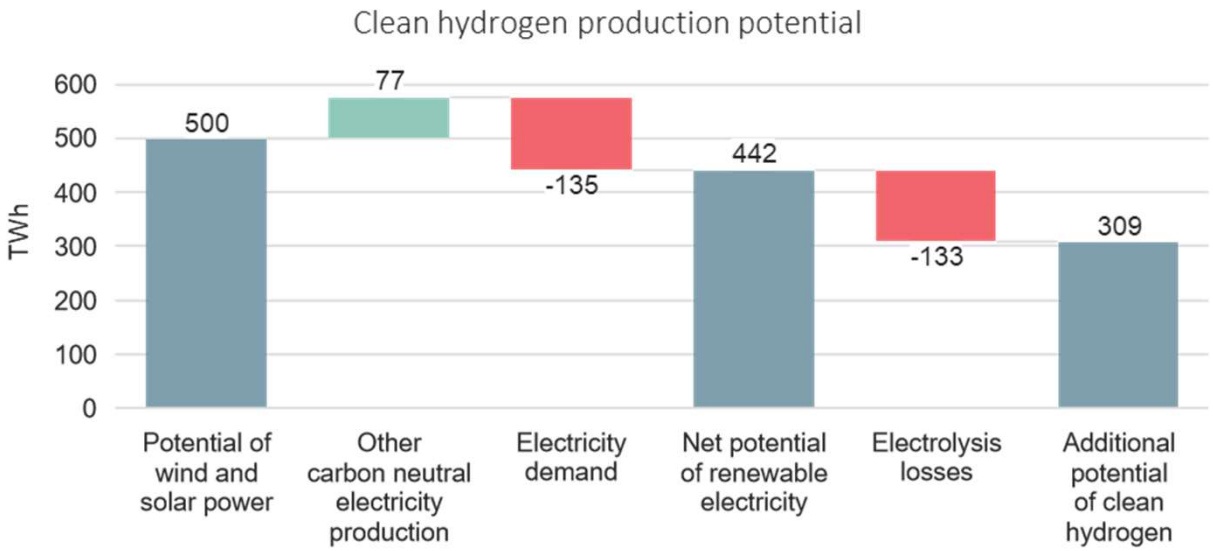
- In 2021, 87% of electricity produced in Finland was produced carbon-dioxide neutrally and 54% with renewable energy sources
- Wind power boom: It is estimated that the total wind power capacity will reach approximately 18,000 MW by the end of the decade
  - Finland combines factors such as good wind conditions with the possibility of constructing cost-effective onshore wind power based on tall hub height
  - The cost level of Finnish onshore wind power is significantly lower than that of European offshore wind power



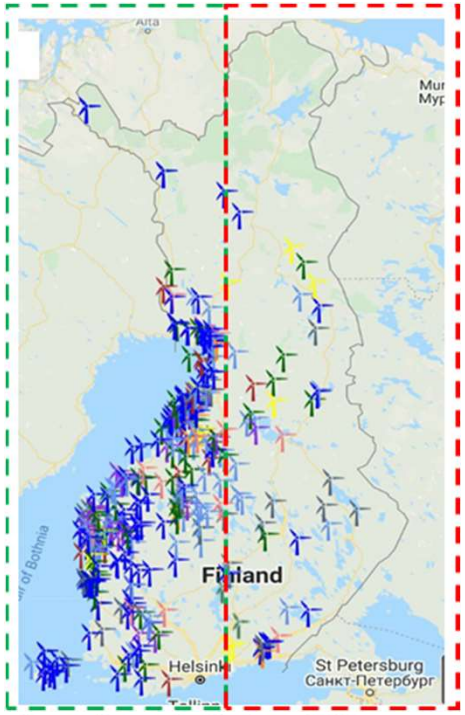
Projected development of wind power capacity in the 2020s. Source: Fingrid Oyj

Finland has significant potential relative to Europe's estimated demand for hydrogen

- Fingrid has received close to 150,000 MW of enquiries for connecting to the main grid, most of which concern onshore wind power
- If all projects were commissioned, they would generate about 500 TWh of electricity per year.
- Of this, almost 450 TWh would be available for new industries, equivalent to more than 300 TWh of clean hydrogen production

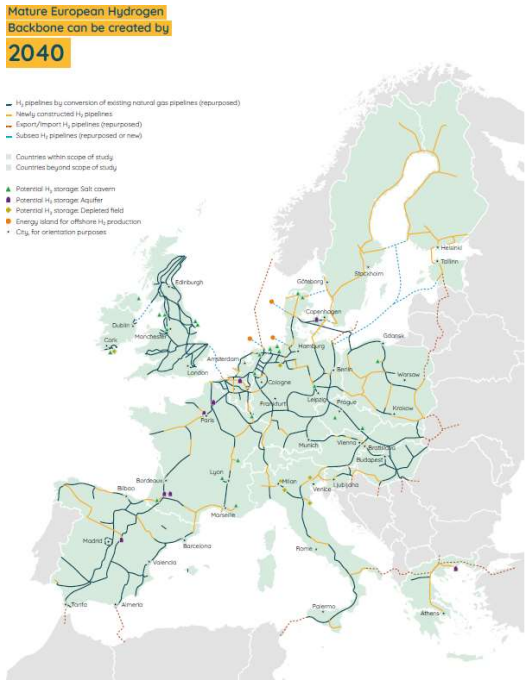


Wind power and hydrogen as a basis for a major new export industry for Nordics



Source: Suomen tuulivoimaprojektit, Ethawind.com

- Excess clean power, mostly onshore wind
  - Case Finland: > 500 TWh
- Compatible industries for e.g. H_2 derivates
- Land area, water, heat demand…
- Relatively close to future demand centers in Europe
- Advanced energy markets
- High personal, governmental and company ambitions to tackle climate change
- Good investment environment for capex intensive industries



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Target state for Finnish Hydrogen Economy in 2030:

Finnish hydrogen industry building carbon neutral society globally

- **Clean electricity** is abundantly available, with the most competitive price in Europe
- **Systemic value add maximized** through extensive sector integration
- **Finland leader in creating and applying flexible, enabling EU-regulation**
- **Finnish hydrogen know-how and solutions on the world leading level**
- **Finland attracting most investments** (per GDP) in hydrogen economy in Europe
- **Carbon handprint** of Finnish Hydrogen cluster exceeding many times the Finnish net emissions (baseline 2018 level)

HCF priorities in 2022

- Contribution to Finland's Climate and Energy Strategy which will include also a H2 strategy. Based on White Paper.
- Strong company driven Hydrogen Strategy to Finland under discussion
- Contribution to the finalization of the Fit for 55 –package. Position paper. done and sent
- Updating the information of the industrial hydrogen projects in Finland. 18 Finnish projects on Hydrogen Cluster's web page www.h2cluster.fi
- A survey of the skills and R&I needs in the member companies and another one the education and training provision and R&I priorities relevant for H2 economy by universities and research institutions (RI) in Finland underway.
- HCF member companies developing joint national, cross-border and European initiatives for R&I and participating in preparation of Hydrogen IPCEI projects as well as Hydrogen Valley consortiums.

Vetystrategia ja sen tavoitteet

Viimeisimmät ajankohtaiset klusterista

- Suomessa on selvä tarve vetytalousstrategialle. Tavoite on luoda kunnianhimoinen teollisuuspoliittinen ohjelma. Uusiutuvan sähkön potentiaali tulee edelleen liian vähän esille, ilmasto- ja energiastrategiassa arviot olivat liian matalat, eikä mahdollisuuksiin juuri menty.
- Vetytalousstrategia kattaa uusiutuvan riittävän saannin kilpailukykyiseen hintaan ja vision vedyn käytöstä Suomessa (teolliset investoinnit, huoltovarmuus, teollisuuden prosessit, liikenne), Suomen vientipotentiaalin, kohdemarkkinat viennille, vetylogistiikkainfrastruktuurin kehittämisen ja investoinnit Suomeen.

Vetystrategia ja sen tavoitteet

..jatkuu

- Seuraavaksi valmistellaan tarjouspyyntö. Valitun firman kanssa tullaan järjestämään työpajoja. Kohde on seuraava hallitus ja muut olennaiset sidosryhmät (esim. ulkomaiset sijoittajat).
- Koulutus: JOTPA:n rahoitus 3,5 M€ saatu FITECHille. Johdatus vetytalouteen käynnistyy jo tämän vuoden aikana.
- Työryhmä 4 perustaa CCfD-pienryhmän (Carbon Contracts for Difference)
- Projektit on saatu kartalle ja lisää projekteja jo tulossa
- Riskiskenariotyöpaja pidetty ja työ jatkuu

Finnish Hydrogen projects

1. Hycamite TCD Technologies - Production of hydrogen and high-quality solid, sustainable carbon without CO2 emissions, Kokkola

2. Aurelia Turbines, CHP generation with small gas turbines, Kokkola

3. EPV Energia, H-FLEX-E Hydrogen production, storage and utilisation, Vaasa

4. Flexens, Hydre, Åland Islands

5. Green NorH2 Energy, Green Hydrogen production and P2X, Naantali

6. P2X Solutions, green hydrogen production, Harjavalta

7. Nordic Ren-Gas, Green Hydrogen production and Power to Gas, Tampere

8. Nordic Ren-Gas, Power- to-Gas facility producing renewable methane and green hydrogen, Mikkeli

9. Nordic Ren-Gas, P2G-production, Lahti

10. UPM-Kymmene, Kaukas Biorefinery Green Hydrogen production, Lappeenranta

11. STR Tecoil, Hydrogen plant producing hydrogen for used lube oil regeneration process, Hamina

12. STR Tecoil, Enlargement and upgrade of the current plant, Hamina

13. Nordic Ren-Gas, Green hydrogen production, Kotka

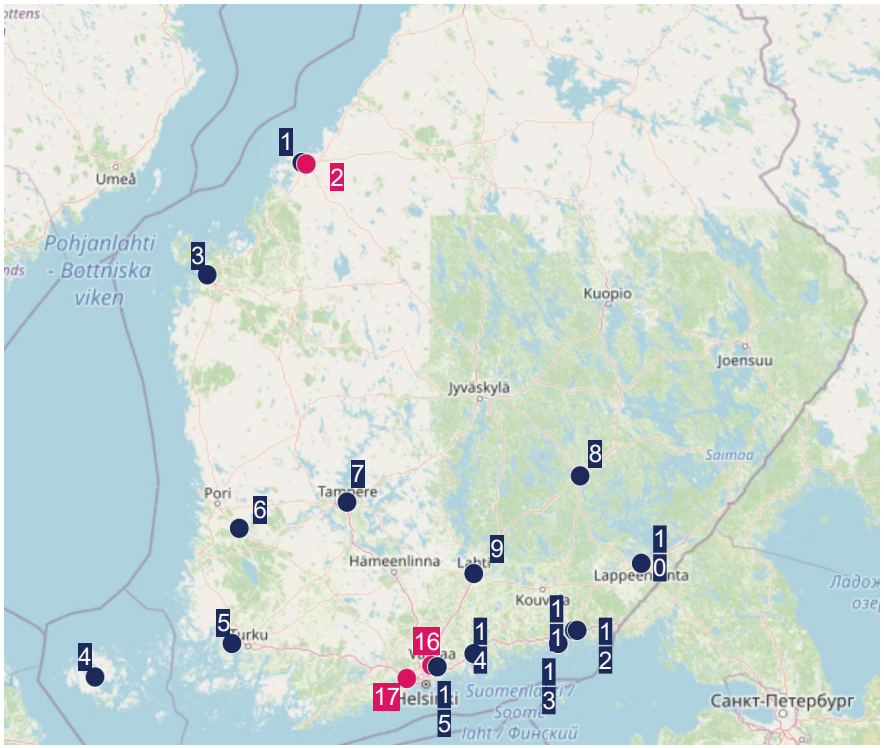
14. Neste, SHARC (green hydrogen production and CCUS), Porvoo

15. Vantaa Energy, power to materials/chemicals, Vantaa

16. Vantaa Energy, Power-to-Gas plant, Vantaa

17. Convion, ConvionSOE electrolyzer in hydrogen production for e-fuel production

18. Neste, MultiPHLY green hydrogen production, Rotterdam



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All members and more information
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Hycamite, Developing Technology to Produce Emission-Free Hydrogen Via a Thermo-catalytic Process, Secured €3M from Investors from Finland, Japan, and Hong Kong

The Finnish Climate Fund invests in hydrogen turbine manufacturer Aurelia Turbines

EPV Energia plus venture partners in Vaasa to cooperate in wind power-to-hydrogen-to-electricity project

FLEXENS AND KIP INFRA TO BUILD 300MW HYDROGEN PLANT IN FINLAND

Neste proceeds into execution phase with partners in the MultiPLHY project, aiming to demonstrate production of green hydrogen at its Rotterdam refinery

Finland's largest Power-to-Gas plant – Wärtsilä and Vantaa Energy to continue planning

Neste contributes to the EU green hydrogen value chain – European Commission grants IPCEI status for Porvoo refinery

P2X Solutions' Hydrogen Project Receives European Comm

We are already making this happen

St1 is planning a synthetic methanol pilot plant in Lappeenranta, Finland

CPC Finland and Prime Green Energy Infrastructure Fund to form joint venture for constructing up to 200 MW green hydrogen/e-methane facility in Kristinestad, Finland.

Flexens and HydRe collaborate to launch hydrogen transport in Finland

Green NortH2 Energy, Meriaura and Wärtsilä cooperate in building a cargo vessel that runs on green ammonia

P2X SOLUTIONS AGREES TO €20M EQUITY INVESTMENT

UPM joins clean hydrogen coalitions in the EU and Finland to promote the emerging hydrogen economy

FINLAND'S LARGEST HYDROGEN ECONOMY HUB PLANNED IN LAHTI

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National Hydrogen Cluster – WG5 - Safety and security

- WG5 Working Group was formed in the beginning of year 2022 in need to look into safety and security issues in hydrogen ecosystem.
- Since FHC is formed by a large group of companies of varying level of knowhow and awareness in hydrogen and it’s safety, it was decided jointly to collaborate and gather information into a common store (Cluster Teams).

Active subjects

- The effects of large production of hydrogen including storage and transportation to safety
- Benchmarking with different countries
- Relevant accident scenarios

National Hydrogen Cluster – WG5 - Safety and security

- Public opinion on hydrogen safety
- Permitting and safety
- Cyber security and safety

Affiliate groups

- Kaasuyhdistys ry
- TUKES
- KEMESTA
- PELA
- ELY
- National Emergency Supply Agency (NESA)

National Hydrogen Cluster – WG5 - Safety and security

Working group internal minigroups

- ISO-group – list of requlations and standards can be found in Cluster WG5 Teams
- Risk Scenario-group – workshop facilitated by AFRY in November, 2022
- TUKES ’Hydrogen Guide’ vs. ’Safety Cookbook’ – cooperation primed between TUKES and WG 5.

Starting 2023

Next:

- Technology reviews
- ELY brief update
- National Emergency Supply Agency (NESA)
- Risk scenario workshops storaging and distribution

THANK YOU!