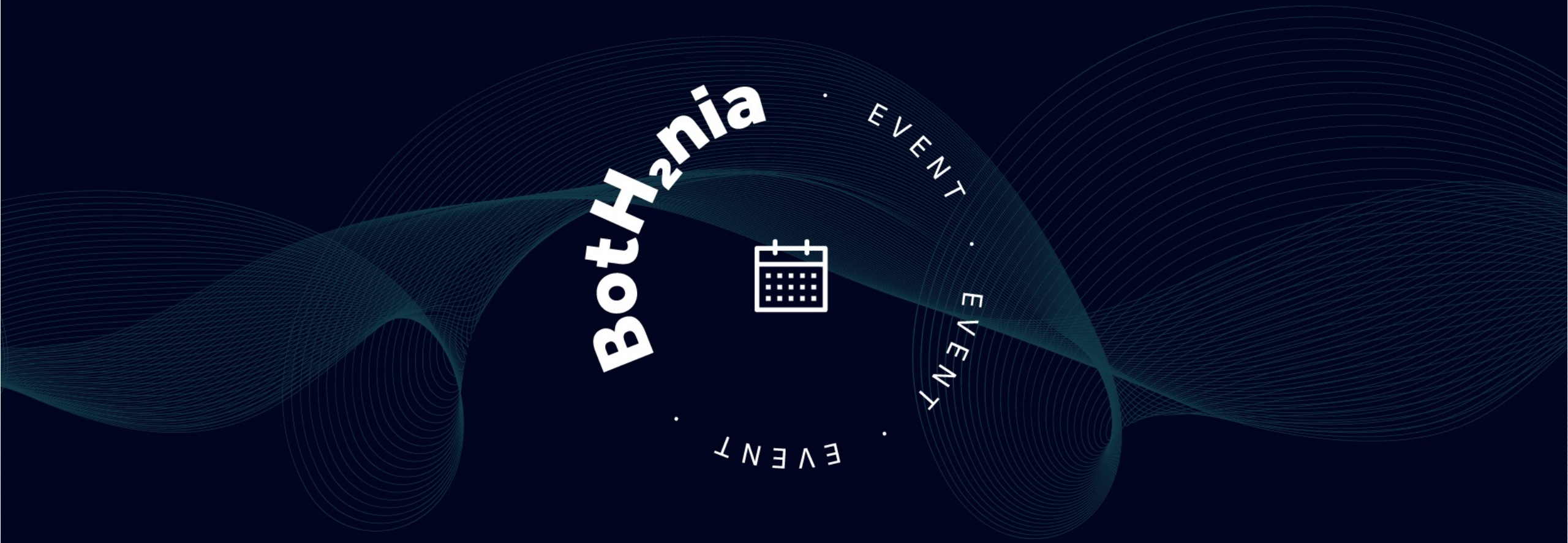
POHJOIS-POHJANMAA
COUNCIL OF OULU REGION



BotH$_2$nia goes Kokkola 16.3.2022

This is a presentation given at the event BothH_2nia goes Kokkola on 16.3.2022.

BothH_2nia is a network of operators interested in hydrogen. The objective of the network is to create a Nordic hydrogen cluster around the Baltic Sea, beginning with the Bothnian Bay. BothH_2nia strengthens the position of the north in the European hydrogen industry!

BothH_2nia invites all businesses, research institutes, investors, municipalities and cities to roll up their sleeves for a greener future.

Please notice that the presentation has been modified to comply with the Accessibility Directive. In case for need the original material, please contact Minna Näsman (minna.nasman@both2nia.com).

www.both2nia.com

FINGRID

GASGRID

Exploring potential of hydrogen networks in Finland and Baltic Sea region

Sara Kärki, Gasgrid Finland Oy & Mikko Heikkilä, Fingrid Oyj

Who we are…

- Gasgrid Finland Oy is a Finnish state-owned company and transmission system operator with system responsibility. We offer our customers safe, reliable and cost-efficient transmission of gases. We actively develop our transmission platform, services and the gas market in a customer-oriented manner to promote the carbon-neutral energy system of the future.
- Fingrid is Finland's electricity transmission system operator. We secure reliable electricity cost effectively for our customers and society and shape the clean, market-oriented power system of the future.
- The companies explore together the potential of hydrogen economy and networks

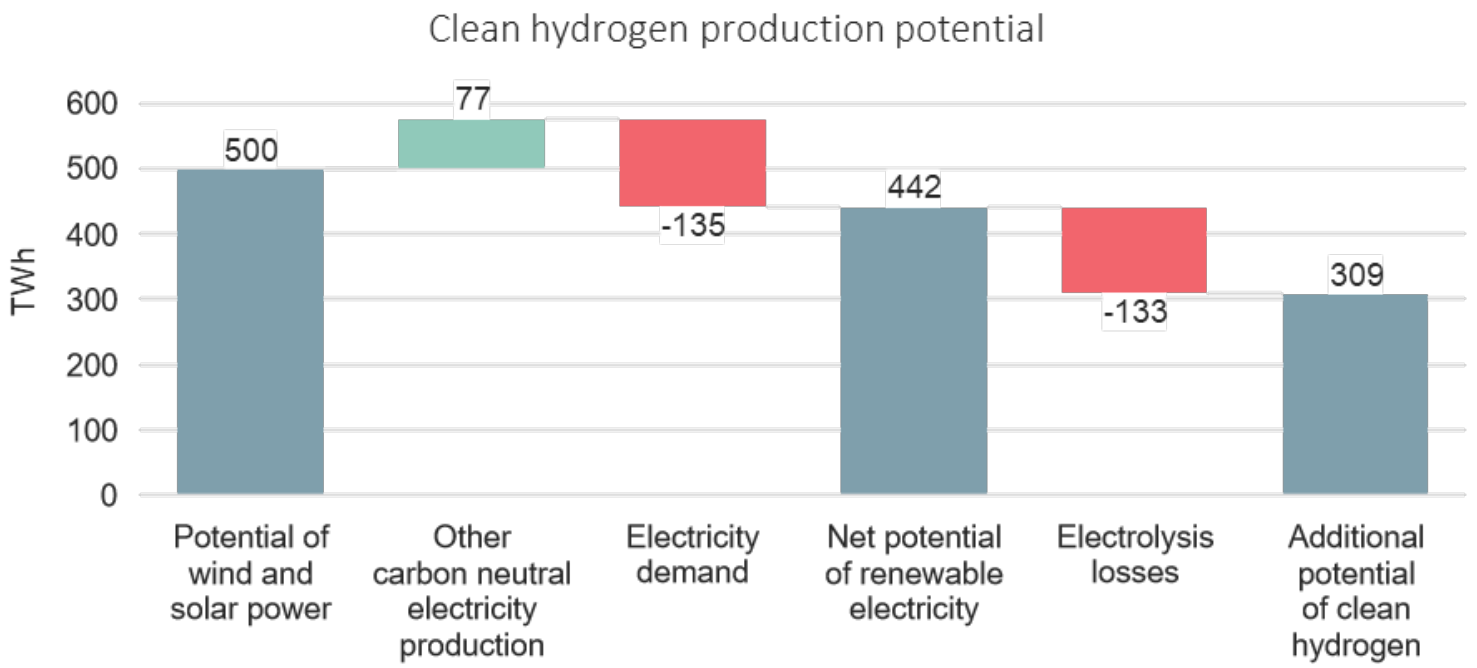
Hydrogen economy as a solution to achieve carbon neutrality and reduce dependency on energy imports

- Hydrogen produced from water and electricity is a scalable solution for reducing emissions, especially for processes that are difficult to electrify directly
- Hydrogen demand is estimated to grow to up to 1,500–2,300 TWh/a by 2050, considering all demand sectors.

Collected by Guidehouse (2021). The possibilities of Finnish hydrogen economy: https://gasgrid.fi/wp-content/uploads/Gasgrid_Selvitys-Suomen-vetytalouden-potentiaalista_FIN-FINAL.pdf

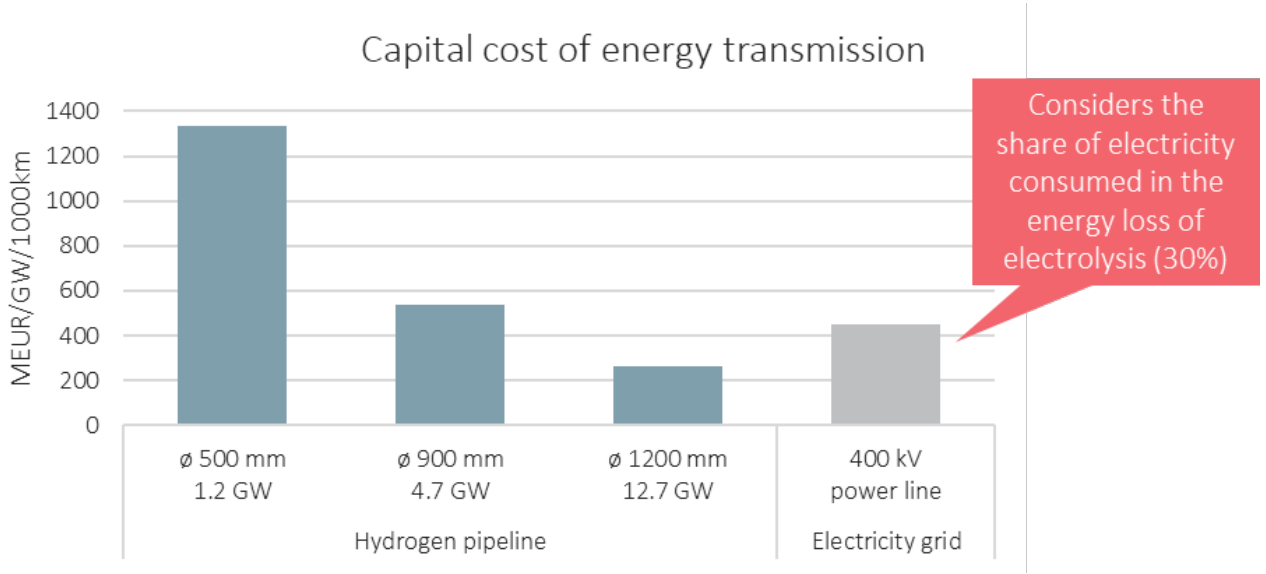
Finland has significant potential relative to Europe's estimated demand for hydrogen

- 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



Hydrogen transmission infrastructure can support both the utilisation of wind power and the entire energy system

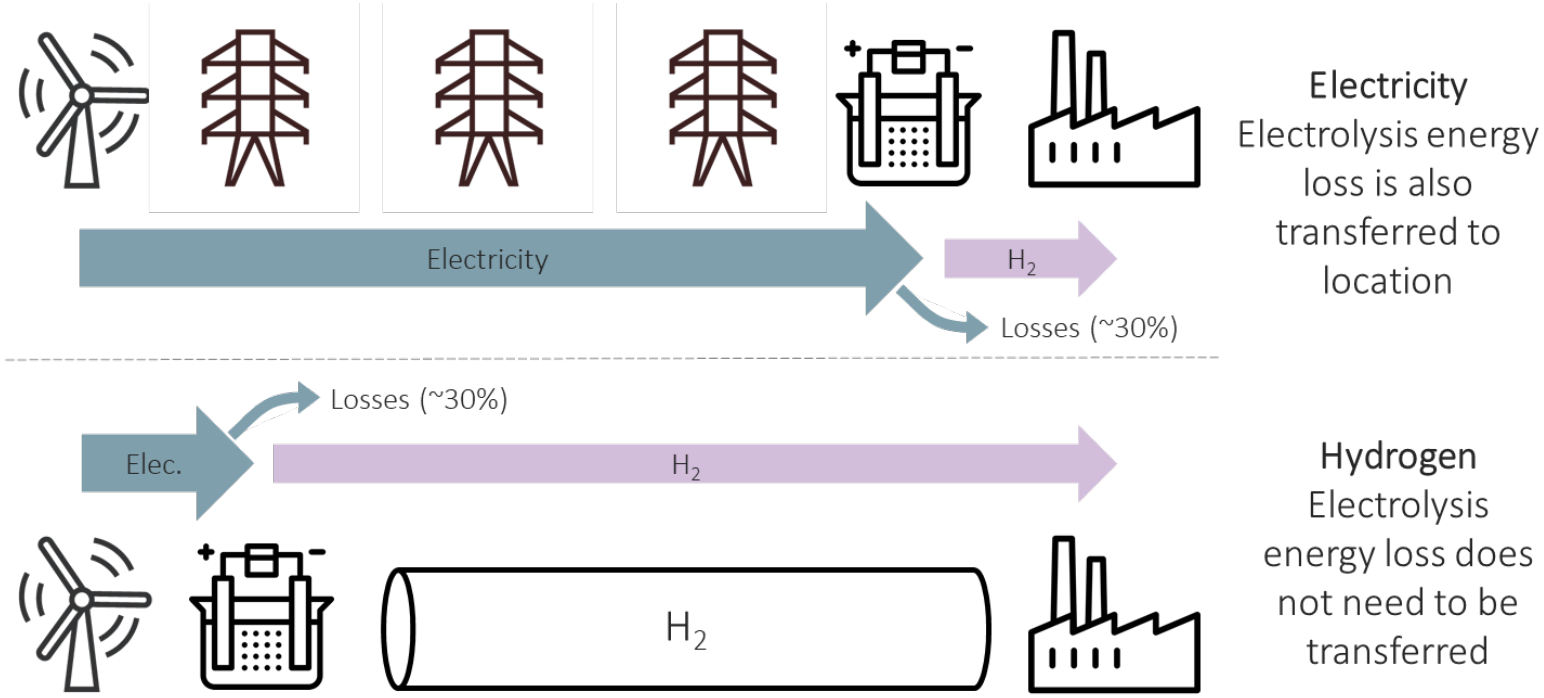
- When large quantities of energy are transmitted, hydrogen transmission is competitive compared to electricity transmission.
- Hydrogen transmission infrastructure would enable electrolysers to be located near electricity production sites, thus reducing the need for electricity transmission
  - In particular, north-south hydrogen transmission infrastructure can contribute to the full utilisation of Finland's wind power potential
  - This would enable hydrogen production in the north and consumption in the south



Capital cost of energy transmission with hydrogen pipeline and electricity grid

The capital cost and transmission capacity of hydrogen pipelines are based on the European Gas TSOs' estimates of the cost of a new hydrogen pipeline including compressors. Source European Hydrogen Backbone (2021): https://gasforclimate2050.eu/wp-content/uploads/2021/06/EHB_Analysing-the-future-demand-supply-and-transport-of-hydrogen_June-2021_v3.pdf
The capital cost of electricity grid is based on Fingrid's actual 400 kV AC overhead line network investment costs.

Producing hydrogen near the electricity production site reduces the need for energy transmission to deliver the same amount of hydrogen for the end-user

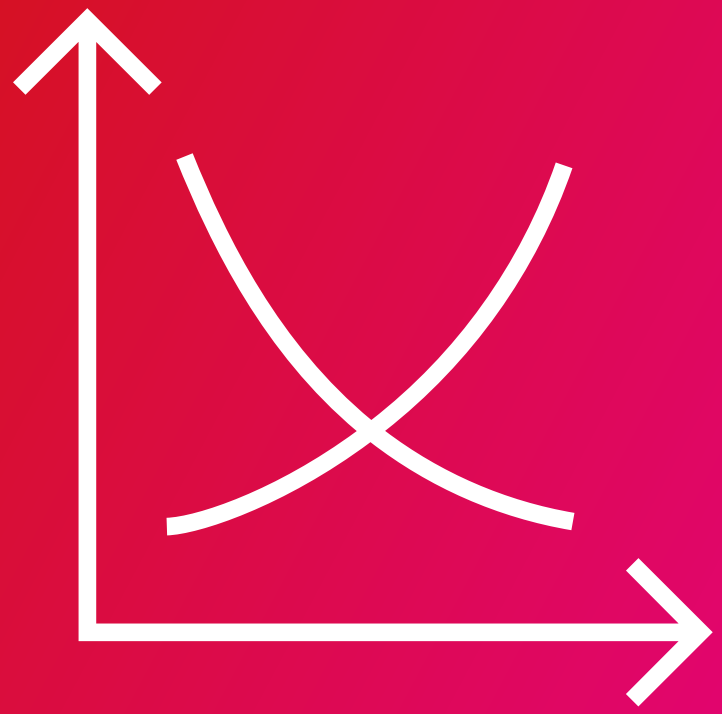


Electricity
Electrolysis energy loss is also transferred to location

Hydrogen
Electrolysis energy loss does not need to be transferred

Hydrogen transmission infrastructure enables an efficient hydrogen market

- The hydrogen network connects several different hydrogen producers and consumers and enables open trading within the network.
  - Competition would bring efficiency and risk management benefits compared to a situation where each hydrogen user produces and stores the hydrogen, they need locally at their consumption point.
- Within a large market, production and consumption can be flexible according to the market situation, and storage opportunities may also arise in the market.
  - This would make it possible to use hydrogen even if its production is not momentarily profitable for example due to a high price of electricity. For the electricity market, this would increase flexibility that balances electricity price peaks.



Stakeholder views on hydrogen and TSO cooperation

The interviewed companies hoped that Finland's electricity and hydrogen infrastructure would be developed together, with the aim of an overall optimal solution.

Value chains and competitiveness arise from cooperation between companies – a company can't compete on the international markets alone.

Several companies have plans for the production and export of hydrogen products.

In many industrial processes, hydrogen use is continuous, and it must be deliverable in all situations. This is promoted, for example, by the integration of operators into the same network or by hydrogen storage.

The hydrogen economy is one way for companies to achieve carbon-neutrality targets profitably.

The electricity and hydrogen markets are seen as strongly interlinked, both in terms of price and production structure.

Gasgrid and Fingrid's hydrogen economy draft scenarios

Strong Regional Hydrogen Economy

- Hydrogen production in Finland grows strongly. Demand for hydrogen is boosted by Finland's development as a major exporter of P2X-products, such as electric fuels.
- Cross-border hydrogen transmission infrastructure will not be built except from Finland to Northern Sweden.
- The lack of cross-border transmission infrastructure reduces the flexibility of the hydrogen system compared to other scenarios and increases the need for domestic hydrogen storage.

European Hydrogen Market

- Hydrogen production in Finland grows strongly. Hydrogen is produced in Finland especially for export.
- Domestic use of hydrogen is limited to meeting the carbon neutrality targets of the existing industries.
- Pipeline transmission infrastructure will be built for large-scale hydrogen exports to both Northern Sweden and Central Europe.
- Hydrogen cross-border connections to the rest of Europe improve the flexibility of the system.

Leading Hydrogen Ecosystem

- Hydrogen production in Finland grows very strongly. Production is driven by both strong growth in domestic demand and hydrogen exports.
- The very high hydrogen production level maximizes the utilisation of renewable electricity resources.
- Pipeline transmission infrastructure will be built for hydrogen exports to both Northern Sweden and Central Europe.
- Hydrogen cross-border connections to the rest of Europe improve the flexibility of the system.

Gasgrid & Fingrid collaboration – sector integration in action

- Joint R&D project continues
  - with scenario development in spring 2022
    - Stakeholder consultation will take place during 2022
  - Value chains will be studied in more detail
  - Hydrogen network construction costs will be evaluated in detail in case studies
  - Final report & seminar in the end of 2022 or early 2023

- The project will support joint planning and development of Finnish energy infrastructure and cross border connections

- Proactive development and planning of energy infrastructure can enable investments throughout value chains enabling achievement of carbon neutrality and reduction of fossil energy usage

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