



# Final seminar of Gasgrid's and Fingrid's hydrogen economy project

Compiled presentation materials  
7 November 2023

# Final seminar of Gasgrid's and Fingrid's hydrogen economy project – contents of the presentation materials

## Contents of the presentation

- Transformation of the energy market and background of the joint project
- Energy infrastructure as an enabler of new hydrogen value chains
- Opportunities of the hydrogen economy for Finland
- Working together towards a cost-effective energy system
- Opportunities created by a large hydrogen market



# Transformation of the energy market and background of the joint project

Mikko Heikkilä, Fingrid & Sara Kärki, Gasgrid Finland

**The EU is aiming for a 20-million-tonne consumption of clean hydrogen by 2030...**

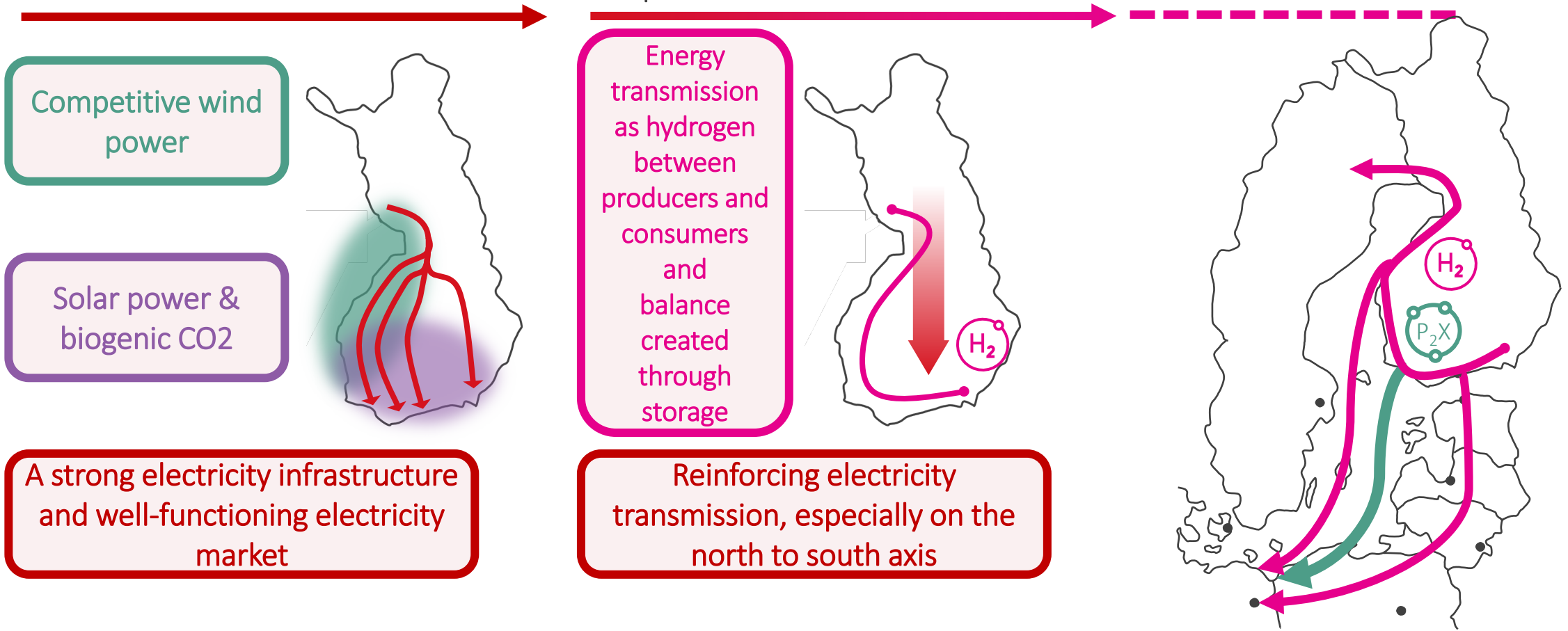
**... and Finland is aiming to be  
a leader of the European  
hydrogen economy**

# Finland has a historic opportunity to lead the way

Finland is particularly well positioned

A strong energy infrastructure lets us realise our potential

Enables the birth of a new export industry



Competitive wind power

Solar power & biogenic CO2

A strong electricity infrastructure and well-functioning electricity market

Energy transmission as hydrogen between producers and consumers and balance created through storage

Reinforcing electricity transmission, especially on the north to south axis

# The Finnish supply of clean, competitive electricity ranks among the best in Europe

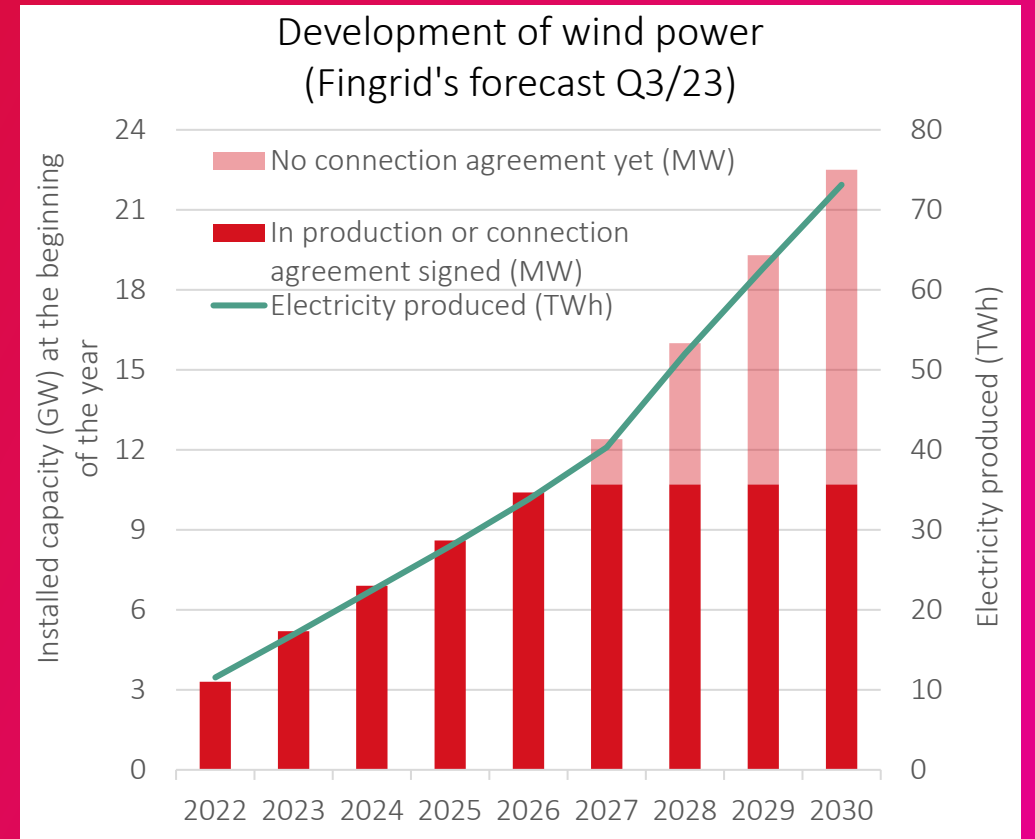
## Main grid connection enquiries

Electricity production:

**340 GW / ~1000 TWh**

Consumption:

**22 GW / ~150 TWh**





# Development of the hydrogen economy is a joint effort



# Preliminary "connection enquiries" to the hydrogen network

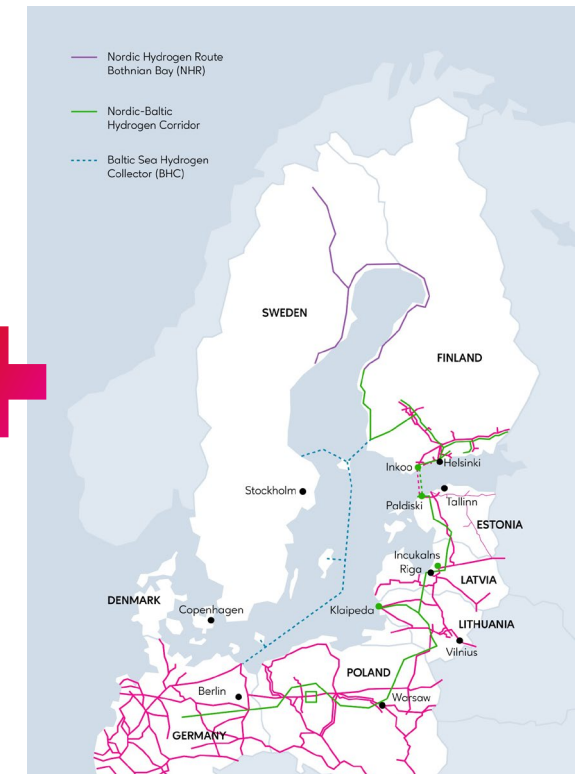
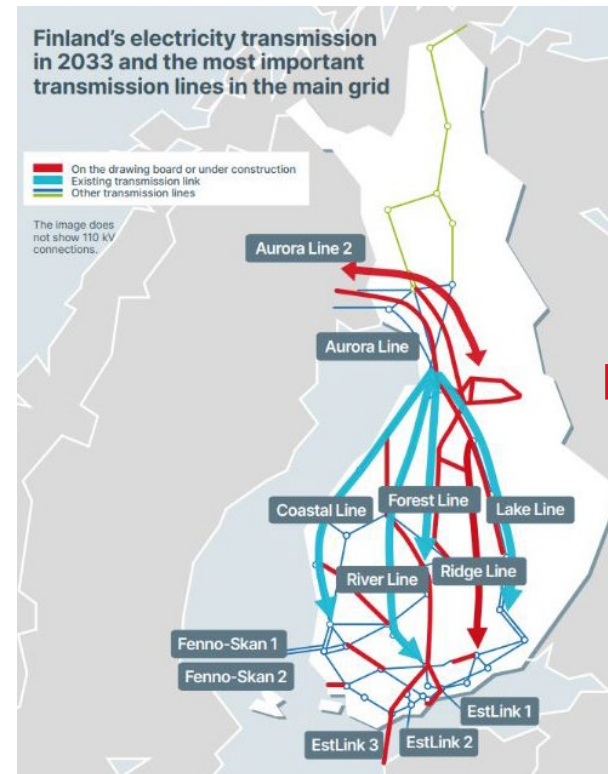
Hydrogen production:  
**>80 TWh/year**

Hydrogen consumption:  
**>20 TWh/year**

\*Industry actors' indications of future connections to the hydrogen network in Gasgrid's hydrogen market survey

# Energy transmission networks as enablers of the hydrogen economy and the clean energy system

- Main goals of the joint project
  - Establish the energy infrastructure requirements for the implementation of a clean and cost-effective system
  - Support the co-design and co-development of the energy infrastructure, enabling investments in clean energy
- Joint project launched in 2021
  - Interim report published in spring 2022
  - Scenario consultations summer–autumn 2022
  - Scenarios published in spring 2023
- The joint project is part of the wider HYGCEL project series
  - Business Finland has granted funding to both the joint project and the wider project series



# Stakeholders see cooperation between transmission network operators as vital for the emerging hydrogen market

The companies interviewed hoped that the Finnish **electricity and hydrogen infrastructure would be developed together**, with the aim of achieving an **optimal** solution.

Several industrial processes **continuously use hydrogen**, and the supply must not be interrupted. This would be furthered by measures such as **integrating operators into the same network or the storage of hydrogen**.

**Value chains and competitiveness** are born from cooperation between companies – you cannot make it alone in the international market.

The hydrogen economy is one way for companies to achieve **carbon neutrality goals profitably**.

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

A **strong link** is seen **between the electricity and hydrogen markets**, both in terms of prices and production structures.

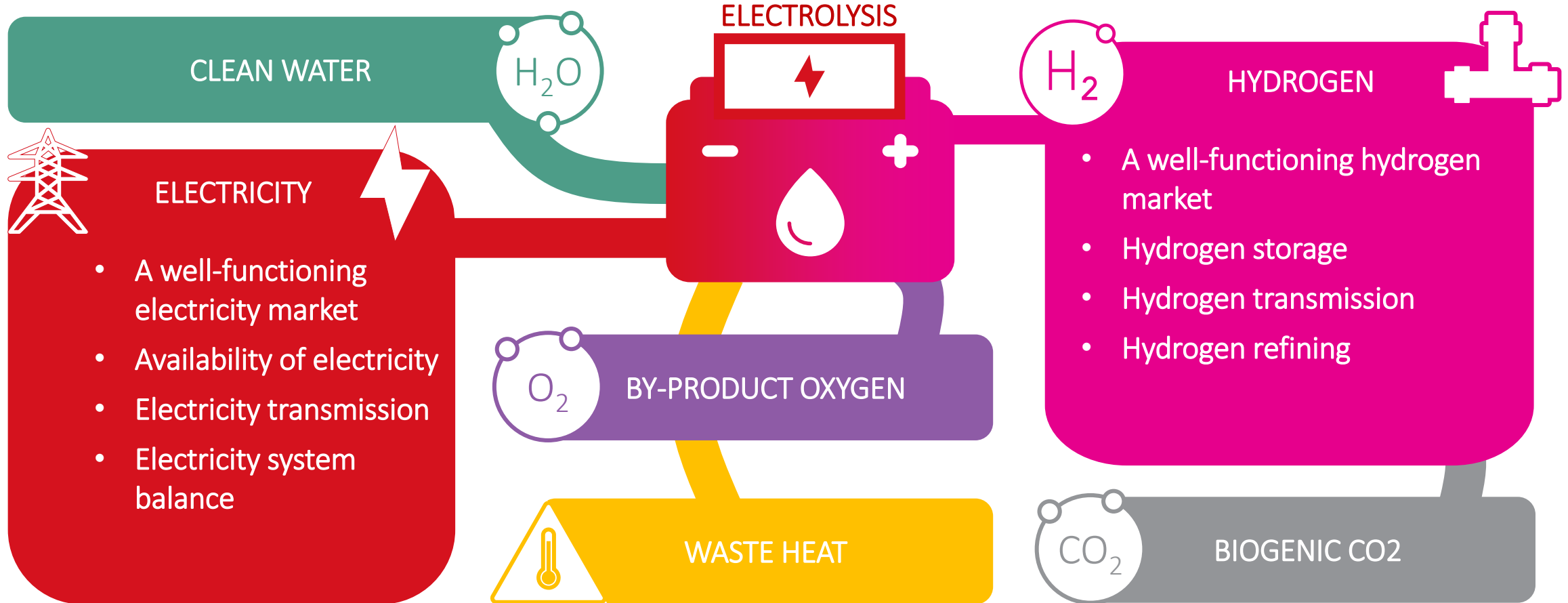


# Energy infrastructure as an enabler of new hydrogen value chains

Venla Saarela, Gasgrid & Jussi Närhi, Fingrid

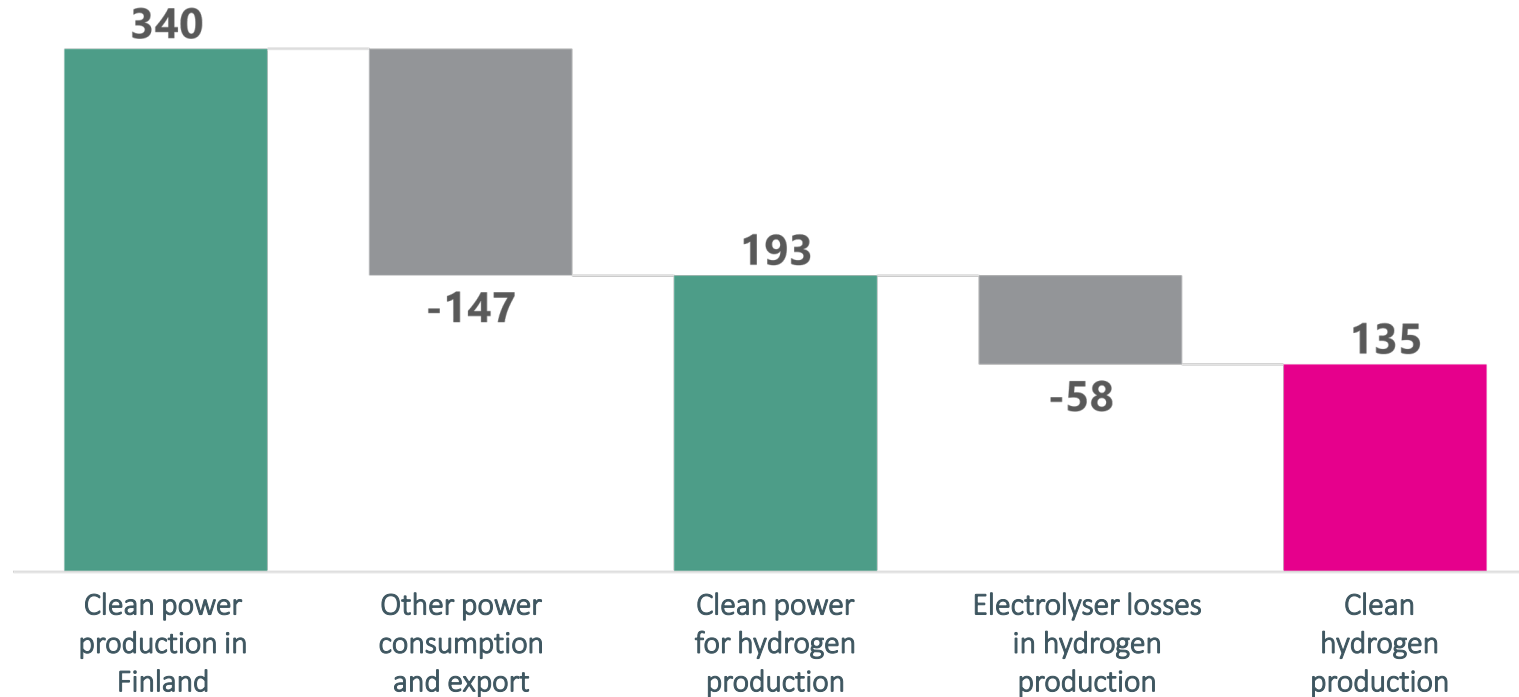


# Green Electricity + Water = Green Hydrogen



# Finland has enormous potential to produce renewable electricity and clean hydrogen

Highest growth scenario prospects for Finland in 2040  
(TWh electricity/hydrogen)



## Wind power

will be the most significant form of electricity production

## Hydrogen production

will be the largest application for electricity

## Hydrogen storages

will enable the maximal exploitation of affordable renewable electricity

**The competitive advantage of Finnish  
hydrogen production  
is based on affordable wind power**

# We have chosen ambitious growth assumptions for the hydrogen economy's development scenarios

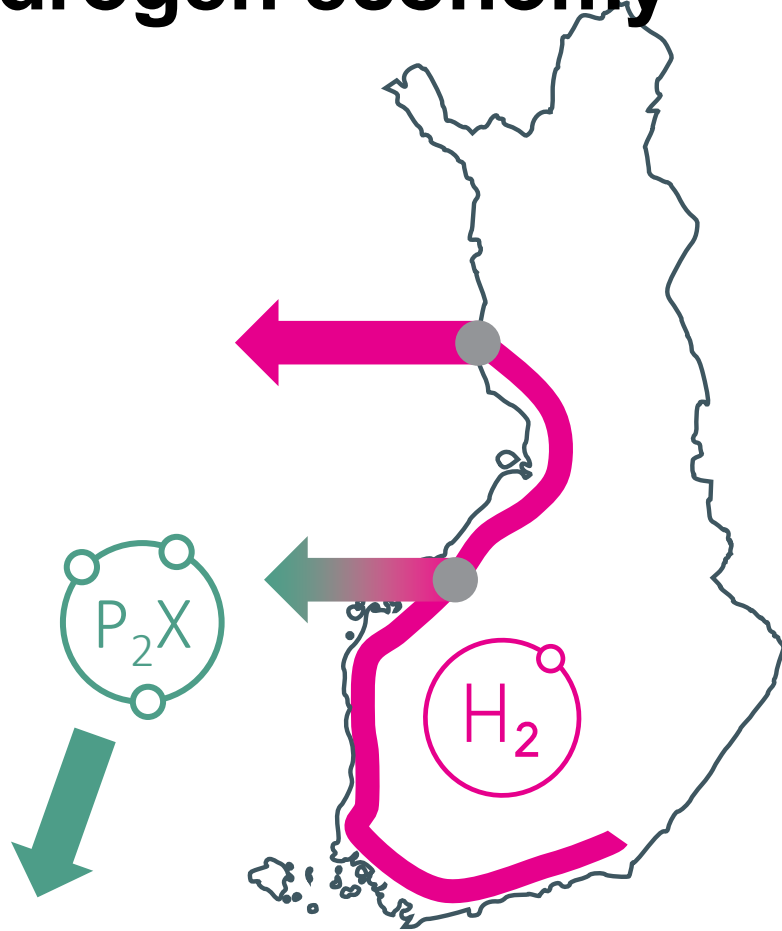
## Scenarios developed in the joint project

- In-depth exploration of energy system development
- Facilitate the identification of phenomena within and between the electricity and hydrogen systems
- Help ensure that transmission infrastructure development needs are assessed comprehensively and in good time

**Actual investments in the transmission infrastructure will be implemented according to identified needs and through concrete projects**

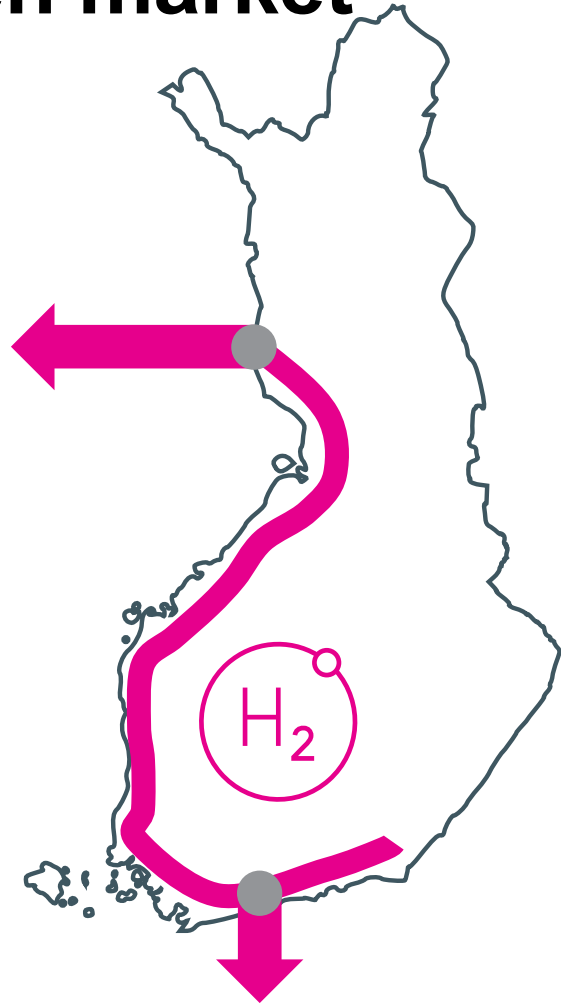


# “A strong regional hydrogen economy”



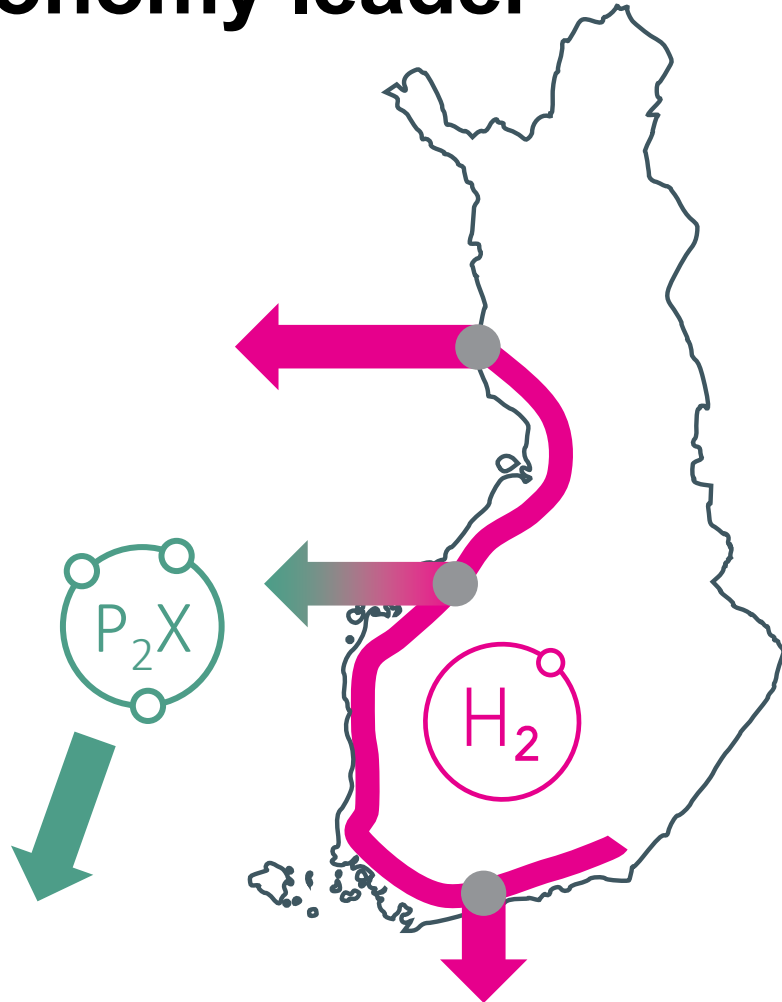
- The hydrogen transmission infrastructure inside Finland and between Finland and Northern Sweden is completed
- Finland develops into a major producer of downstream hydrogen products
- The hydrogen pipeline's storage capacity and domestic hydrogen storages add flexibility to the system

# “An efficient European hydrogen market”



- Domestic hydrogen transmission infrastructure and cross-border infrastructures between Finland and Northern Sweden and Central Europe
- Finland develops into a major producer of clean hydrogen gas
- In addition to domestic hydrogen stores, the storage capacity of large cross-border transmission pipes and the opportunity to use the large hydrogen storages in Central Europe create flexibility

# “Finland the hydrogen economy leader”



- Domestic hydrogen transmission infrastructure and cross-border infrastructures between Finland and Northern Sweden and Central Europe
- Finland develops into a major producer of clean hydrogen gas and hydrogen downstream products
- Large cross-border transmission pipes and storages in Central Europe provide additional flexibility

**In all scenarios, Finland produces  
over 10% of the EU's clean hydrogen**



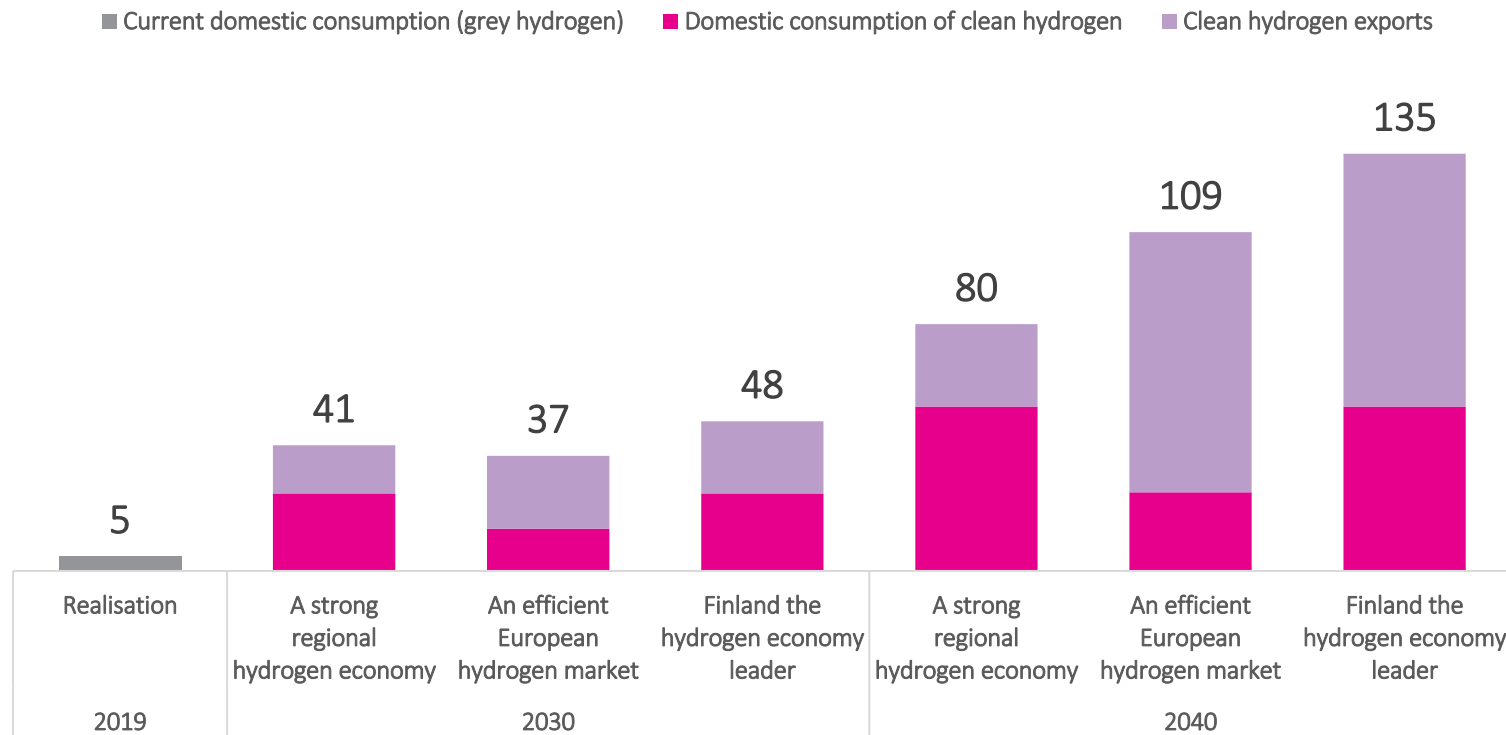


# Opportunities of the hydrogen economy for Finland

Jussi Närhi, Fingrid & Venla Saarela, Gasgrid

# Finland grows into a major producer of clean hydrogen gas and hydrogen downstream products

Finland produces clean hydrogen for domestic demand and export  
(TWh hydrogen)



- Replacing current domestic consumption
- New products based on clean hydrogen
- A response to the growing need for clean hydrogen on the European markets

# Wind power will be the most significant form of electricity production and a large share of electricity will be used for hydrogen production

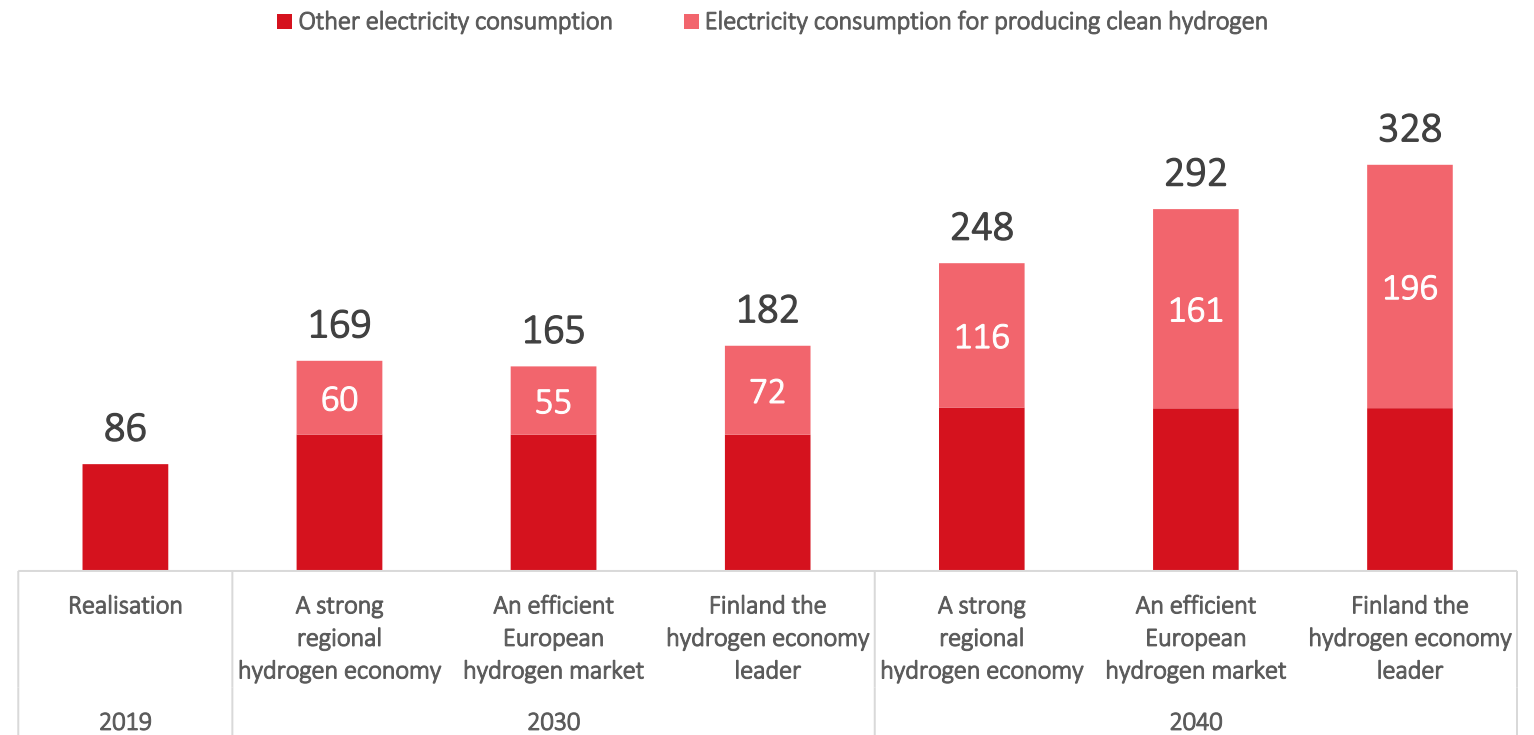
Share of Finland's electricity production used to produce clean hydrogen

- **2030: 30–40%**
- **2040: 45–60%**

New capacity required to produce clean hydrogen with renewable wind and solar power

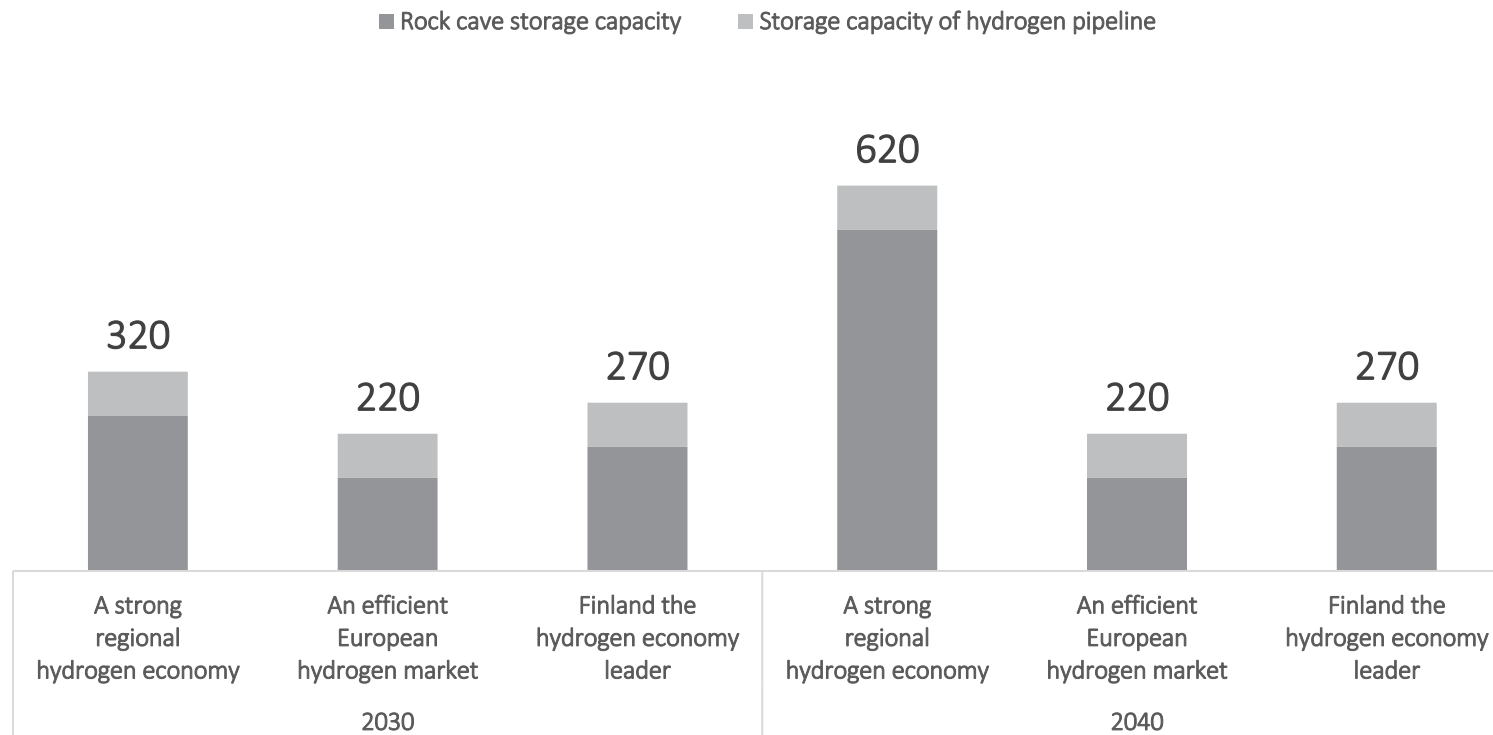
- **2030: 15–25 GW**
- **2040: 35–60 GW**

## Finnish electricity consumption grows due to hydrogen production (TWh electricity)



# Flexibility to the energy system and affordable renewable energy through hydrogen storage

## Hydrogen stored in Finland's rock caves and hydrogen pipeline (GWh hydrogen)



### Storage enables flexible hydrogen production

- Flexibility secures affordable electricity prices

### Hydrogen transmission pipes as hourly and daily stores

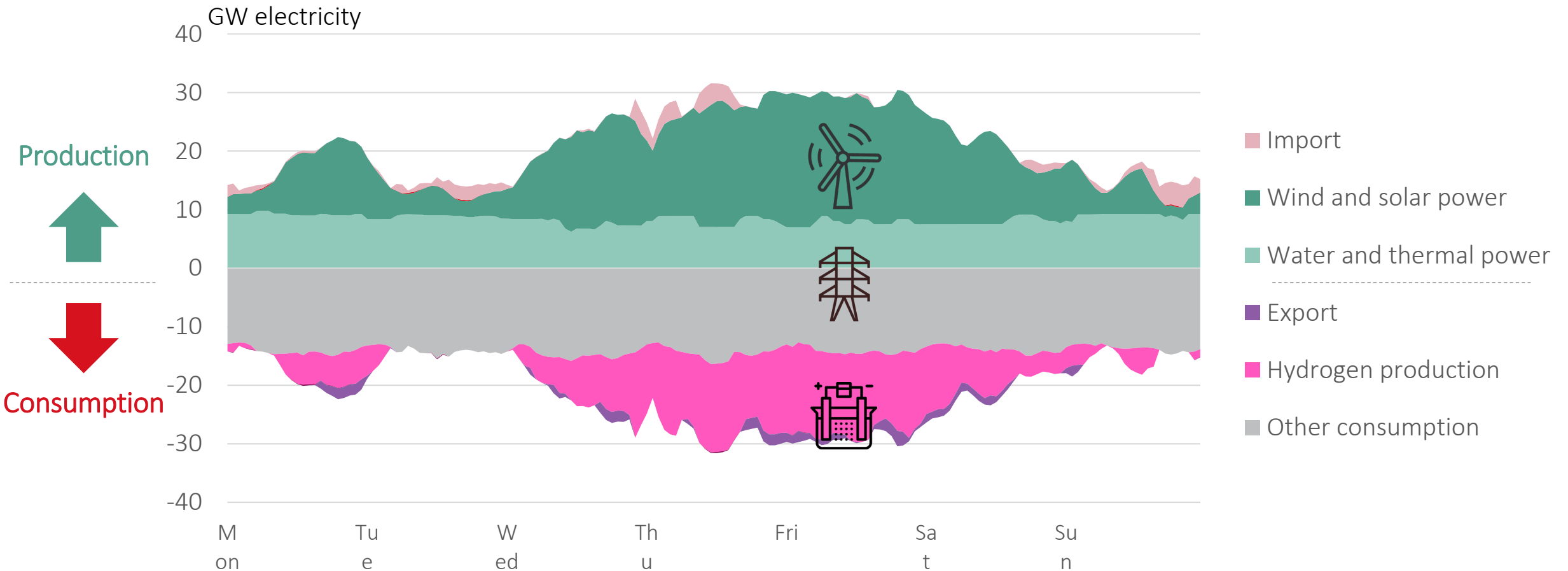
### Seasonal storage need

- Finland's rock caves are a cost-effective option
- Access to evaporate caves via the Central European pipe connection

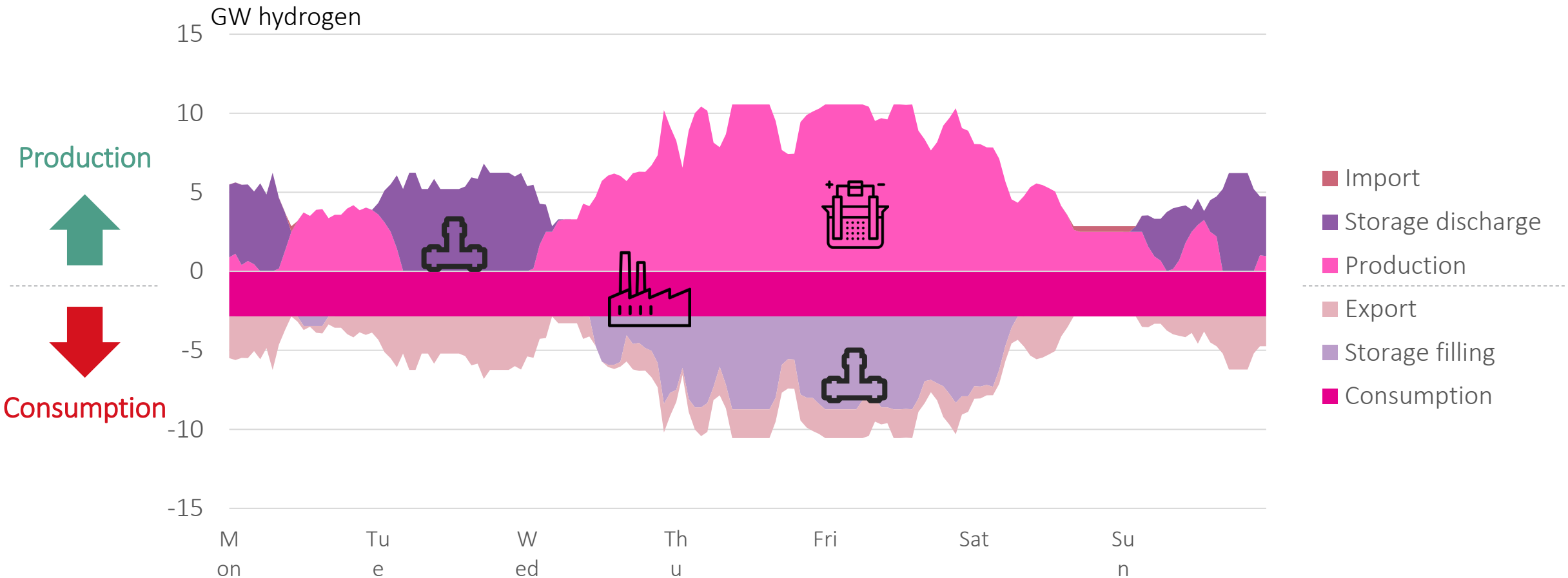


# Large-scale exploitation of wind power requires flexibility

# Electricity is converted into hydrogen during high winds, when there is plenty of cheap electricity on offer



# Hydrogen production is flexible, but end users receive a steady supply of hydrogen through transmission and storage



# The integration of electricity and hydrogen balances the energy system



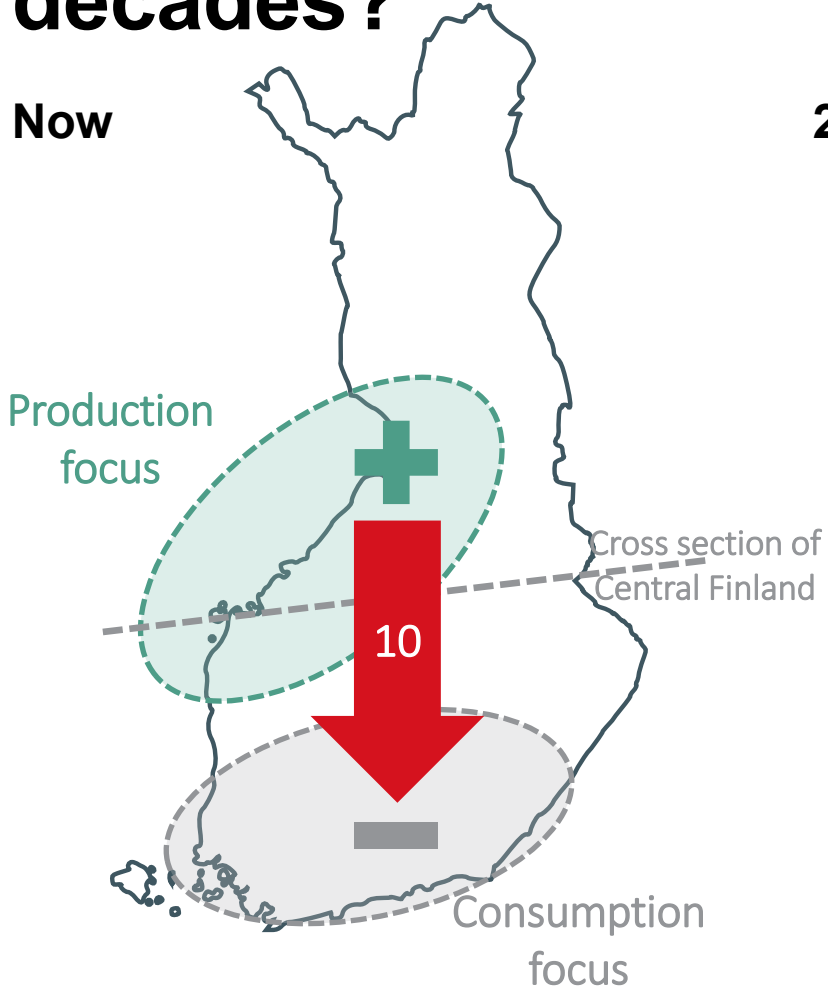
# Working together towards a cost-effective energy system

Venla Saarela, Gasgrid & Jussi Närhi, Fingrid

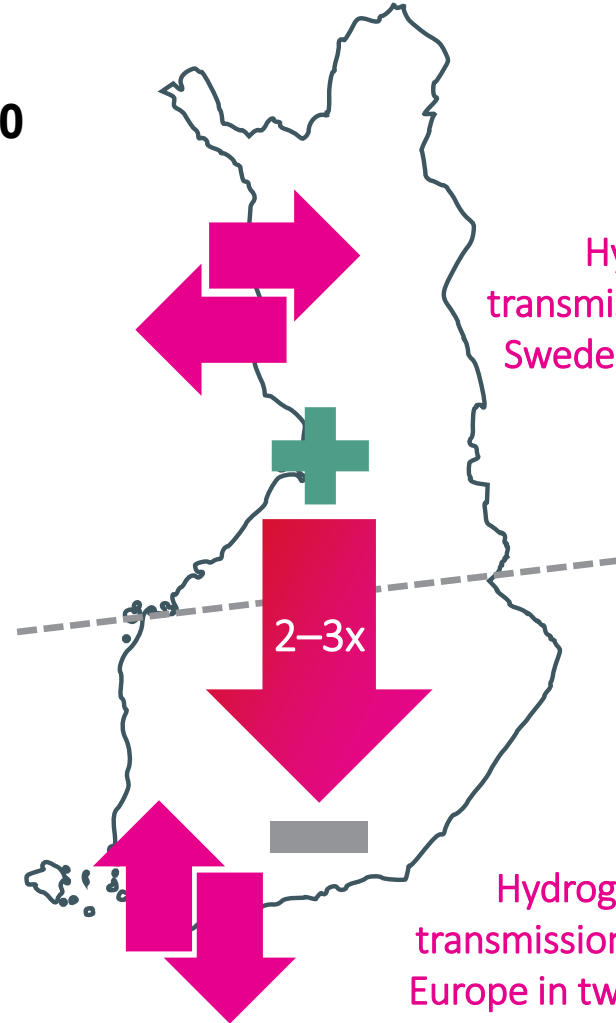


# How will transmission volumes develop in the coming decades?

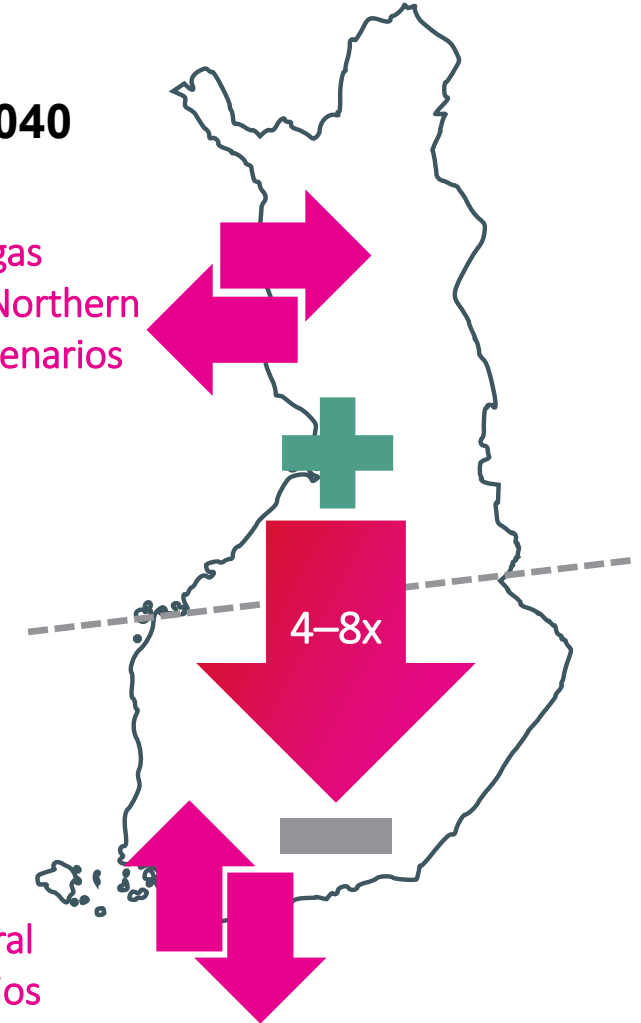
Now



2030



2040



Hydrogen gas transmission to Northern Sweden in all scenarios

Hydrogen gas transmission to Central Europe in two scenarios

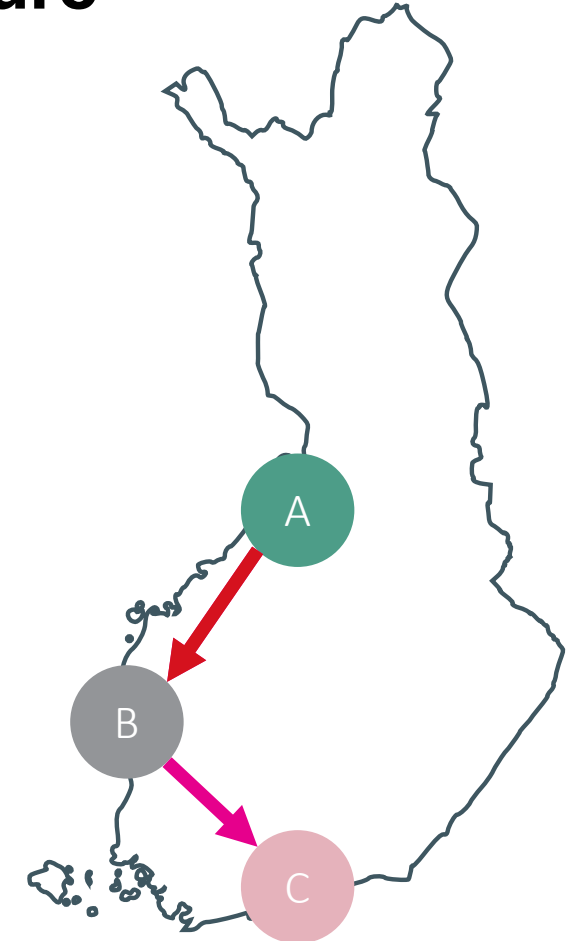
# Identifying the energy transmission needs of industry actors is vital for the development of transmission infrastructure

Energy transmission needs will be determined by the relationship of renewable electricity production, hydrogen production and hydrogen consumption

Example	Location A <span style="background-color: #2e8b57; color: white; border-radius: 50%; padding: 2px 6px;">A</span>	Location B <span style="background-color: #696969; color: white; border-radius: 50%; padding: 2px 6px;">B</span>	Location C <span style="background-color: #c06060; color: white; border-radius: 50%; padding: 2px 6px;">C</span>
1.			
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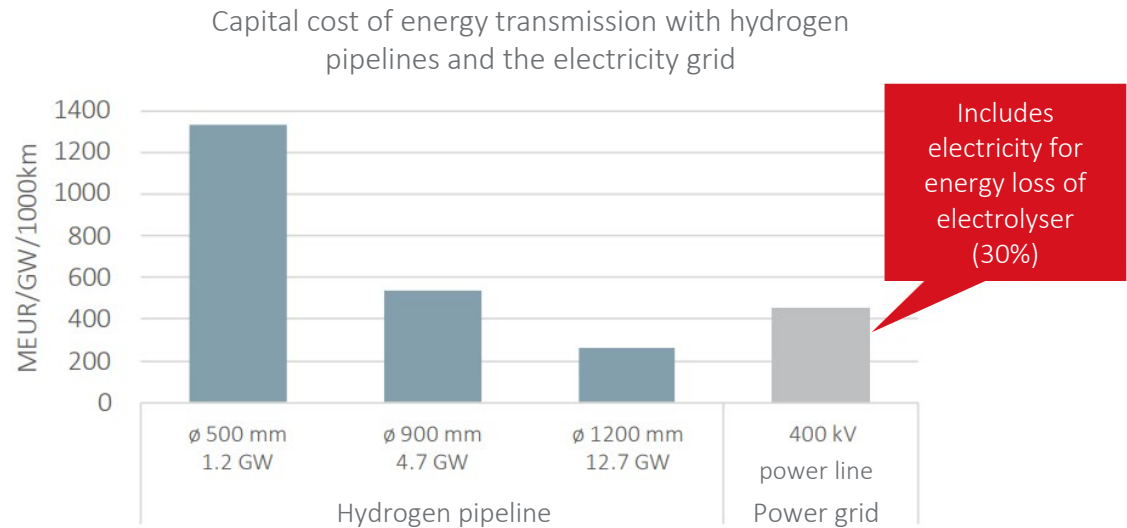
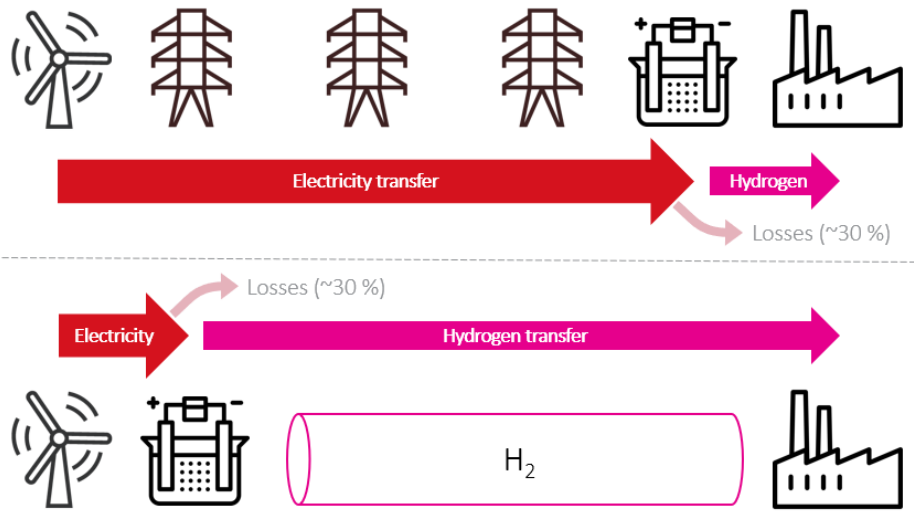
Symbols:	Renewables production	Hydrogen production (electrolyser)	Hydrogen use in the industry	Electricity transmission	Hydrogen transmission
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# Hydrogen transmission is cost-effective for transmitting large amounts of energy

If the end-use of the energy will be as hydrogen, more energy will have to be transmitted as electricity compared to hydrogen due to the energy losses occurring in electrolysis...

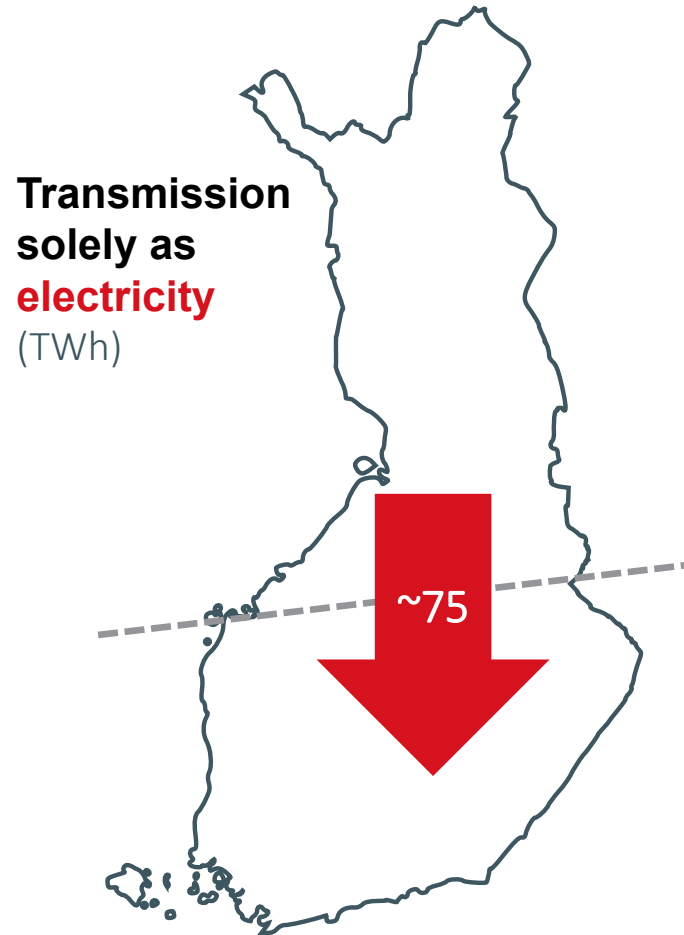
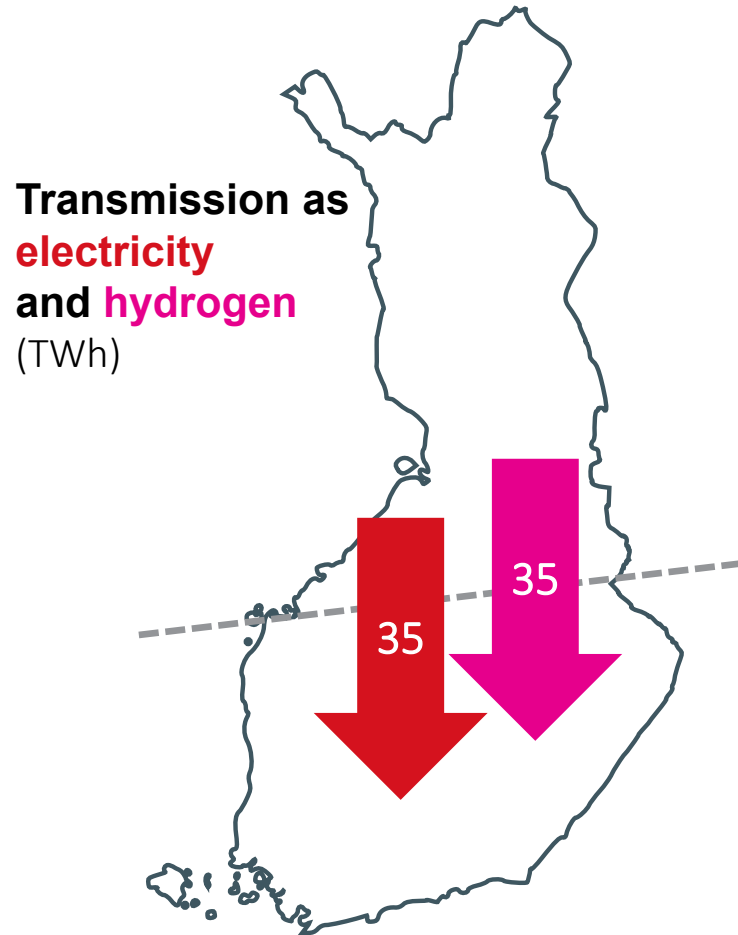
... making hydrogen transmission competitive compared to electricity transmission for large amounts of energy



Source: EHB (European gas TSOs) and Fingrid

# How to manage growing transmission volumes cost-effectively?

# Using both transmission infrastructures is efficient!



Transmission needs in the “Finland the hydrogen economy leader” scenario in 2040

Transmission as electricity alone would require the construction of

**dozens of power lines**

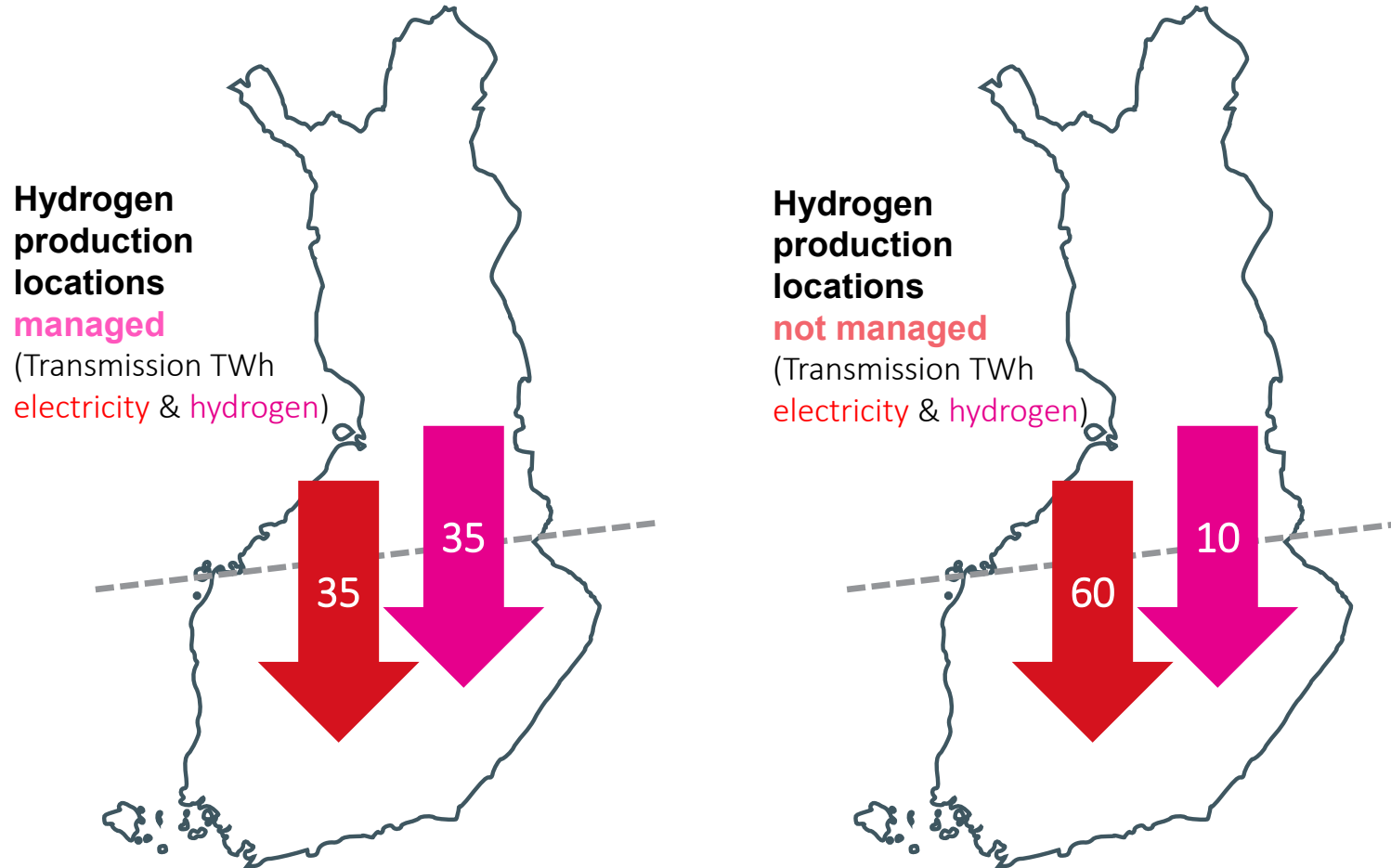
running from north to south

**One hydrogen pipeline**

can transmit as much energy as

**~15 power lines**

# Location matters in enabling growth



Transmission needs in the “Finland the hydrogen economy leader” scenario in 2040

For managing the system's **total costs** and leveraging its **growth potential**, it is important to encourage production and consumption sites:

- **to act flexibly in the market** and consider the status and transmission capacity of the electricity and hydrogen system
- to establish themselves in locations **that take electricity and hydrogen transmission investments into account**



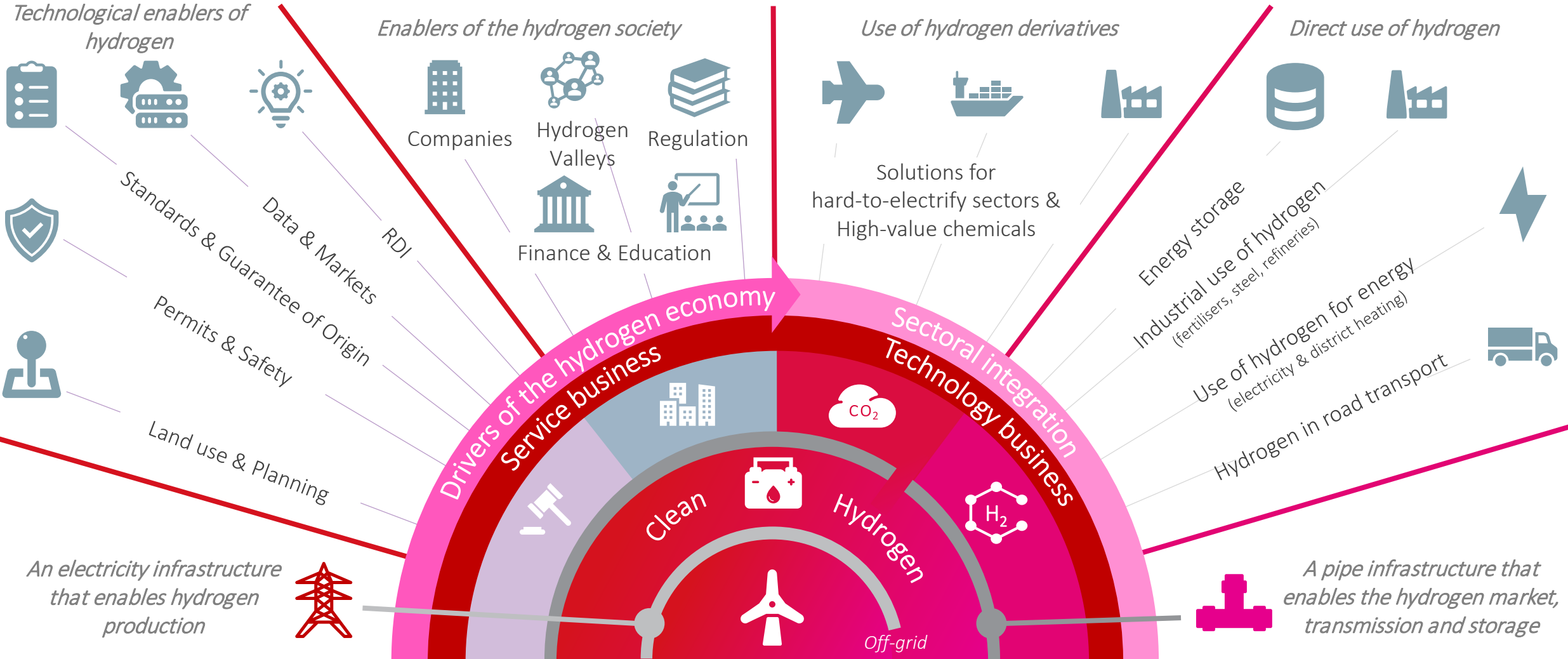
# Co-development of transmission infrastructure enables growth and responding to customer needs



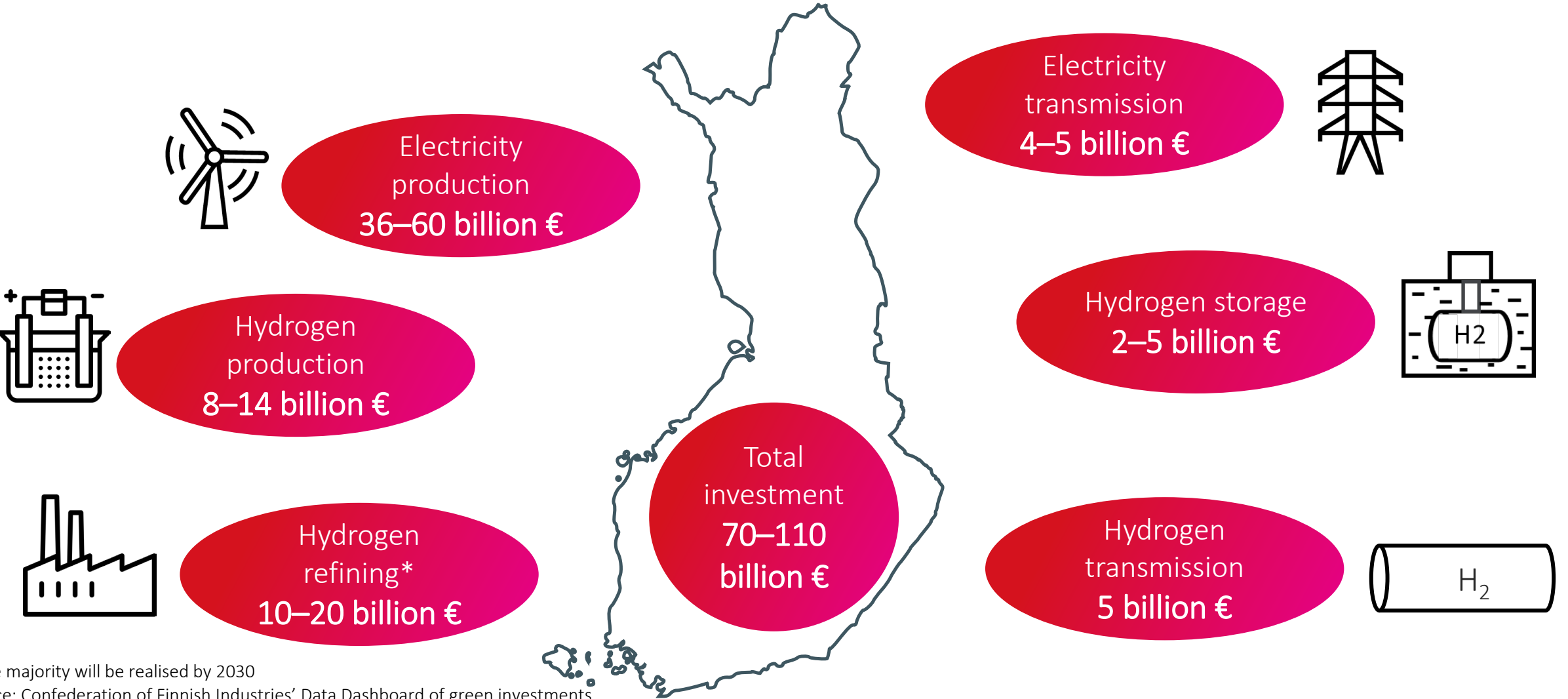
# Opportunities created by a large hydrogen market

Sara Kärki, Gasgrid & Mikko Heikkilä, Fingrid

# Energy infrastructure as an enabler of new hydrogen value chains



# Billions in investments to Finland



\* The majority will be realised by 2030

Source: Confederation of Finnish Industries’ Data Dashboard of green investments

# The main conclusions of the hydrogen economy project

Finland has excellent potential to become a forerunner of the hydrogen economy

- Great potential in renewable electricity production
- Strong main grid
- Expert workforce and several companies for different parts of the value chain

Development of electricity and hydrogen infrastructure enables growth of the hydrogen economy

- Proactive development of the main grid and hydrogen transmission grid for customer needs
- Efficient leveraging of both transmission infrastructures is key – location matters!



# Hydrogen economy leadership through cooperation

**FINGRID**

**THANK YOU!**

GASGRID

