

Industrial Sector Coupling in Finnish Renewable Energy Markets

Merja Mäkelä

Saarbrücken

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Agenda

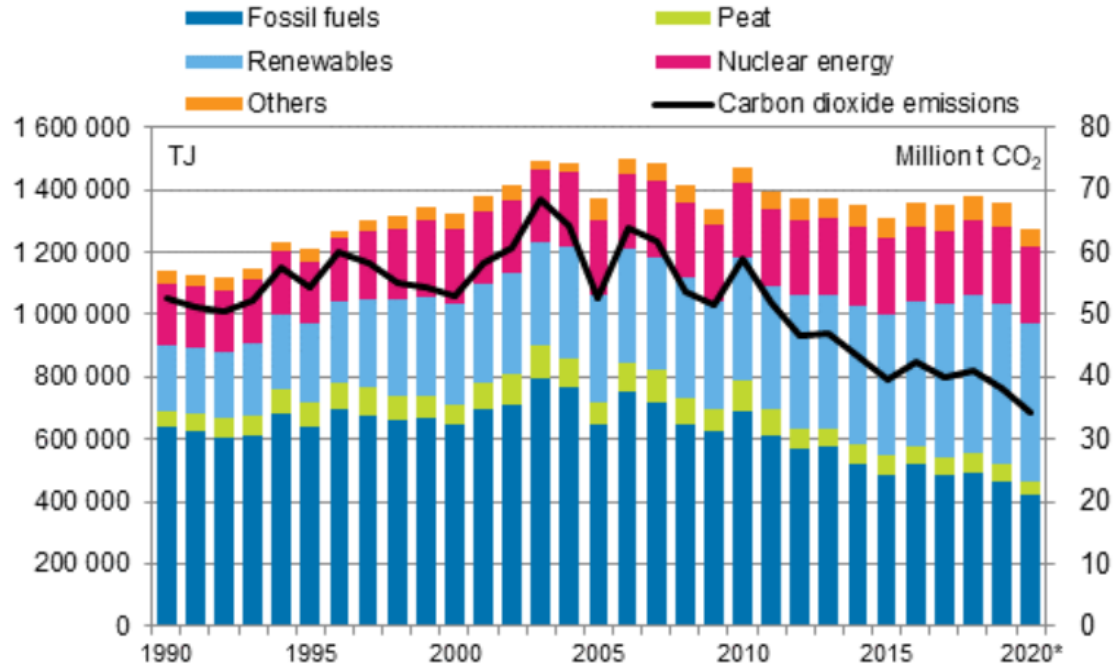
- 1 Introduction
- 2 Sector coupling of forest industries
- 3 Significant CHP production
- 4 Increasing wind power
- 5 Conclusions



Source: Kotka Energy

1 Introduction

Total energy consumption and carbon dioxide emissions 1990-2020 in Finland

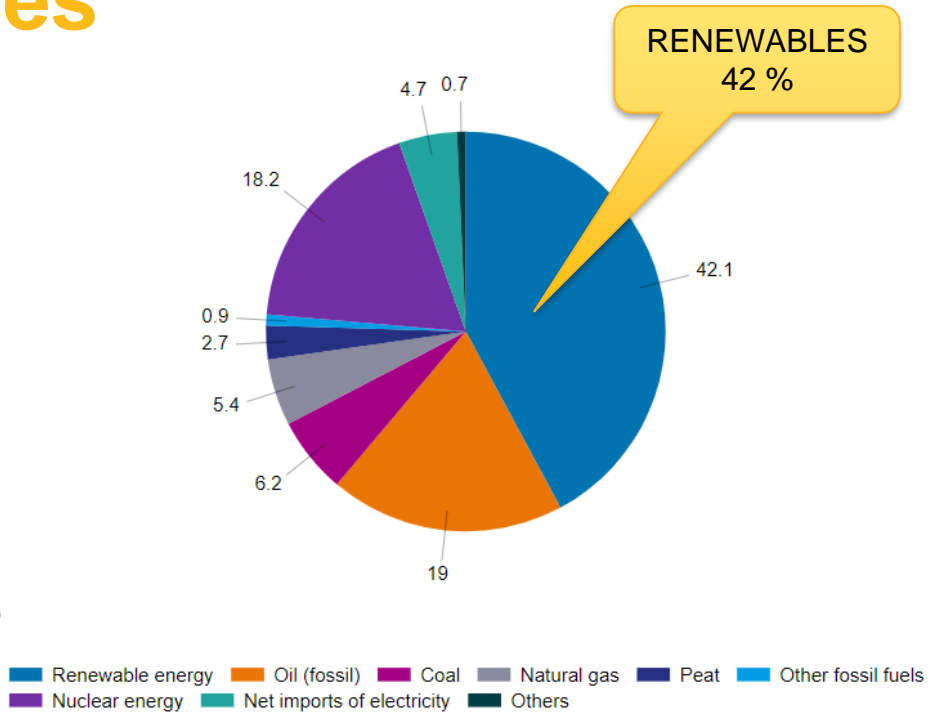


Source: Official Statistics of Finland, 2021










Total Finnish energy consumption in 2021 by sources

- Renewables 42 %
 - Wood + black liquor (30 %)
 - Hydro (4 %)
 - Wind (2 %)
 - Others including solar (6 %)
- Fossil oil 19 %
- Nuclear reactions 18 %
- Others including imported electr. 21 %



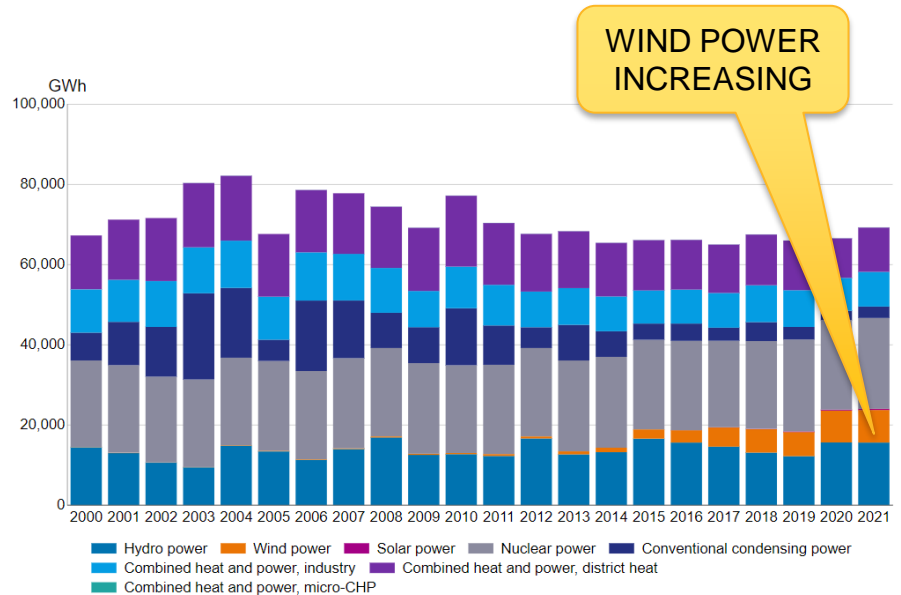
Source: Official Statistics of Finland, 2022

Challenges in Finnish energy policies

- Plenty of electricity imports (~20 % of electricity)
 - High electricity wholesale prices in the Nordic electricity market already in 2021 
 - Waiting for the start-up of the NPP OL3 
- Most renewables wood-based (~80 % of renewables)
 - Combustion processes > emissions 
 - Forests needed also as carbon gaps  
 - Wood needed also for industries  

Electricity production in Finland 1990-2021

- By production mode in 2021
 - Net imports 20.5 %
 - CHP + cond. power 25.7 %
 - Nuclear power 26.1 %
 - Solar power 0.4 %
 - Wind power 9.4 %
 - Hydro power 17.9 %

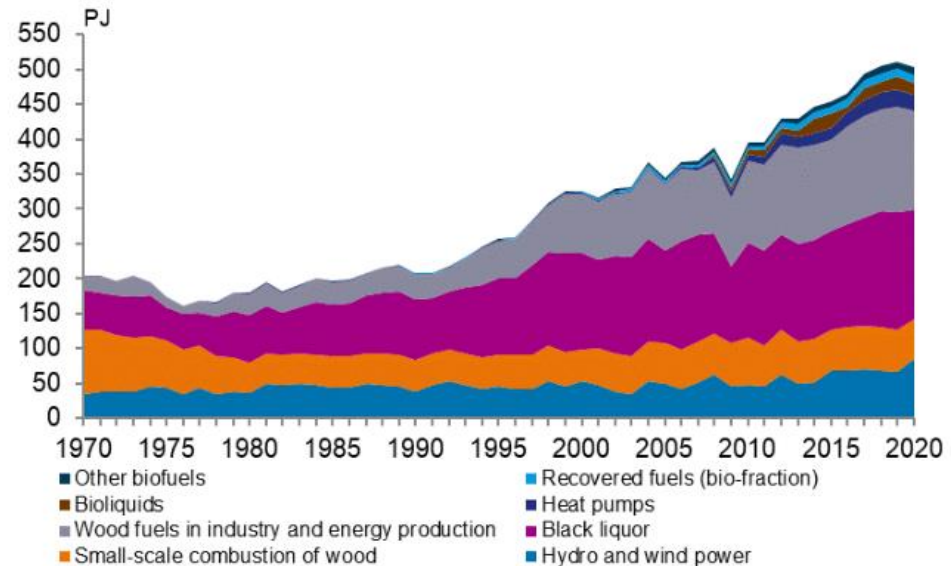


Source: Official Statistics of Finland, 2022

2 Sector coupling of forest industries

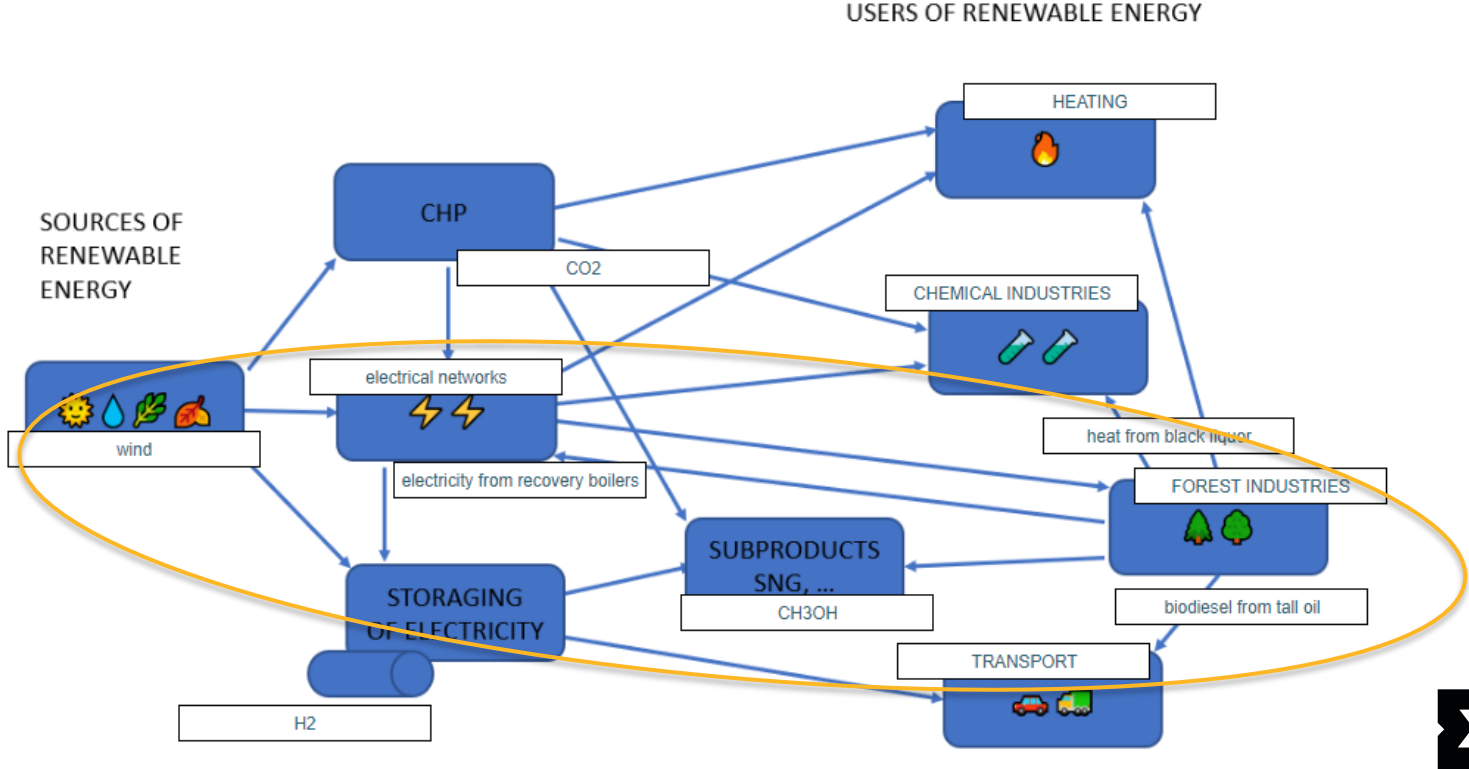
Renewable energy sources in 1970-2020

- Wood-based sources from forest industries make most (~ 80 %) of renewables:
 - bioliquids
 - industrial combustion of wood waste
 - small-scale combustion of wood waste.



Source: Official Statistics of Finland, 2021

Role of pulp mills



Recovery boilers of pulp mills

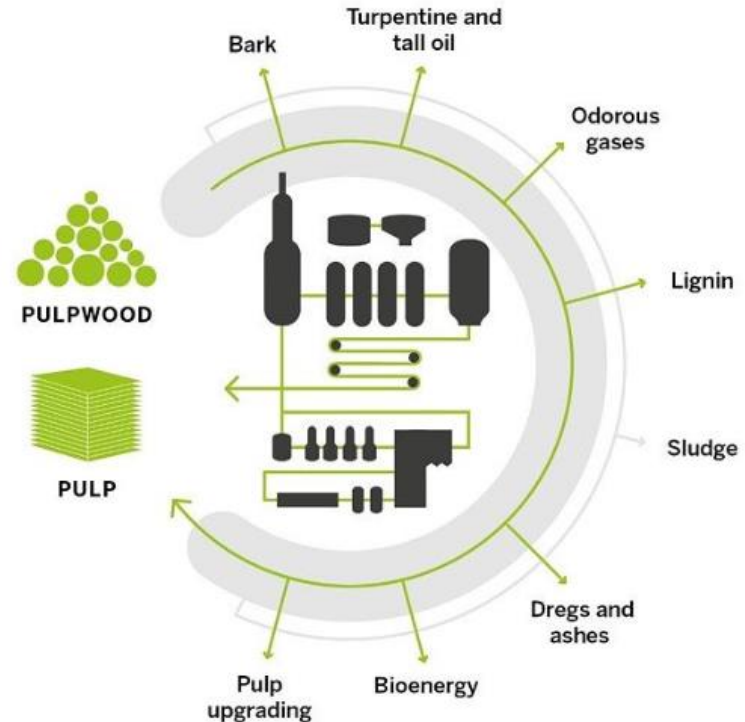
- Modern recovery boilers of pulp mills (bio product mills) produce more heat and power than they need themselves.
 - Black liquor (mixture of remaining wood parts and chemicals) is combusted and the chemicals are recovered.
 - Heat is used for own processes, neighbouring industrial processes and for district heating.
 - Power is used for own processes, other industrial processes and for national networks.



Source:
<https://www.metsagroup.com/metsafibre/about-metsafibre/pulp-production/aanekoski-bioproduct-mill/>

Important energy-related products from pulp mills

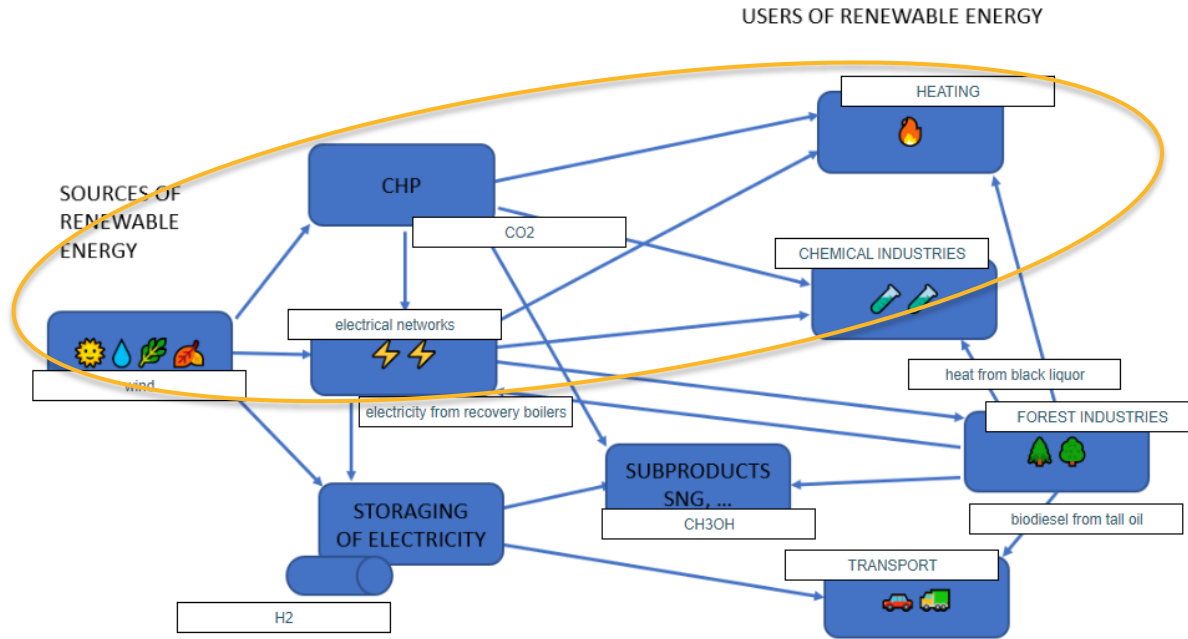
- Pulp as the main product for tissue and paperboard grades
- Bark and sludges for energy
- Process gases for energy
- Lignin for consumer articles and energy
- Tall oil for biodiesel



Source: <https://www.metsagroup.com>

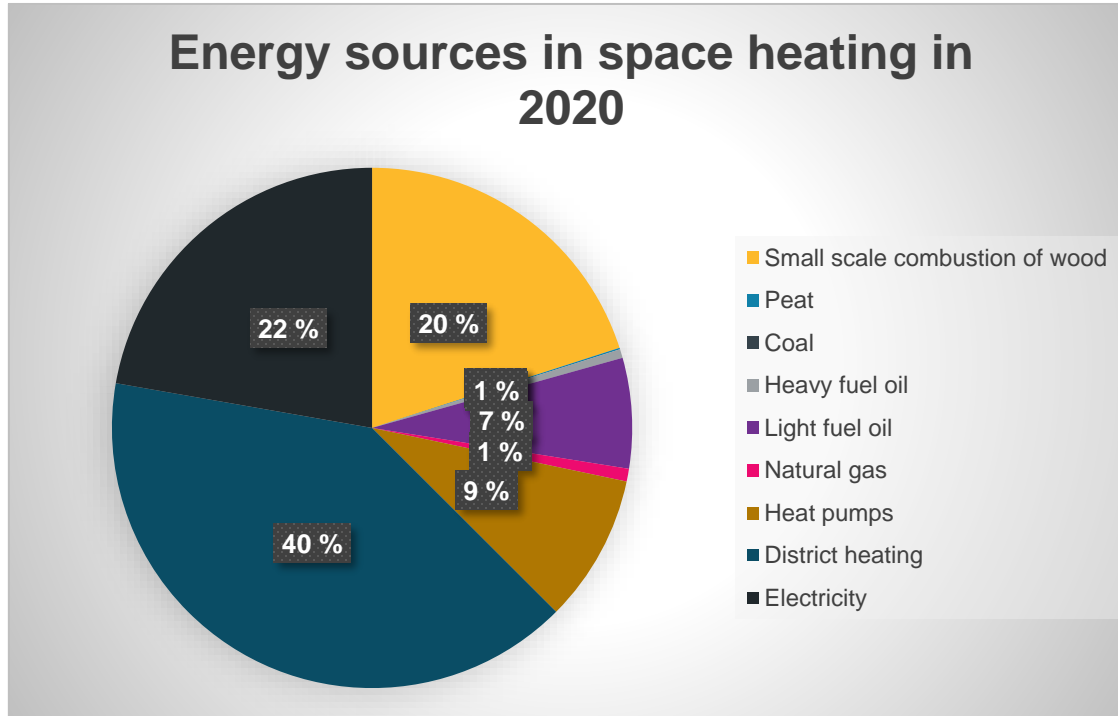
3 Significant CHP production

Role of combined heat and power (CHP)

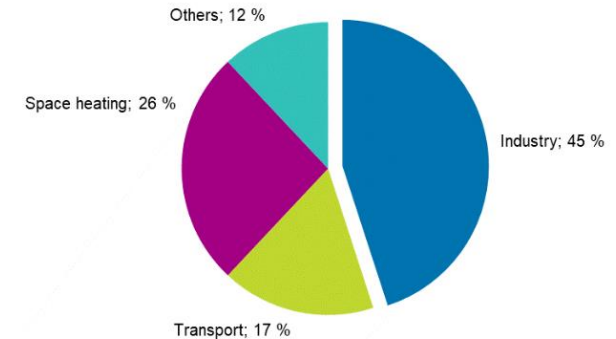


- CHP about 40 % of space heating (using all kinds of sources)
 - Increasing interests in SMRs
- CHP about 26 % of generated power (using all kinds of sources)
- Many CHP plants participating in reserve markets
- CO₂ recovery increasing

Space heating in 2020



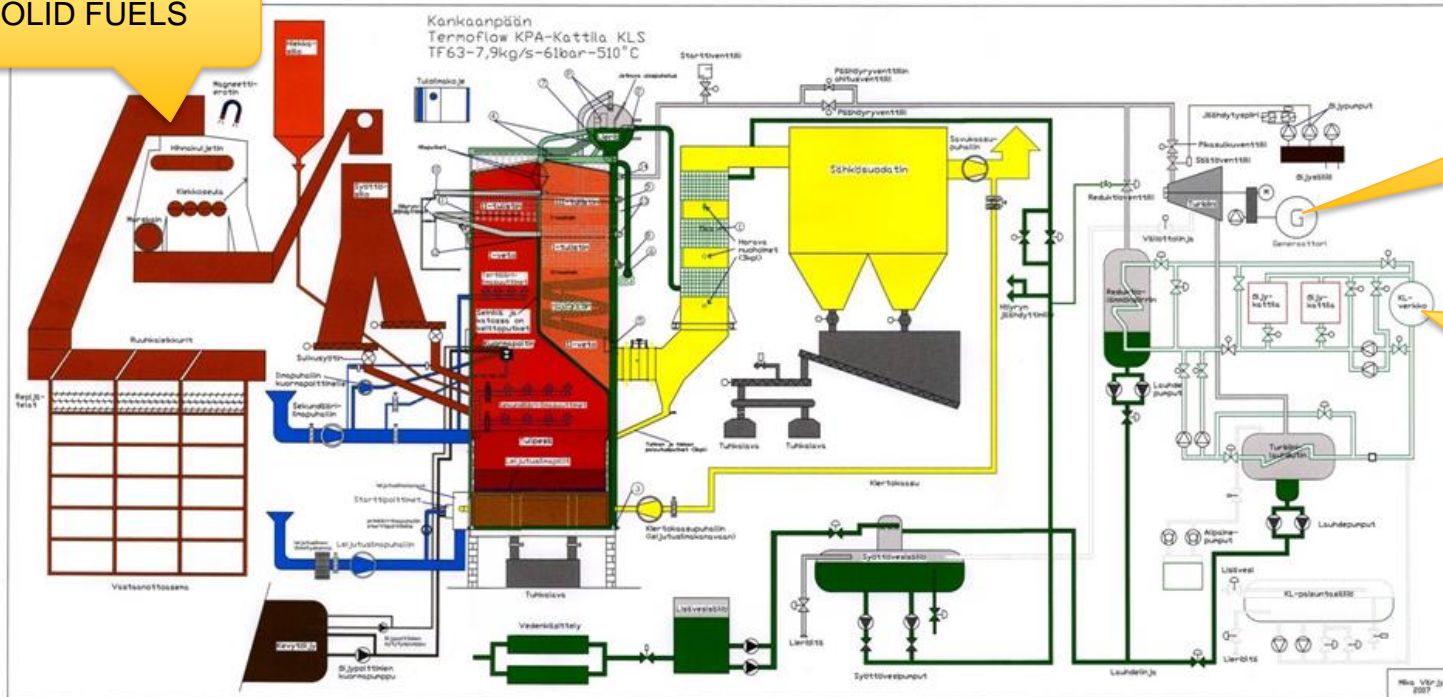
- Significant sources
 - District heating 40 %
 - Electricity 20 %
 - Small-scale wood 20 %



Source: Based on Official Statistics of Finland, 2021

Combined heat and power plant

SOLID FUELS



POWER FOR ELECTRICAL NETWORKS

HEAT FOR DISTRICT HEATING

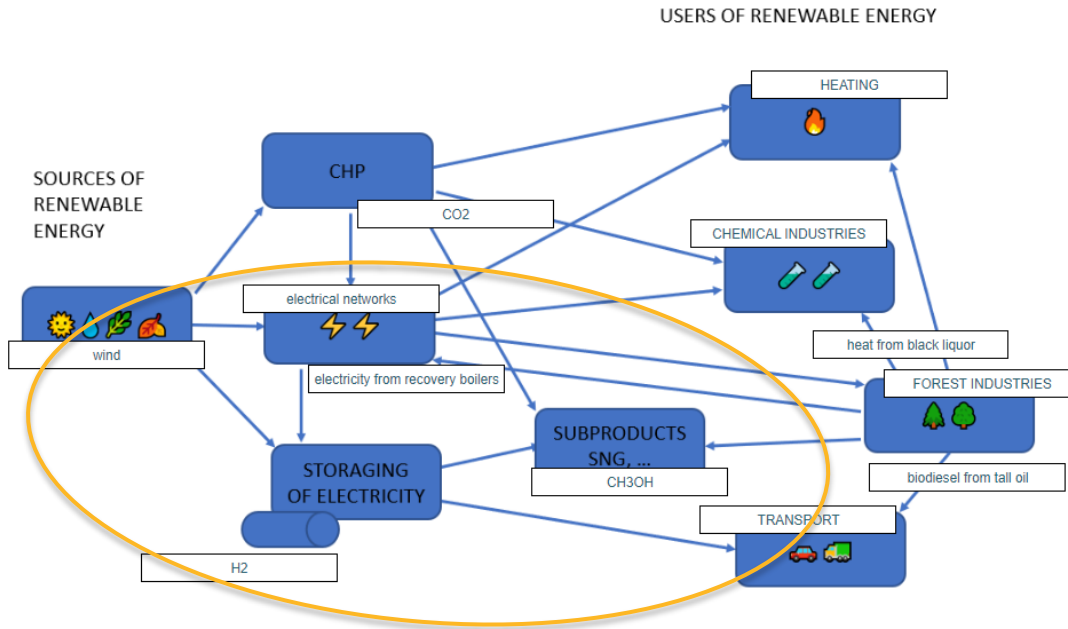
Industrial coupling to district heating

- Case Vatajankoski in Kankaanpää
 - Recovery heat as steam from the plaster plate company Knauf feeding the district heating water circuit
 - Recovery heat from a data center warming the local swimming hall water
 - Storing waste heat into a sand battery and using it to industrial partners' needs and district heating

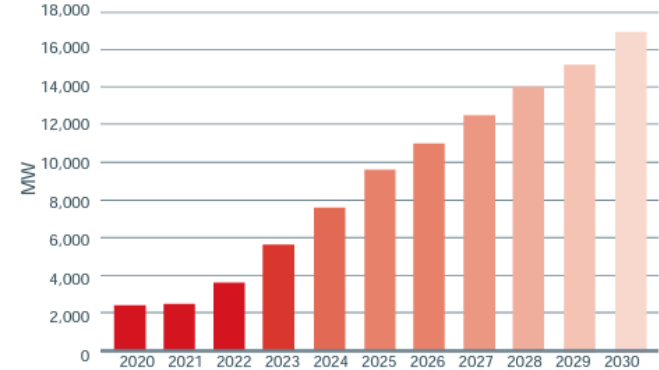


4 Increasing wind power

Role of wind power



Wind power capacity trend in Finland



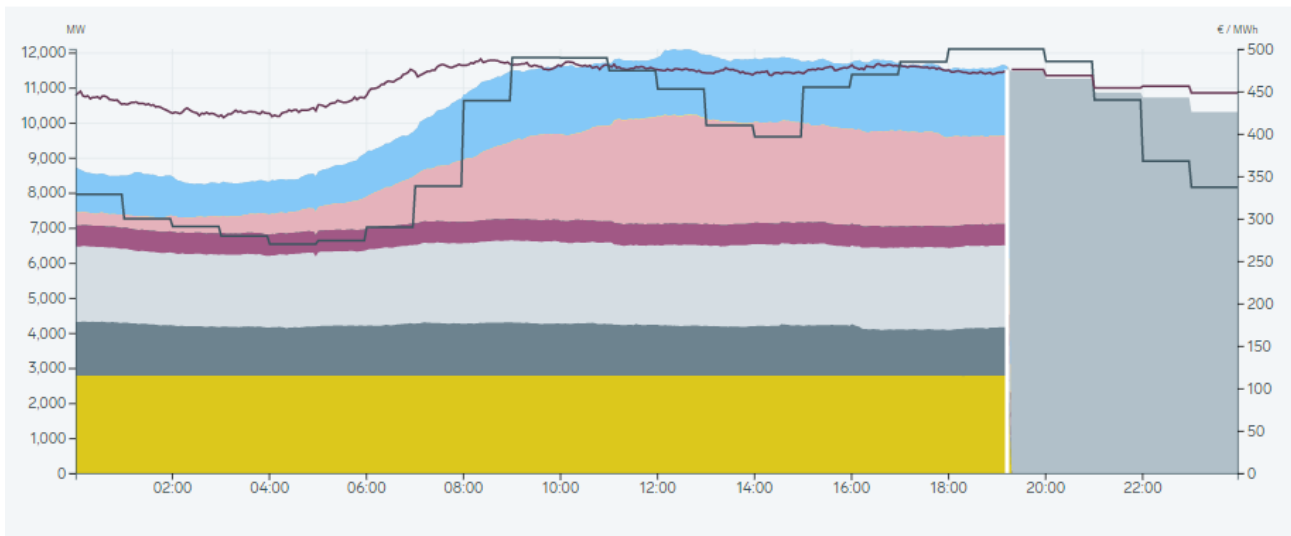
- Current capacity about 4000 MW
- Also feasible for working as a power reserve

Source: Fingrid 2022

Today

Day:

15.12.2022



Power production in Finland 15.12.2022

Nuclear power 2 785 MW	Cogeneration industry 1 382 MW	Cogeneration district heating 2 325 MW	Other production 609 MW	Peak load power 0 MW
Wind power 2 511 MW	Solar power 0 MW	Hydro power 2 002 MW	Production forecast - MW	
Consumption 11 444 MW	Electricity price in Finland 499,9 €/MWh	Production CO ₂ -emission estimate 76 g/kWh	Consumption CO ₂ -emission estimate 73 g/kWh	Consumption forecast - MW

Source: Fingrid 15.12.2022



With more wind power more hydrogen

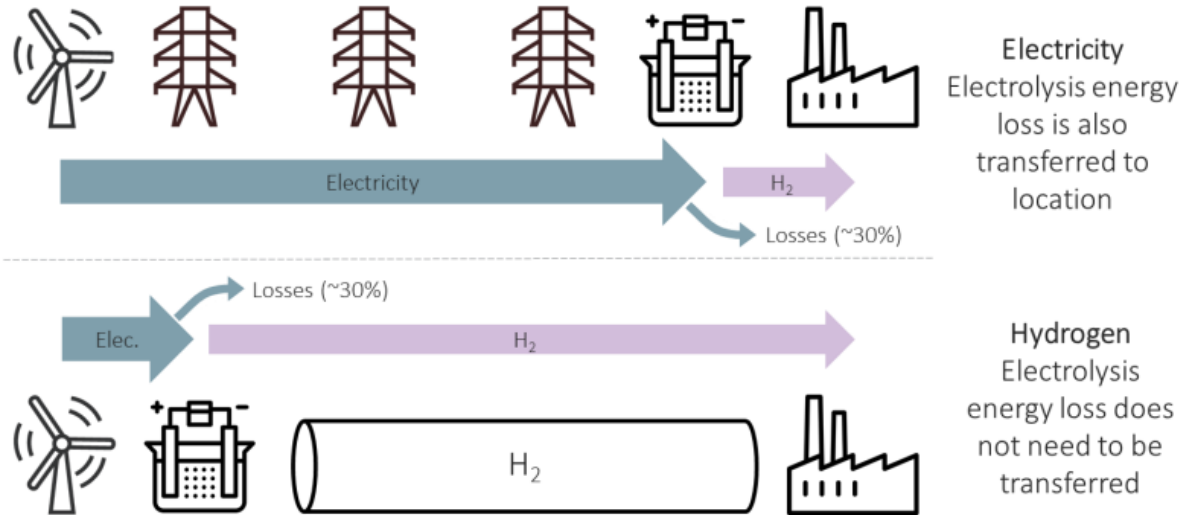
- Construction costs of onshore wind power regarded as reasonable
- Estimated future hydrogen production potential both for domestic and foreign needs
 - Hydrogen profitability perhaps in 4-6 years
- First industrial size (20 MW) hydrogen and methane production plant in construction 2022-2024 in Harjavalta
 - Based on electrolysis
 - Wind and solar power used
 - Oxygen and heat utilized in local industries
 - Constructor: Finnish company P2X Solutions
 - Plans for further capacity

Source: Intermediate Report Fingrid and Gasgrid, 15.3.2022

Source: <https://www.fingridlehti.fi/en/hydrogen-is-transforming-the-energy-sector/#99c6bf1a> 9.10.2022

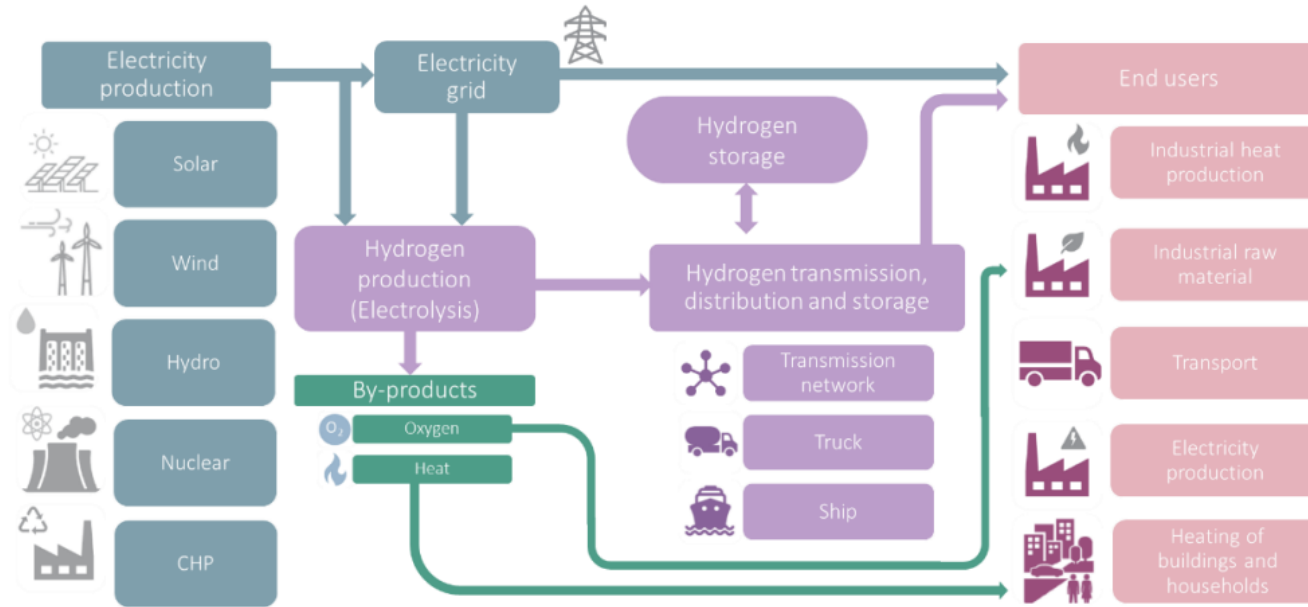


Hydrogen network needed



- The production of hydrogen near wind power is preferred.
- Wind power mostly located in Northern Finland, usage mostly in Southern Finland.

Potential sector coupling of hydrogen in Finland



Source: Intermediate Report Fingrid and Gasgrid, 15.3.2022

5 Conclusions

Final conclusions

- In the Finnish forest industries, the recycling and utilizing of subproducts is rather efficient.
- In the CHP production for district heating, more coupling methods with local industries are developed.
- With increasing wind power hydrogen production is estimated to be potential both for domestic and foreign markets.

Literature

- Energy in Finland pocketbook (in English), Statistics of Finland, 2022, 56 p., available in: <https://stat.fi/en/statistics/ehk#graphs>
- Solution for a green Nordic energy system, Fingrid 2022, available in: <https://www.fingrid.fi/sahkomarkkinat/markkinoiden-yhtenaisyys/sahkomarkkinoiden-kehityshankkeet/>
- Energy transmission infrastructure as enabler of hydrogen economy and clean energy system, Intermediate report, Fingrid and Gasgrid 15.3.2022, available in: <https://www.fingrid.fi/en/news/news/2022/an-intermediate-report-of-a-joint-hydrogen-economy-study-presents-the-opportunities-that-transmission-infrastructure-enables-for-the-future-energy-system/>



Tunne huominen - All for the future.