SYSTEM EARTH

AIR Turning emissions into opportunities

BUSINESS Sustainable renewal of business and industry

WATER Refining sidestreams into value

ENERGY Transition to carbon-neutral world
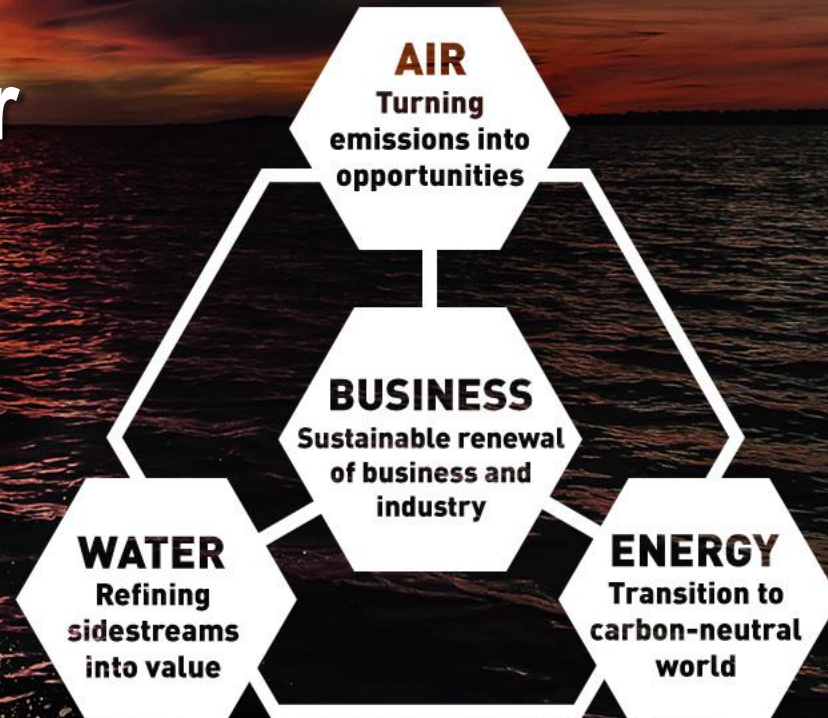
Vision of Finland as major part of the Future energy system in Europe

Petteri Laaksonen, D.Sc., Research Director

petteri.laaksonen@lut.fi

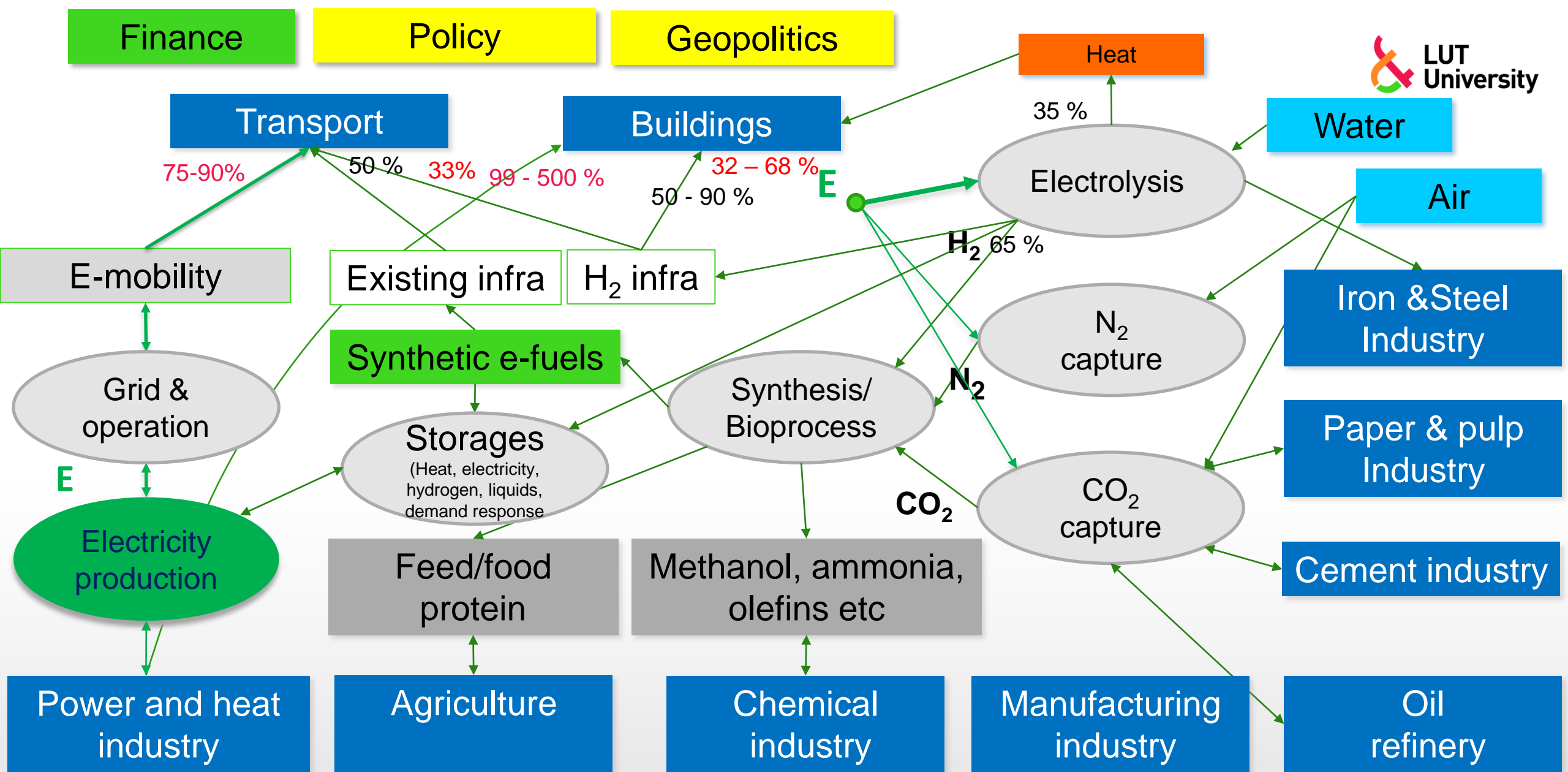LUT University

LUT University ranks

NINTH IN THE WORLD

in terms of climate actions – SDG 13

The Times Higher Education Impact Rankings 2022 assess the social and economic impact of universities against the UN's Sustainable Development Goals.

GREEN ELECTRIFICATION & P2X ECONOMY
-
FINLAND AS ENERGY SUPERPOWER

4

Energy system transition in Europe

- Zero CO$_2$ emission low-cost energy system is based on electricity
- **Core characteristic of energy in future: Power-to-X Economy**
  - Primary energy supply from renewable electricity: mainly solar PV and wind power
  - Direct electrification wherever possible: electric vehicles, heat pumps, desalination, etc.
  - Indirect electrification for e-fuels (marine, aviation), e-chemicals, e-steel; power-to-hydrogen-to-X
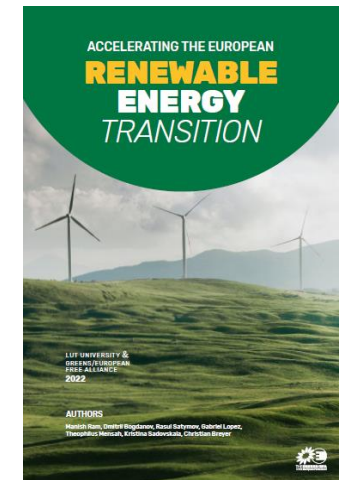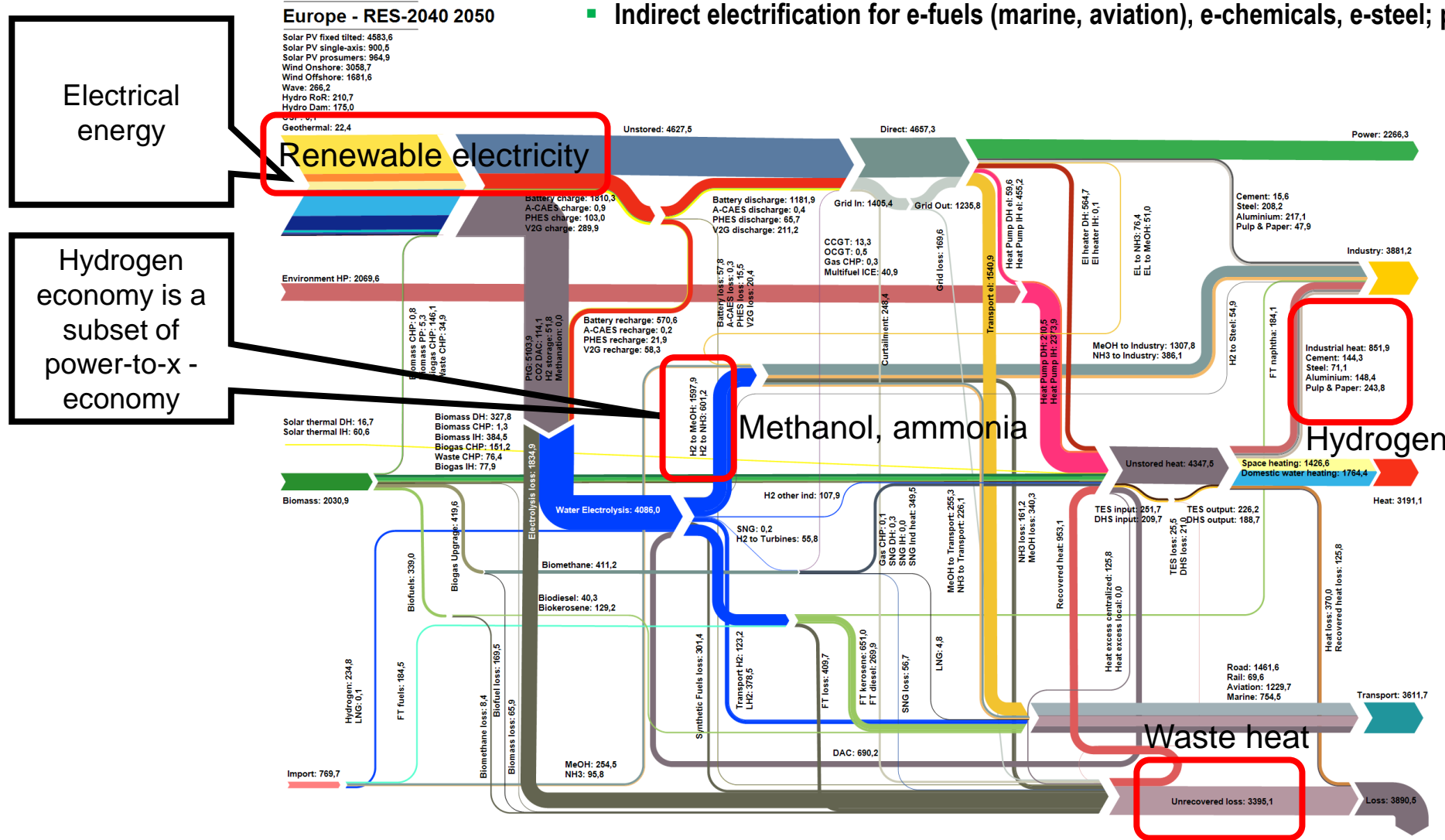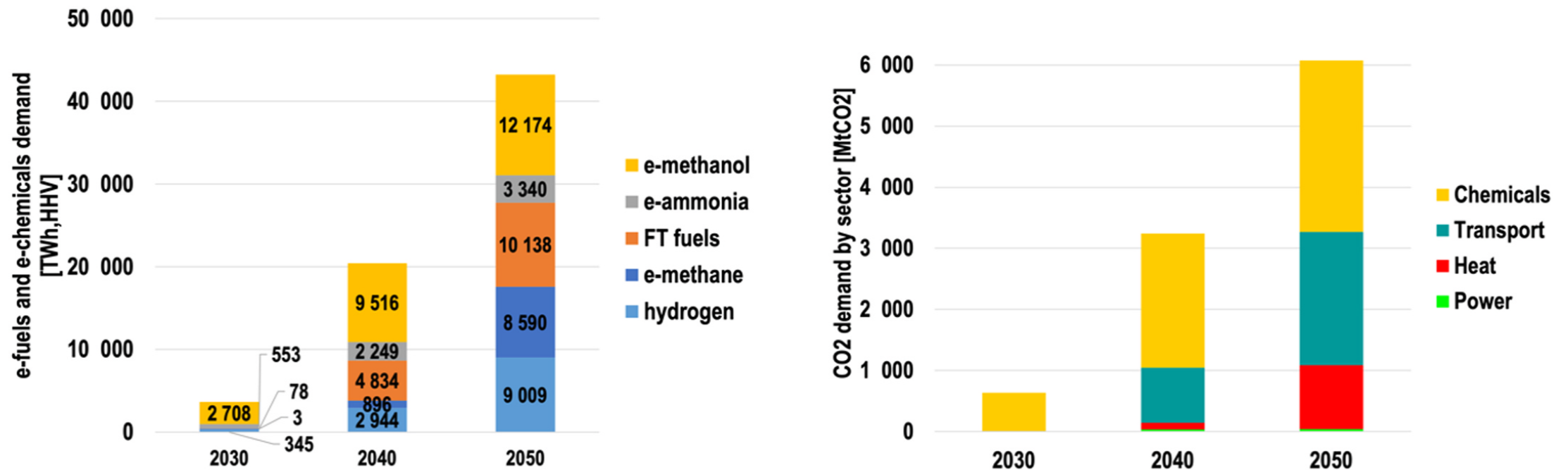

Greens/EFA, 2022

Future demand for P2X products

In 2030, the total potential of captured CO2 from point sources that could be utilised is 2112 Mt/a (T. Galimova et al. 2022)

T. Galimova et al.   *Journal of Cleaner Production 373 (2022) 133920*

Source: " Global demand analysis for carbon dioxide as raw material from key industrial sources and direct air capture to produce renewable electricity-based fuels and chemicals" Tansu Galimova *, Manish Ram , Dmitrii Bogdanov , Mahdi Fasihi , Siavash Khalili , Ashish Gulagi , Hannu Karjunen , Theophilus Nii Odai Mensah , Christian Breyer (2022) , LUT University
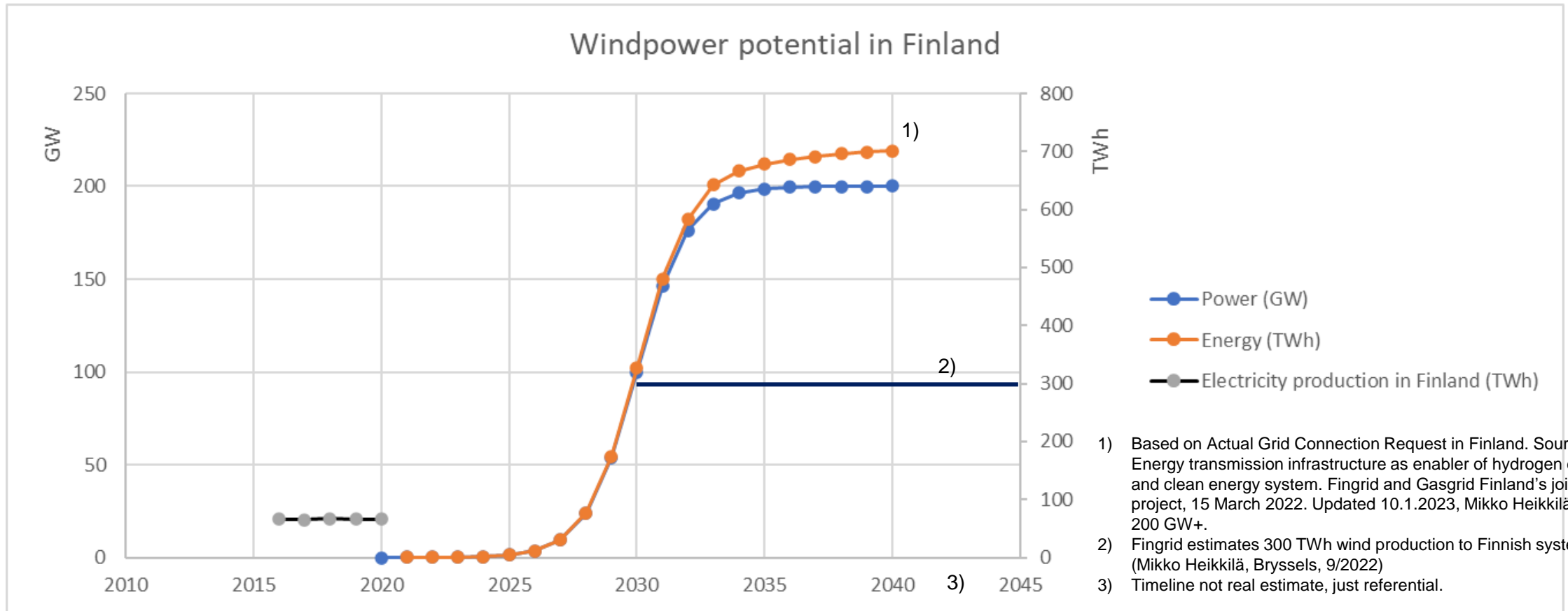
Renewable Energy in Finland

Competitive advantages for Finland in P2X

›› **Large and sparsely populated country**

›› **Raw material availability**
  - ▪ **Bio based CO_2 raw material (20+ MtCO2 annually, equals to 150 Mt MeOH & 15 BEUR/a revenue**
  - ▪ **Cheap electricity compared to rest of the Europe**
    - ▪ **Very big potential for new production (wind and solar) and fast to ramp-up**

›› **Educated people, good education system**

›› **Process industry heritage and skills**

›› **Robust infrastructure**

›› **Good reputation within investors**

›› **Fast permitting processes (some exceptions)**

POTENTIAL OF GREEN ELECTRICITY PRODUCTION

Windpower potential in Finland

Legend:
- Power (GW)
- Energy (TWh)
- Electricity production in Finland (TWh)

1) Based on Actual Grid Connection Request in Finland. Source: Energy transmission infrastructure as enabler of hydrogen economy and clean energy system. Fingrid and Gasgrid Finland's joint project, 15 March 2022. Updated 10.1.2023, Mikko Heikkilä, Fingrid 200 GW+.
2) Fingrid estimates 300 TWh wind production to Finnish system (Mikko Heikkilä, Bryssels, 9/2022)
3) Timeline not real estimate, just referential.

P2X in Finland – some LUT research

» Carbon Negative Åland: Strategic Roadmap
https://lutpub.lut.fi/handle/10024/163456

» Bothnian Bay Hydrogen Valley – Research report
https://lutpub.lut.fi/handle/10024/163667

» South-East Finland Hydrogen Valley – Research report
https://lutpub.lut.fi/handle/10024/164642

» Feasibility Study for Industrial Pilot of Carbon-Neutral Fuel Production – P2X
https://lutpub.lut.fi/handle/10024/162597

NORDIC ELECTRICITY SUPERPOWERS

- Total renewable electricity potential in **Finland exceeds 1000 TWh, representing 10% of the electricity demand in EU.**

- Combined with Sweden and Norway, the potential could be 3500 – 4500 TWh, **covering 35- 45%% of the European electricity demand** of 10 000 TWh

- New P2X **investments will be located neat the electricity production**. Investments in synthesis of methanol, ammonia and other P2X products exceed investments in electricity generation.

- **Total investments exceed 1000 BUER** in Nordic countries.

THINGS TO FOCUS ON

- **System balancing capacities between Finland, Sweden and Norway**
  - Electricity grid
  - Hydrogen pipeline
- **Coherent planning guidelines for infrastructure and P2X production**
- **Strong focus in anticipation of EU Energy strategy and regulation in order to avoid the threats from possible restrictions of the opportunities**
  - Energy Efficiency Directive
  - Renewable Energy Directive
  - Hydrogen Bank (and related subsidies within EU)
  - EU Climate Law (2023/2024 amendments)
  - Etc.

Thank you!

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