SYSTEM EARTH

LUT UNIVERSITY ENERGY DAY EVENT AT BRUSSELS 27.9.2022

VISION FOR EUROPE'S FUTURE ENERGY SYSTEM

Future European Energy System, Nordic perspective & REPowerEU

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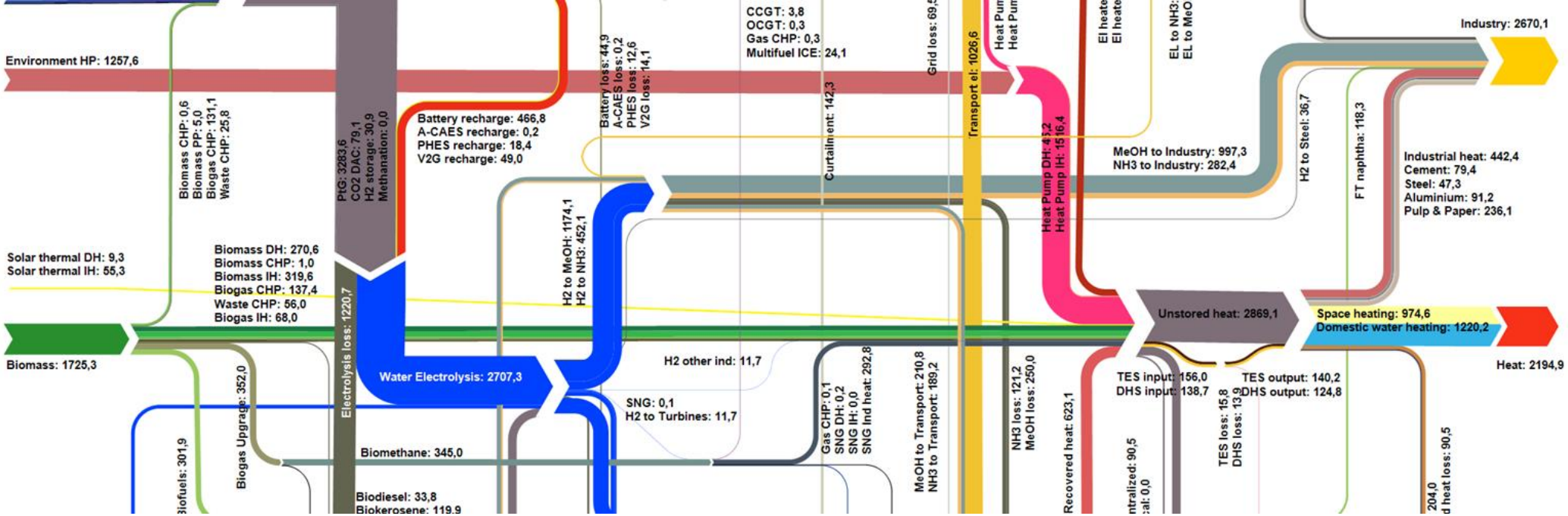


VISION FOR EUROPE'S FUTURE ENERGY SYSTEM

Based on LUT research publication "ACCELERATING THE EUROPEAN RENEWABLE ENERGY TRANSITION" (9/2022), Authors Manish Ram, Dmitrii Bogdanov, Rasul Satymov, Gabriel Lopez, Theophilus Mensah, Kristina Sadovskaia, Christian Breyer

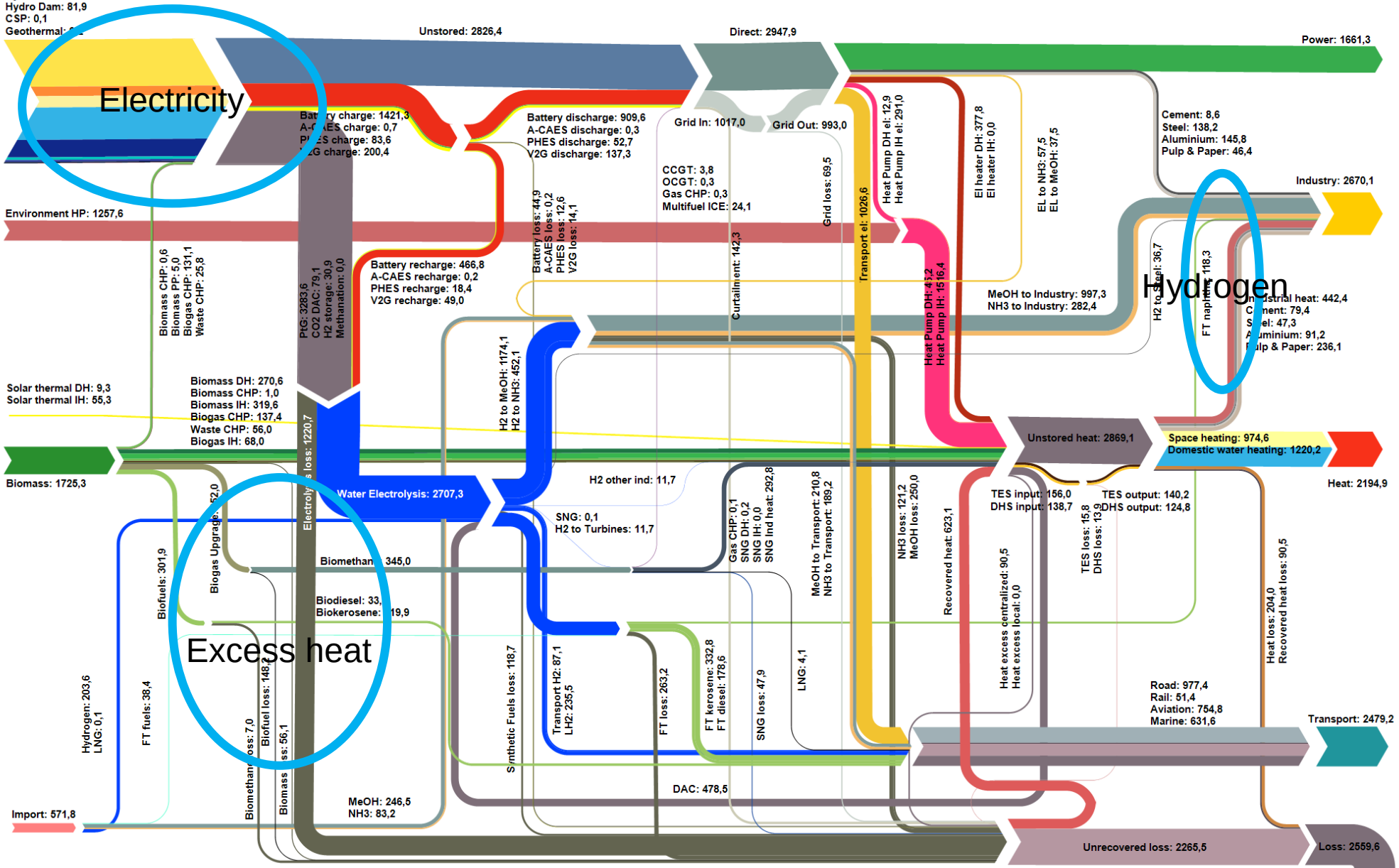
https://extranet.greens-efa.eu/public/media/file/1/7861

ENERGY TRANSITION

- Electrification and efficiency are primary drivers
- Solar and wind emerge as the prime sources of electricity generation replacing fossils
- Heat pumps coupled with electric heating are the prime sources of heat
- Electricity, heat and gas storage are critical for stability and flexibility
- Sector coupling enhanced by e-hydrogen, e-fuels and e-chemicals
- Energy storages in different forms are necessary to balance the energy system
- Bio-based and hard-to-abate like cement carbon dioxide emissions as raw materials – at later stage Direct Air Capture (DAC)

Source: https://extranet.greens-efa.eu/public/media/file/1/7861

EU - RES-2040 2050



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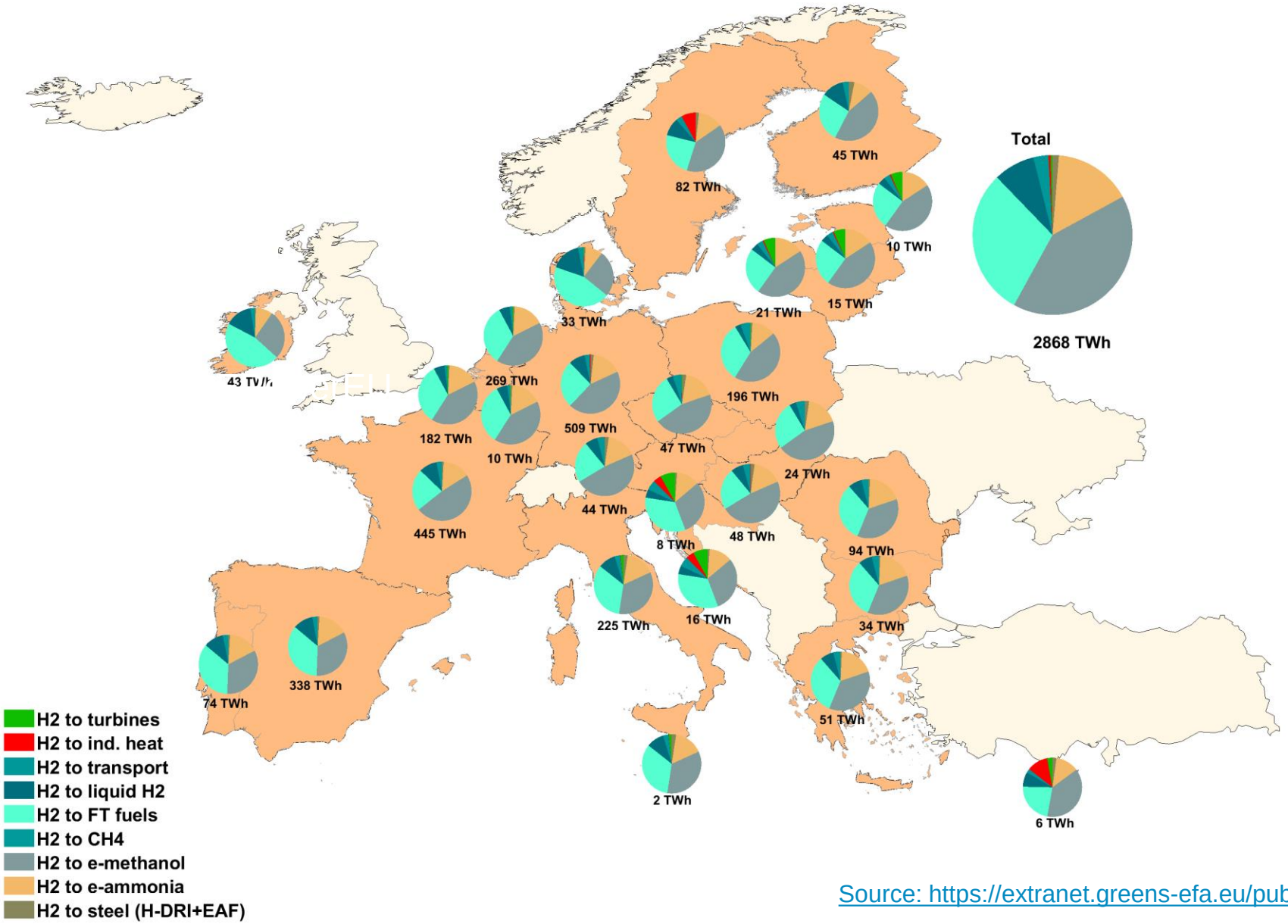
Flow of hydrogen



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INTEGRATED ENERGY SYSTEM TRANSITION ACROSS THE EUROPEAN UNION

- The future system is based as primary energy on renewable energy and mostly on electricity
  - The energy demand does not increase due to improved efficiency in use (modelled in the level of 10 000 TWh)
  - Due to electrification energy efficiency gain will be approximately 1000's of TWh in Europe
  - Energy efficiency does not mean reduction of the use of electricity
  - The transition from fossil to renewable requires 3-4 times more electricity production and energy transmission compared to today
- Electrification cuts through all sectors improving energy efficiency remarkably
  - The demand of electricity increases in industrial sector due to demand of e-chemicals
  - Renewable electricity-based hydrogen emerges as the second most important energy carrier through the transition, mainly for the production of synthetic e-fuels and e-chemicals.
- The demand of Natural Gas/e-methane is zero, biomethane is used, but finally not needed (converted to methanol or hydrogen)

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VISION FOR EUROPE'S FUTURE ENERGY SYSTEM

A scenario of "Future European Energy system" – strategists view

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A SCENARIO OF “FUTURE EUROPEAN ENERGY SYSTEM”

- The electrification will take place gradually but has very big impact - evolutionary transition with radical changes
  - Low-cost electricity is the source of wealth
  - The price of hydrogen is directly dependent of the price of electricity
  - There will be no common electricity price neither hydrogen price
  - Vast investments to infrastructure (grid, etc.) will be needed
    - Due to small demand of direct hydrogen it is of utmost importance to analyze the right infrastructure set-up. CO2 pipeline is one new element.
    - Does the industry relocate near to source of electricity before infrastructure is in place?
- Energy system will become highly complex, but system stability and resilience will improve
  - Industrial relocation near to cheap electricity production and sector coupling will take place
  - Production of electricity integrates to industries
  - Balancing of the system requires different storage and demand response options, as well as functioning energy market

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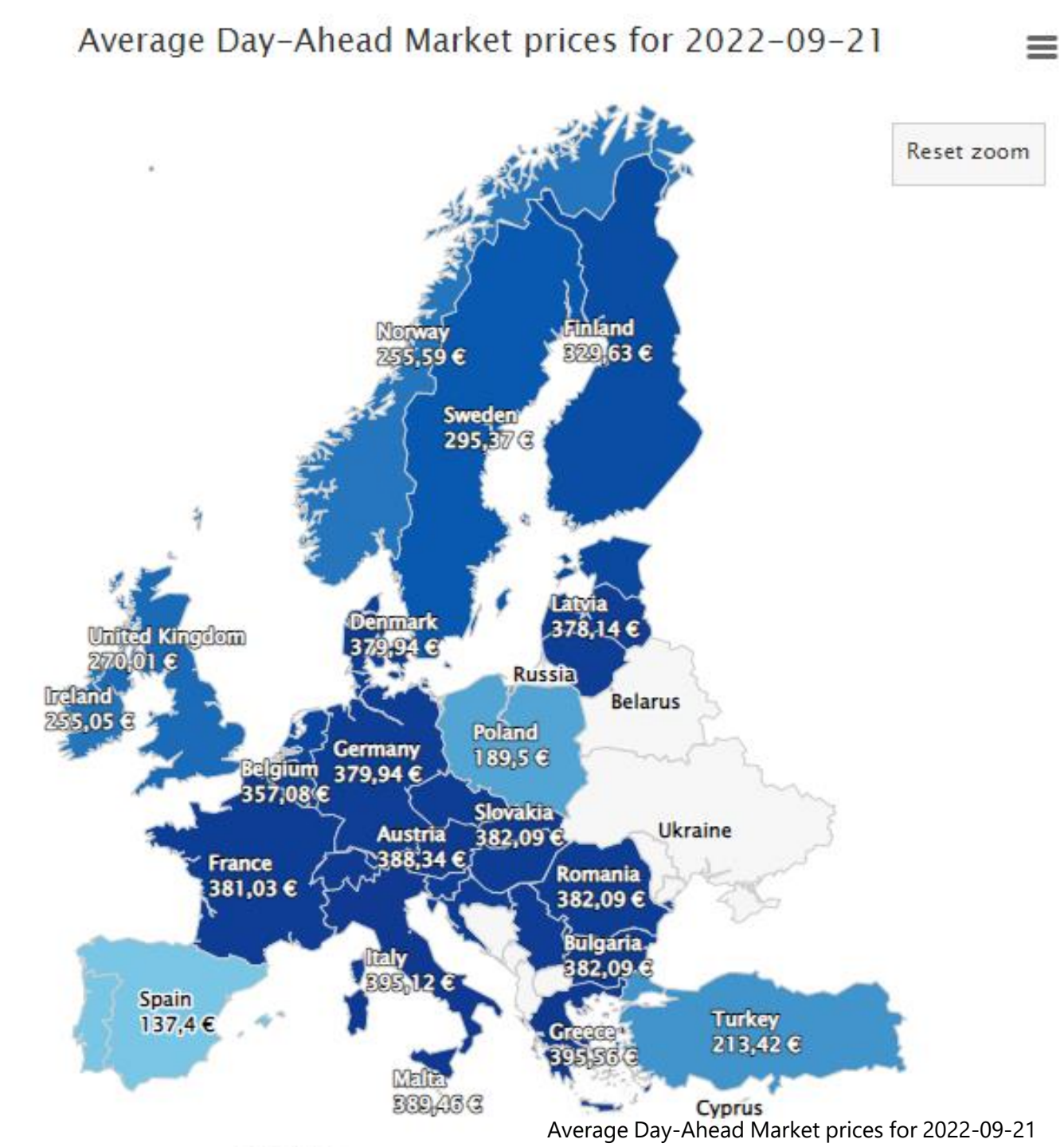
THE ROLE OF NORDIC COUNTRIES IN EUROPE



Average Day-Ahead Market prices for 2022-09-21

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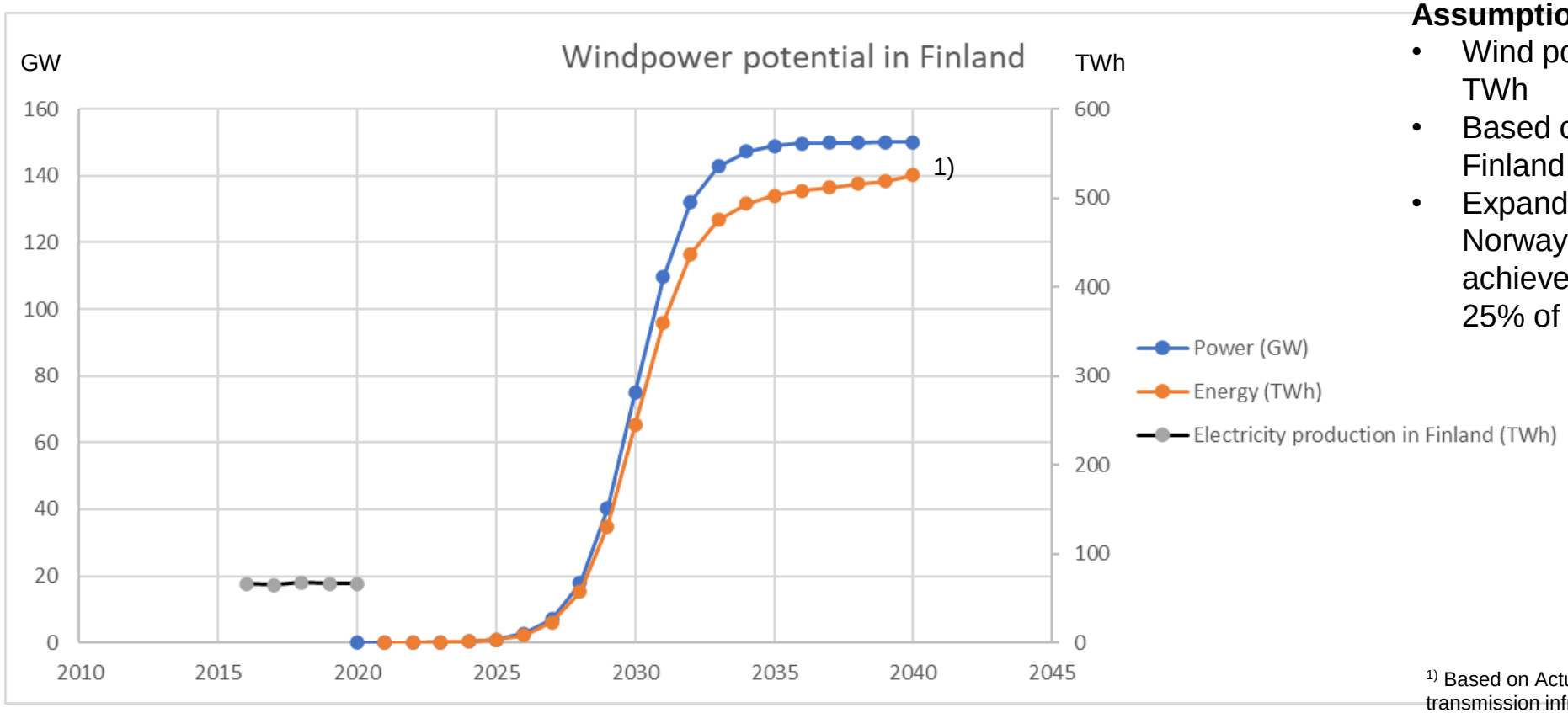
POTENTIAL OF GREEN ELECTRICITY PRODUCTION



Assumptions

- Wind potential in Finland is about 550 TWh
- Based on the research, solar potential in Finland is 10-100% of the wind potential
- Expanding the potential to Sweden and Norway potential of wind and solar could achieve 2150 – 3900 TWh covering about 25% of the European electricity demand

[1] Based on Actual Grid Connection Request in Finland. Source: Energy transmission infrastructure as enabler of hydrogen economy and clean energy system. Initial results from Fingrid and Gasgrid Finland's joint project, 15 March 2022

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OLD INDUSTRIES ARE CONVERTING PROCESSES AND NEW INDUSTRIAL INVESTMENTS NEAR ELECTRICITY PRODUCTION HAVE BEEN ALREADY ANNOUNCED

- SSAB & Vattenfall Green steel in (Sweden)
- H2 Green Steel, Green steel (Sweden)
- Grupo Fertiberia Green Fertilizers (Sweden, Norrbotten)
- St1 & Horisont Energi to collaborate on green ammonia production in Finnmark (Norway)
- St1 P2 Methanol in Lappeenranta (Finland)
- St1 & Vattenfall, Aviation fuel (Sweden)
- Elomatic & Flexens, Green NortH2, Green Ammonia (Finland)
- Ovako recycled steel to green steel (Finland)

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REPowerEU

Affordable, secure and sustainable energy for Europe –

Are actions (regulation, taxation and research agenda) in sync with the intention?

REPowerEU – Some observations

- **Case: REDII directive**
  - Has been prepared since 2018
  - Was put into force in summer 2021 despite of great known flaws
  - Unnecessary regulation of markets – slowing down investments and dismissing GHG emission reduction targets
- **Case: EU Hydrogen Valleys**
  - Firms are far ahead of the research initiatives. Research agenda is lagging behind.
- **Case: Electricity taxation for industry and consumers**
  - High consumer electricity taxation reduces investments to heat pumps with simultaneous subsidies on natural gas


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Thank you!


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