THE NEO-CARBON ENERGY PROJECT

Christian Breyer, professor for Solar Economy
The Neo-Carbon Energy Project
Espoo, October 4, 2018

Final report on the project

Project key figues:

- topic: energy system fully based on renewables
- 4 years: 2014-2017
- budget in total 10 m€
- 3 Finnish Research Partners (VTT, LUT, FFRC)
- Partners: 15 industrial, 3 NGOs, 5 international
- 2 Start-up companies (Soletair, Solar Foods)
- 500,000 Twitter impressions
- 1000 media hits (80% international)
- 70+ scientific publications

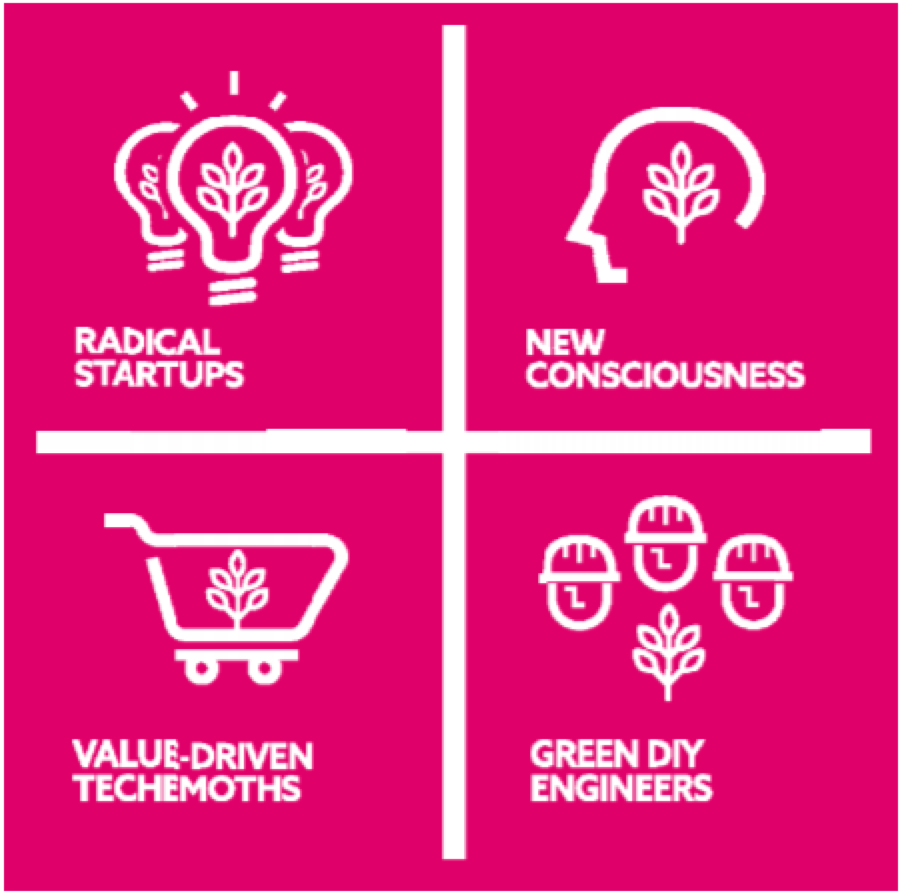
http://www.neocarbonenergy.fi/library/reports/

What is the Vision?

YouTube link

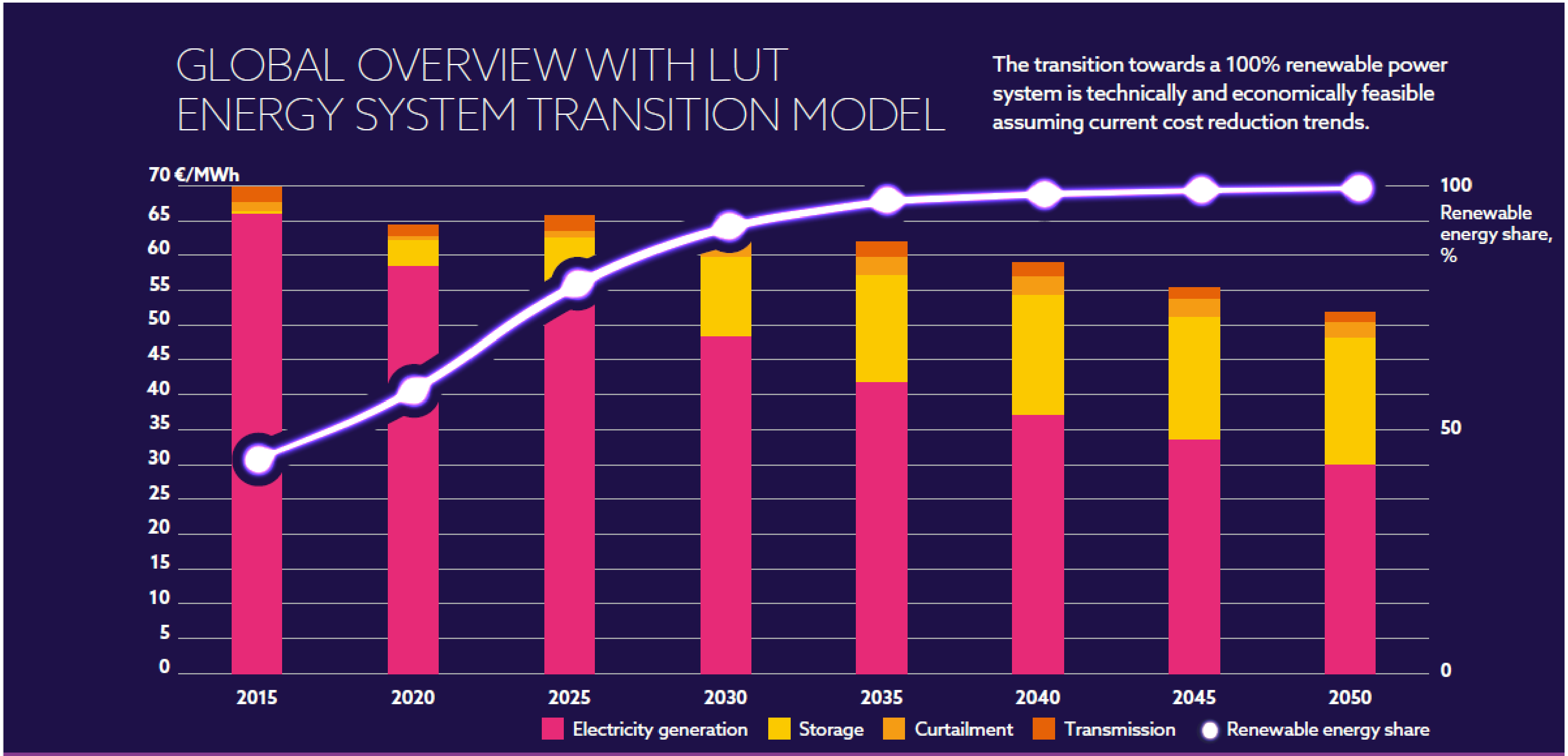
NEO CARBON ENERGY

What may be possible futures?



- Holistic, transdisciplinary and whole-of-society perspective on energy system.
- Focus on possible societal disruptions and transformations enabled and fostered by the renewable energy system.
- The main objective: characterise possible socio-economic futures related to neo-carbon energy system.
- What kinds of societal – economic, cultural, political and lifestylesrelated – changes does the neocarbon energy system promote and enable?
- Four transformative scenarios 2050

Energy System View



COST OF ELECTRICITY IN 2015: 70 €/MWh
FOR FOSSIL BASED POWER SYSTEM

COST OF ELECTRICITY IN 2050: 52 €/MWh
FOR SUSTAINABLE POWER SYSTEM

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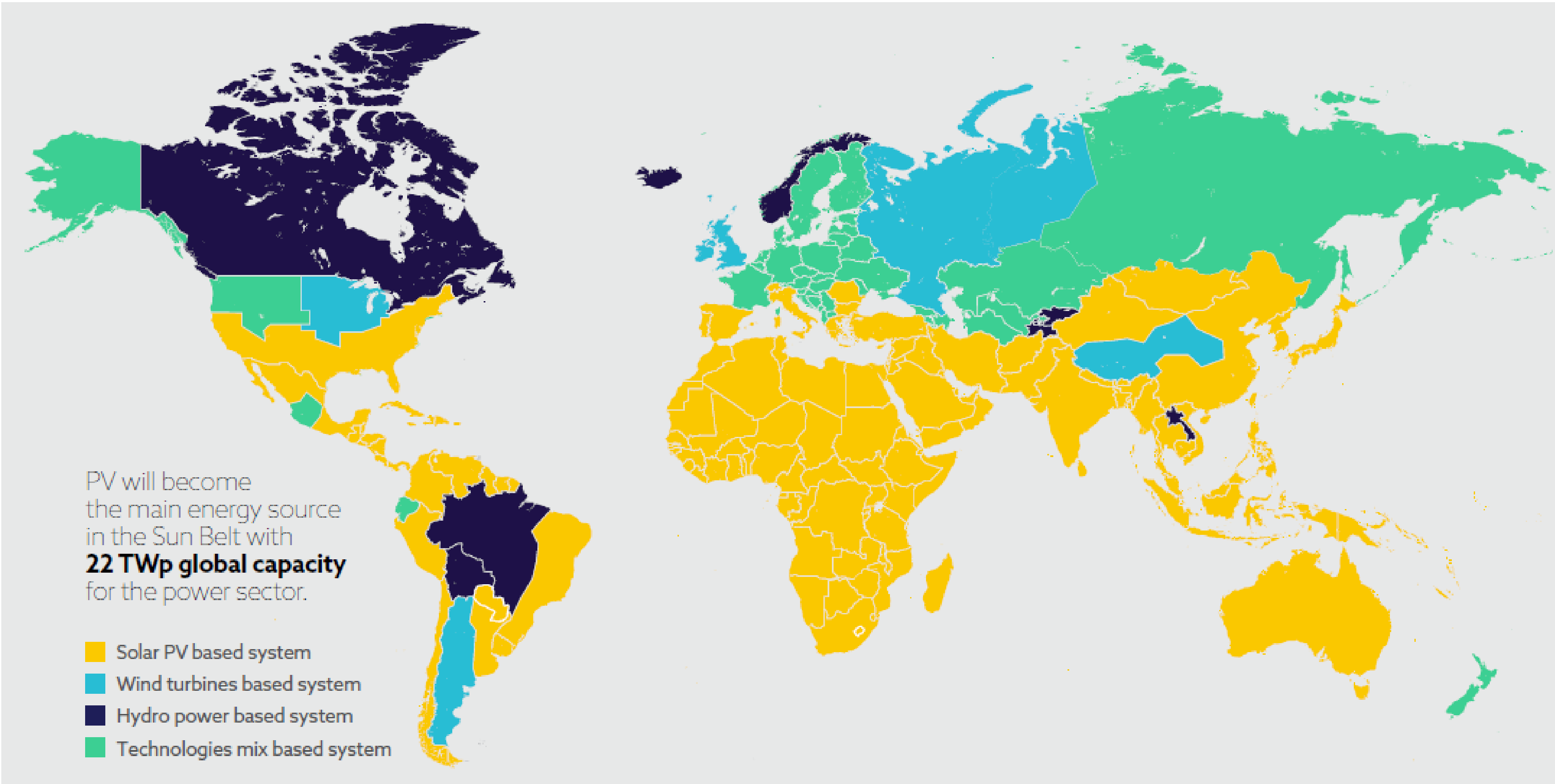
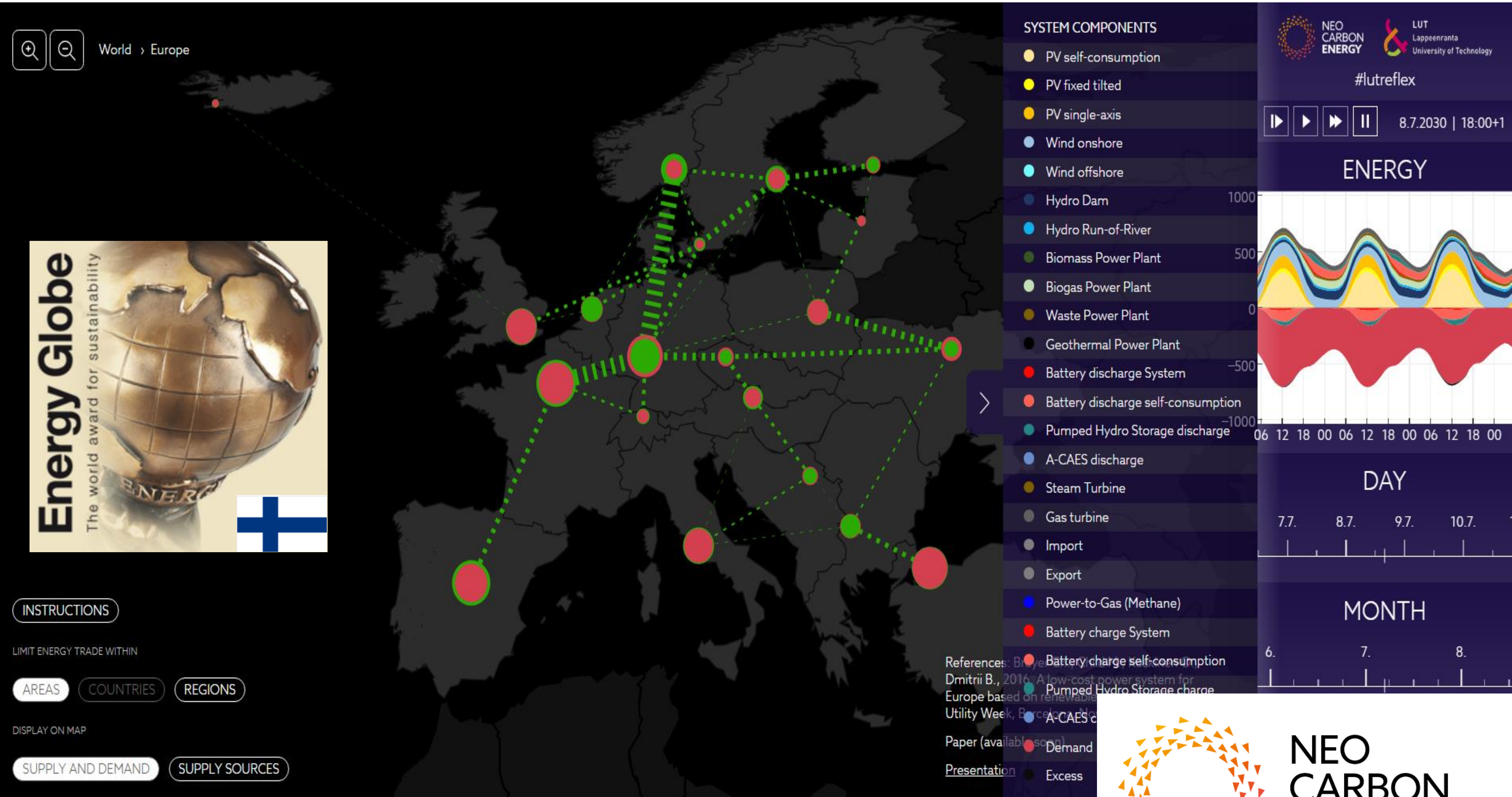
Energy System View



Impact: Energy Globe Award

Global Internet of Energy: http://neocarbonenergy.fi/internetofenergy/#



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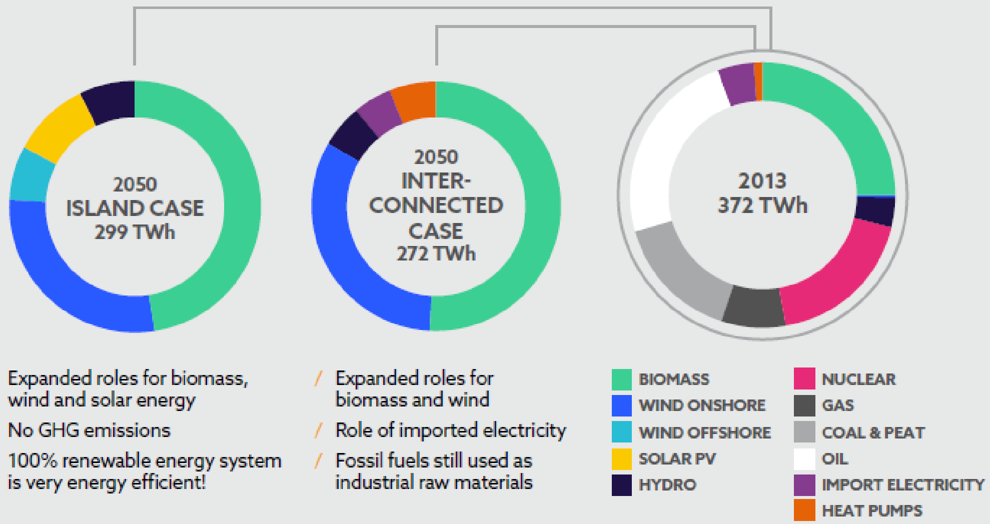
Results for the Nordic

ENERGY CONSUMPTION

Conclusion:
Hourly energy demands can be met by 100% renewable energy

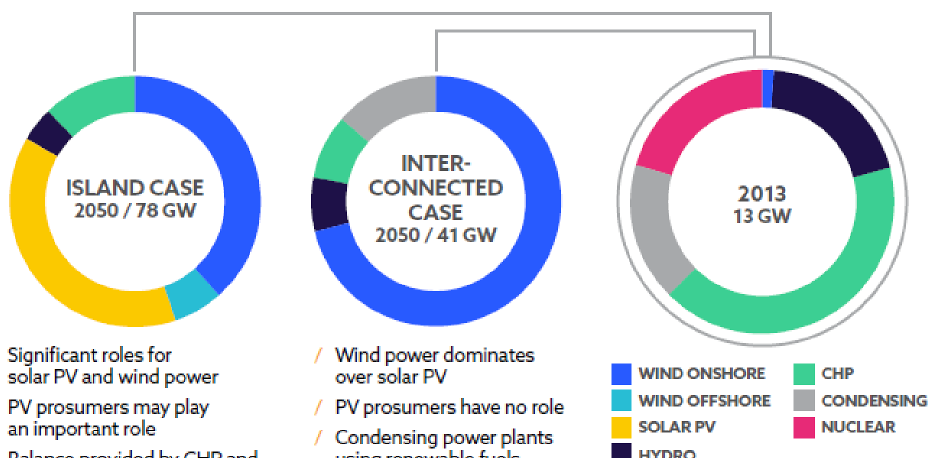


2050 Island case:
- Expanded roles for biomass, wind and solar energy
- No GHG emissions
- 100% renewable energy system is very energy efficient!

2050 Inter-connected case:
- Expanded roles for biomass and wind
- Role of imported electricity
- Fossil fuels still used as industrial raw materials

INSTALLED CAPACITIES

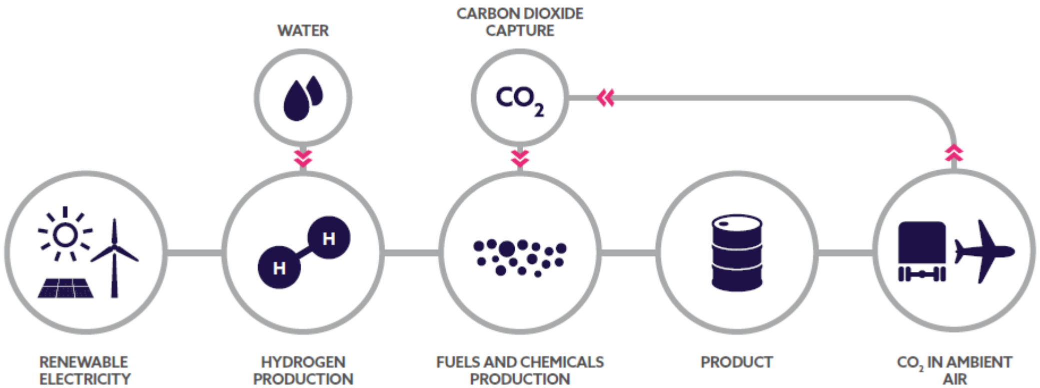
Conclusion:
Wind and solar are important future resources



Island case:
- Significant roles for solar PV and wind power
- PV prosumers may play an important role
- Balance provided by CHP and condensing power plants utilising biomass and sustainable gas
- Hydro retains important role

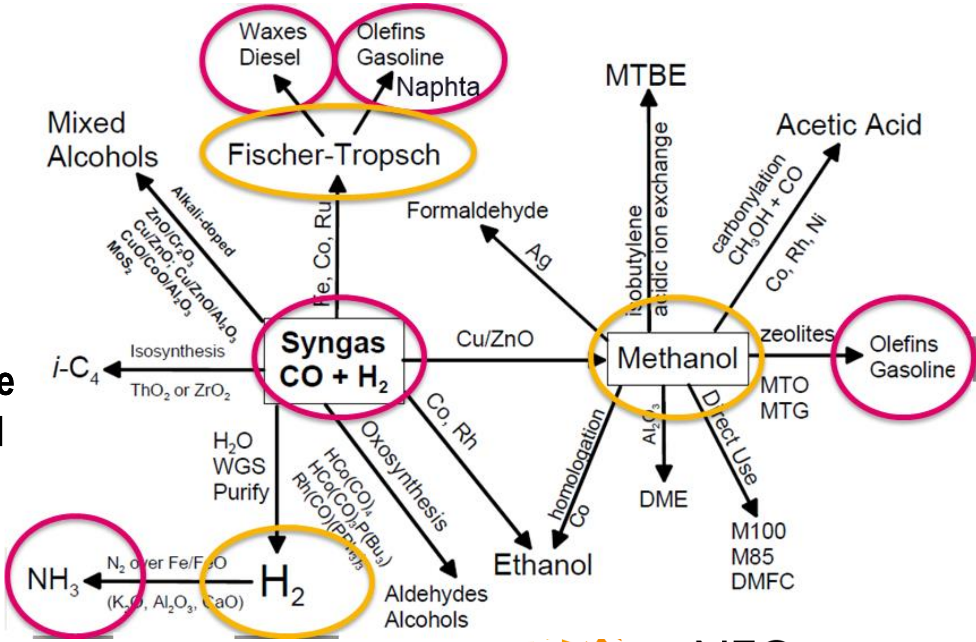
Inter-connected case:
- Wind power dominates over solar PV
- PV prosumers have no role
- Condensing power plants using renewable fuels provide additional flexibility

Hyrdocarbons in future

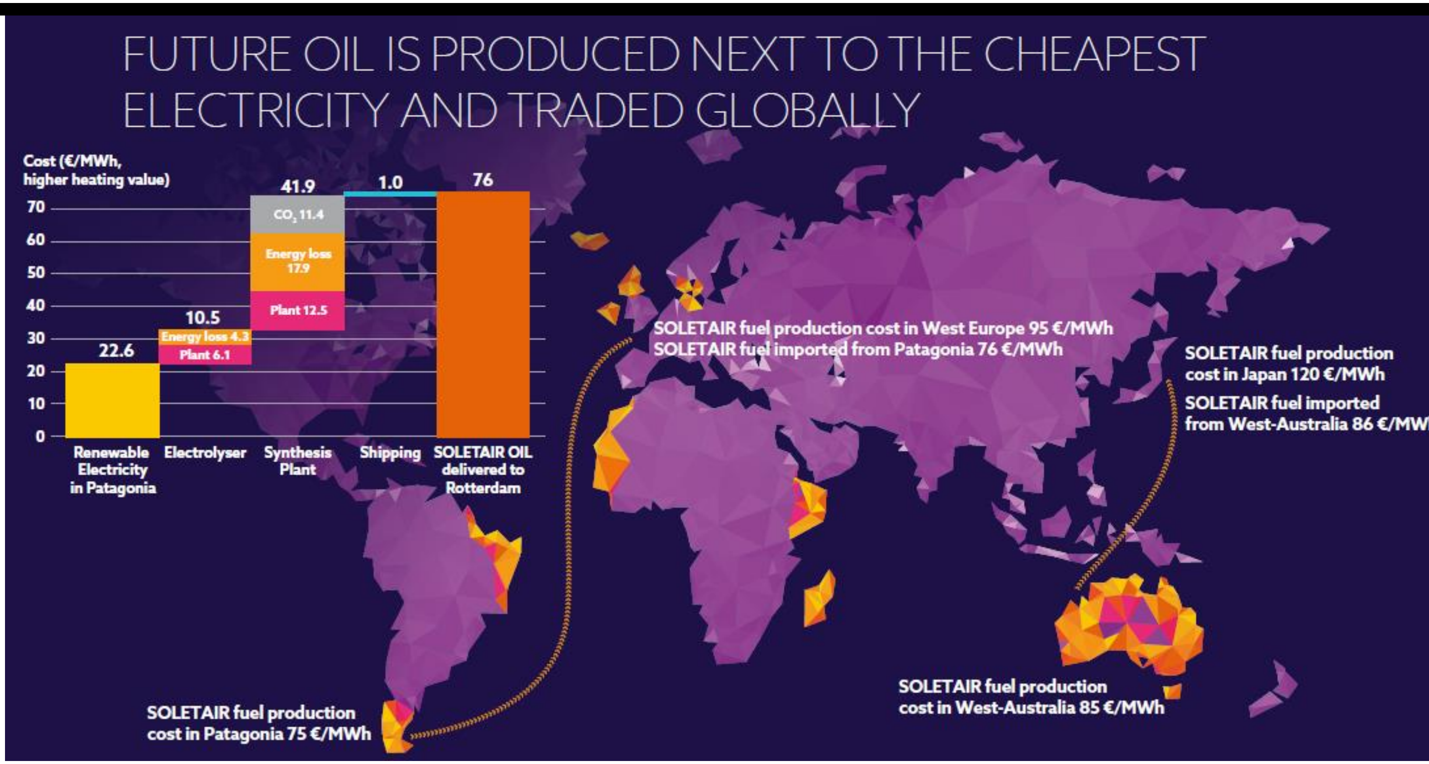


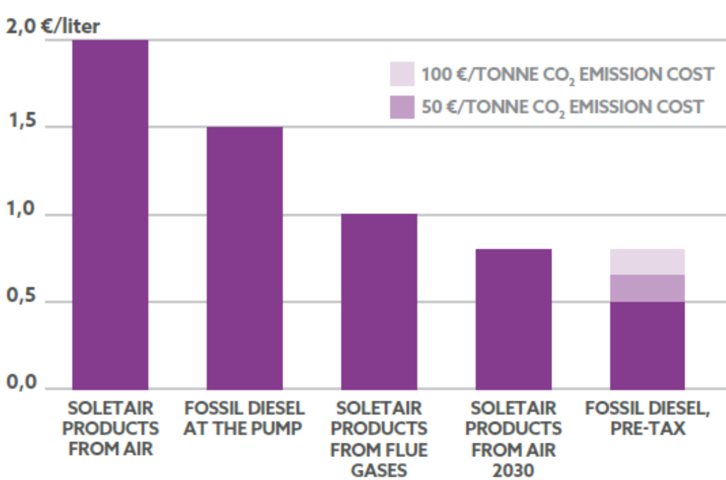
Key insights:

- PtX enables sustainable production of hydrocarbons
- Inredients: electricity, water, air
- w/o PtX COP21 agreement would be wishful thinking
- Profitability from 2020s/ 2030s onwards
- Global hydrocarbon downstream infrastructure usable
- Most difficult sectors to decarbonise can be managed with PtX (aviation, marine, chemistry, metals, etc.)
- CO_2 direct air capture is part of PtX



Electricity based fuels





FUELS FROM CO_2 ARE BECOMING COMPETITIVE

The cost estimates for producing SOLETAIR liquid fuels are around $170/bbl (0.80 €/l) between 2030 and 2040 if produced in a favourable location, for example in Patagonia. Such prices were reached for fossil crude oil in 2008.

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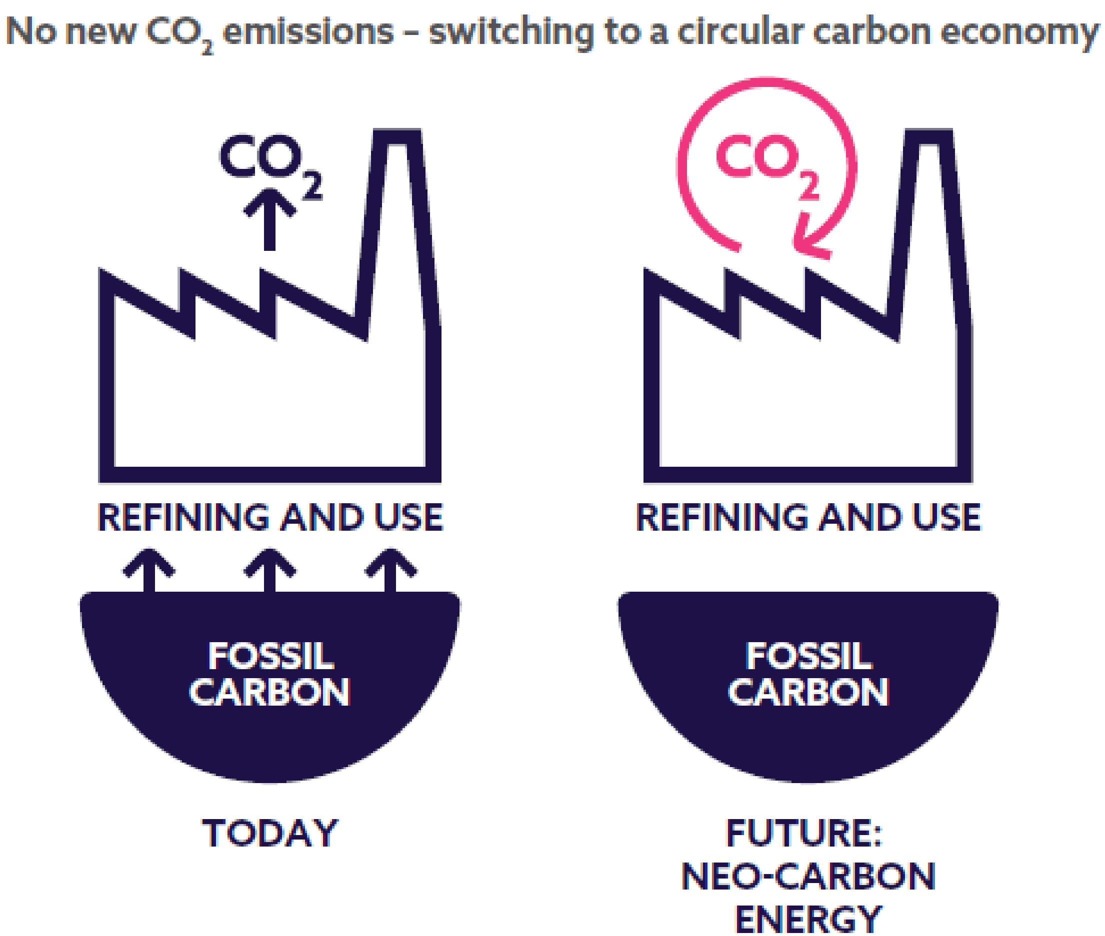
CO_2 in a circular carbon economy



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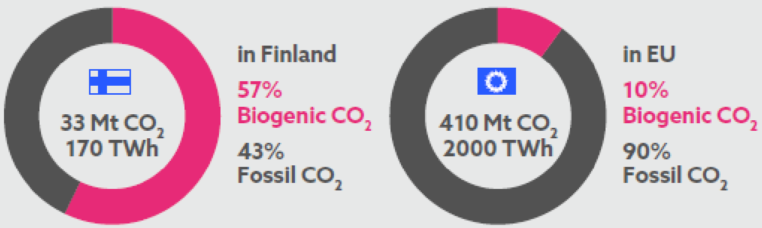
How to source CO_2 in future

CO_2 can be captured from large point sources such as pulp mills.

Mapping of large CO_2 sources in Finland revealed that 57% of CO_2 emitted is from wood combustion.



Biogenic CO_2 emissions from stationary sources and the potential of CO_2 based fuels

POTENTIAL IN THE BALTIC SEA REGION

Pulp & Paper mills' wood-based CO_2 emissions as a source of carbon.

ANNUALLY:

40 MT CO_2

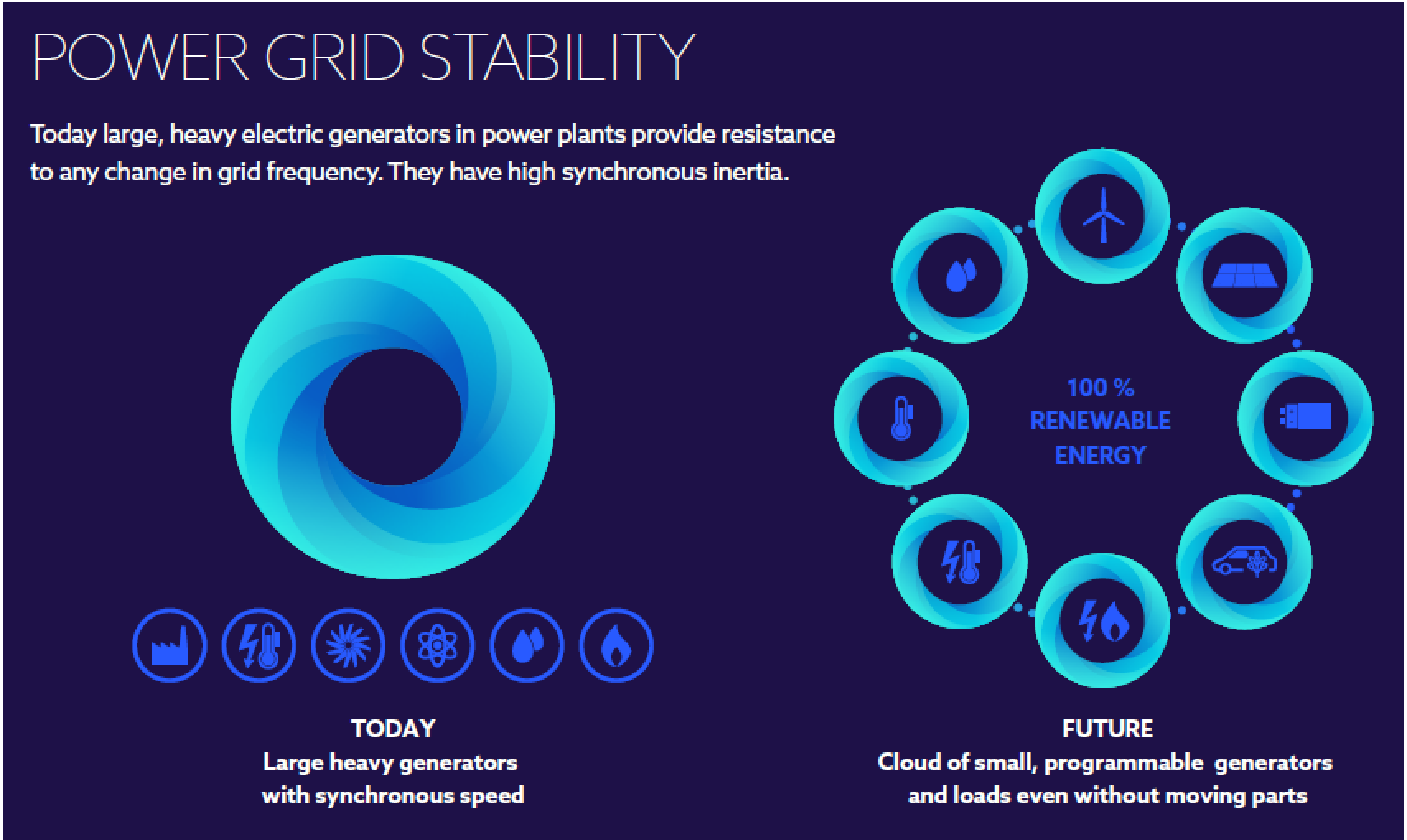
200 TWh

FUEL PRODUCTION POTENTIAL

Key insights:

- Sustainable CO_2 sources are limited (finally only biogenic, limestone part of cement mills and waste incinerators)
- CO_2 direct air capture will emerge to the main source of CO_2 as a raw material
- In addition CO_2 DAC is needed for negative CO_2 emissions to fulfill the Paris Agreement

Grid Stability in a 100% Renewable System



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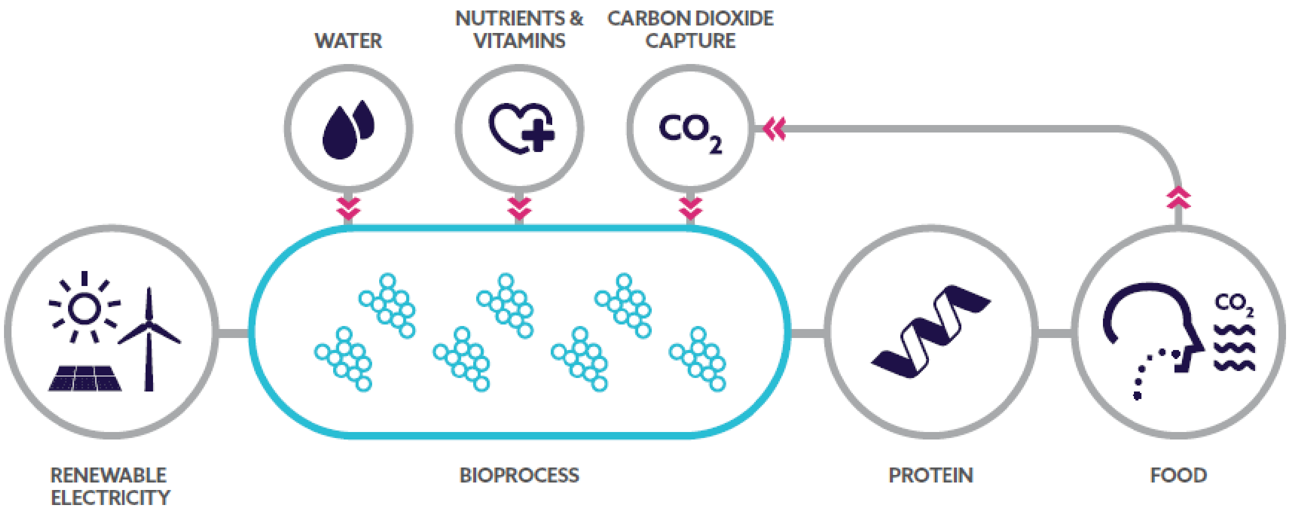
Food from Electricity

THE PRINCIPLE

Neo-Carbon Food is a microbial process. Protein production takes place in a reactor suitable for microorganisms to grow and divide. The energy of the process is electricity, and carbon dioxide is the carbon source.



NEO-CARBON FOOD PRODUCTION REQUIRES **90% LESS LAND AREA** COMPARED TO CONVENTIONAL FOOD PRODUCTION.

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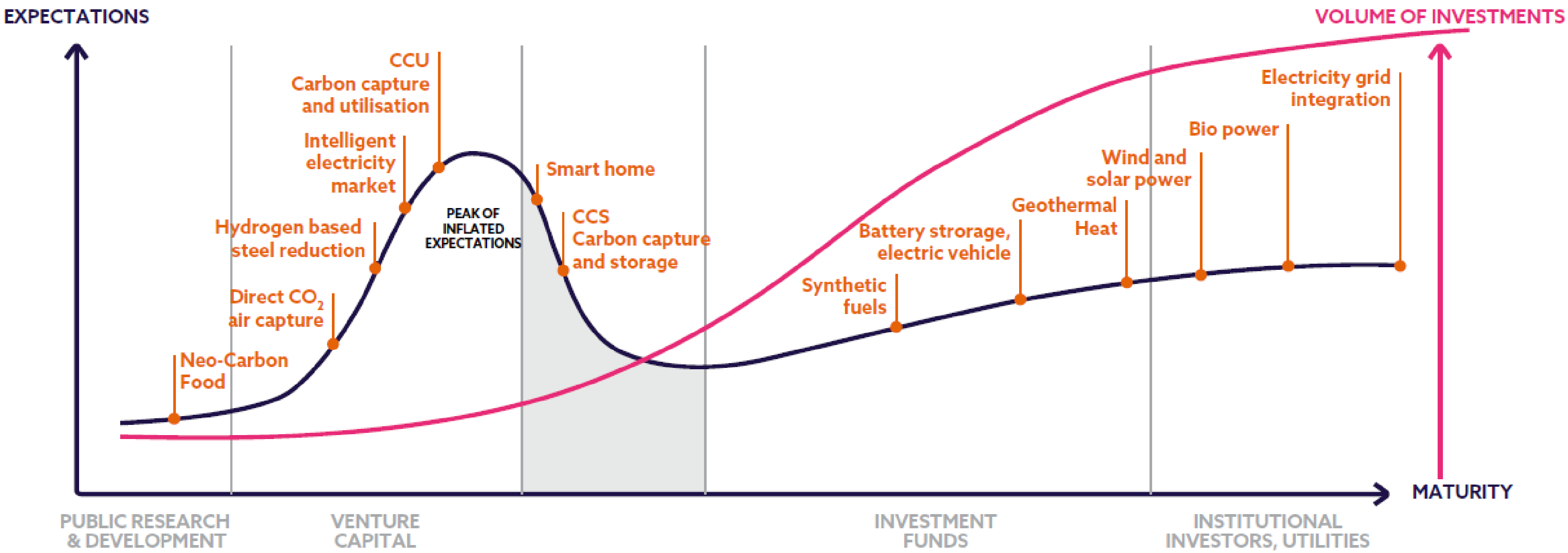
Investors' view on energy futures

INVESTORS' VIEW:
THE MISMATCH OF TECHNOLOGY
HYPE AND INVESTMENTS



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Final report on the project

Key insights:

- There are several possible energy futures
- 100% renewable energy is technically feasible and economically viable (Finland, Nordics, Europe, Global)
- Key components: solar PV, wind energy, battery, PtX (CCU)
- CO_2 direct air capture will be very important
- Food from electricity can resolve area limitations
- Investors are key for a successful transition

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Thank you for your attention …
… and to the team!

NEO CARBON ENERGY
TRUST IN RENEWABLE.

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all publications at: www.researchgate.net/profile/Christian_Breyer
new publications also announced via Twitter: @ChristianOnRE

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