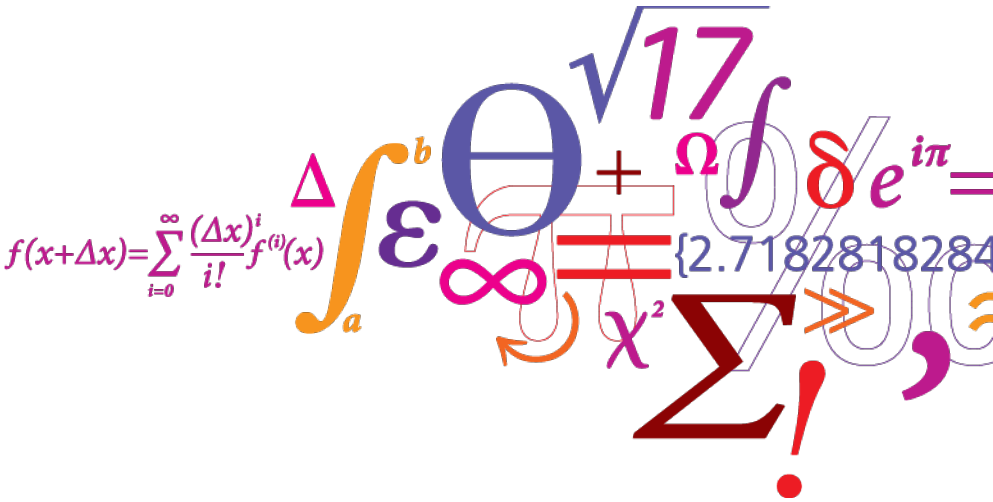
Current state of 2050 modelling - Scandinavia

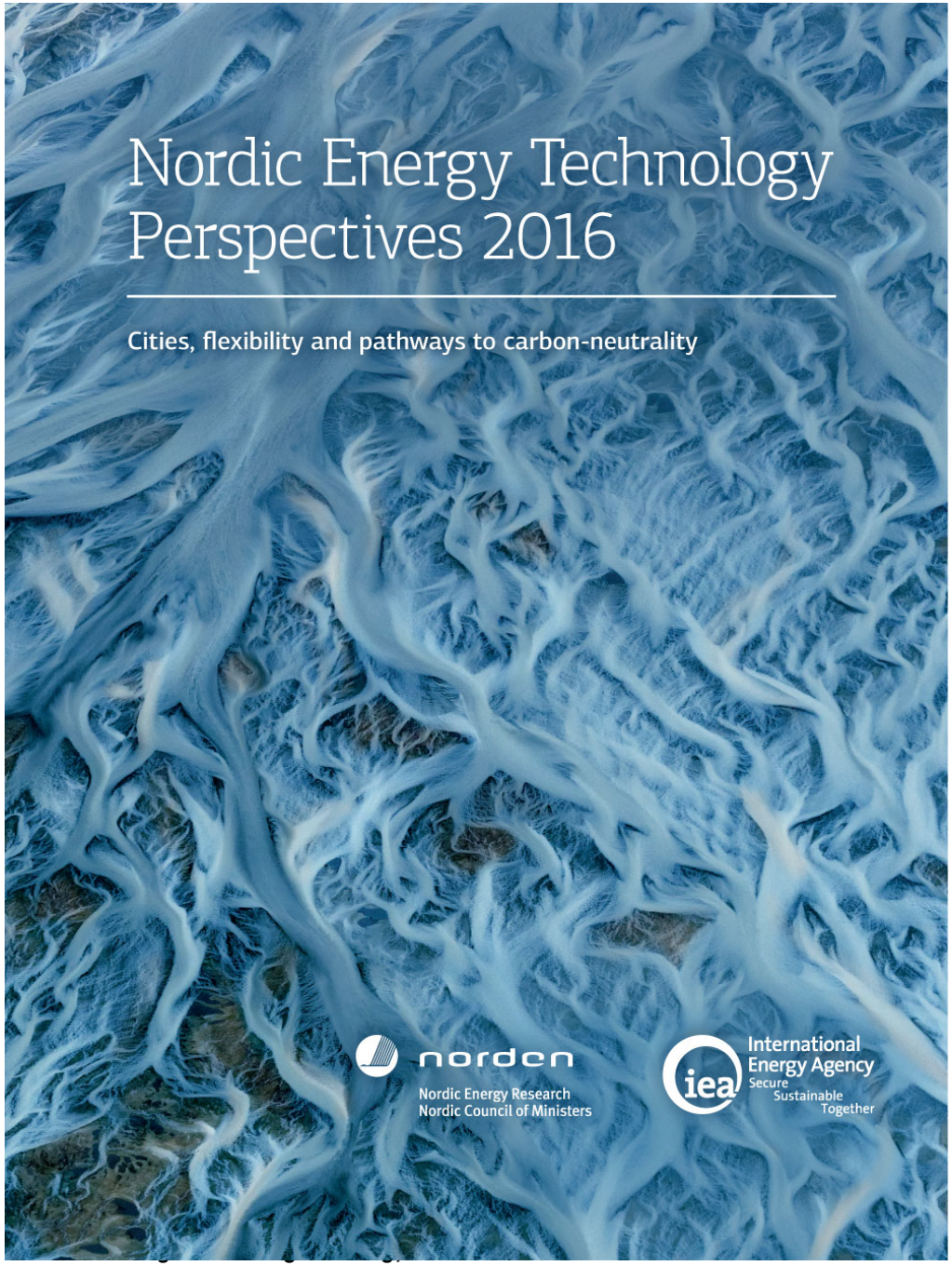
Professor WSR Marie Münster
Climate Recon
Copenhagen
27 Feb 2019



DTU Management Engineering
Institut for Systemer, Produktion og Ledelse

Outline

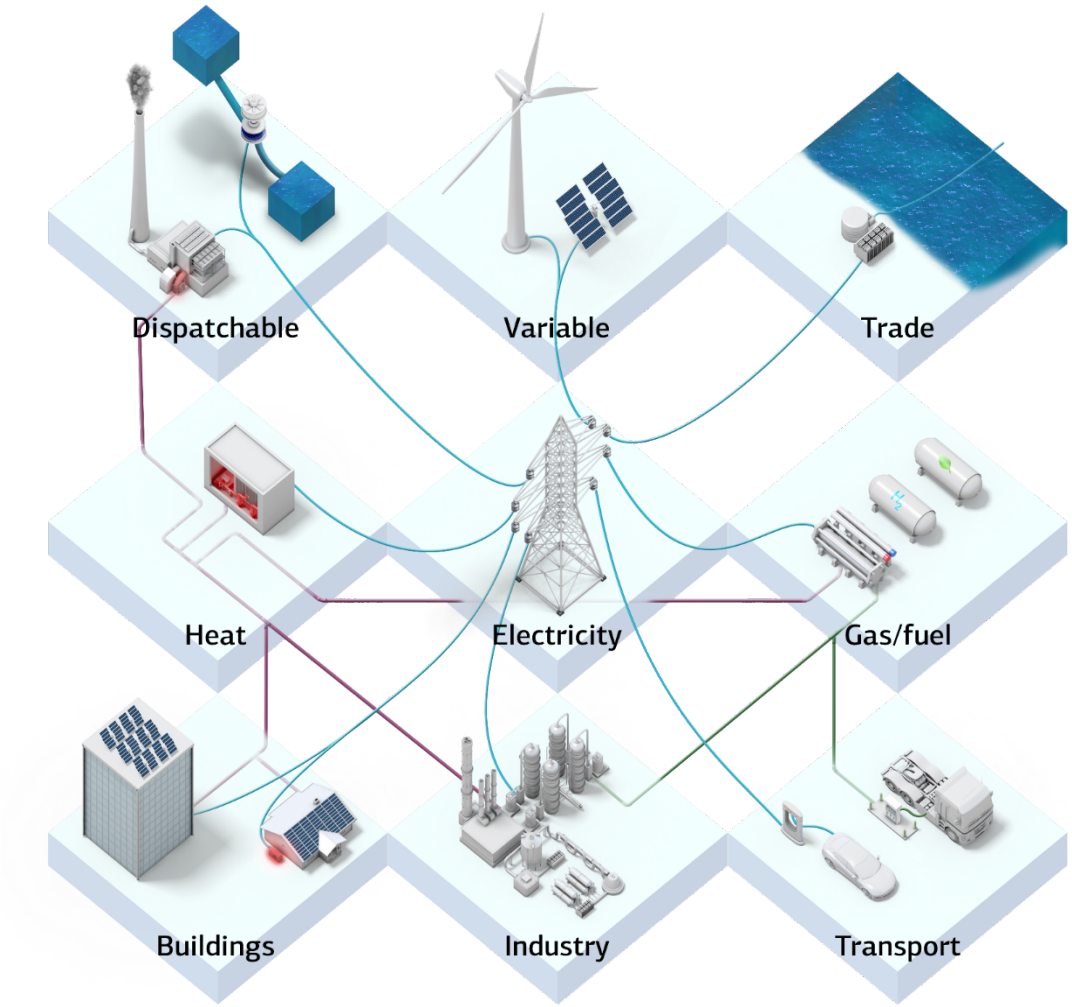
- Nordic ETP 2016
- Danish Energy Agency
- DTU scenario



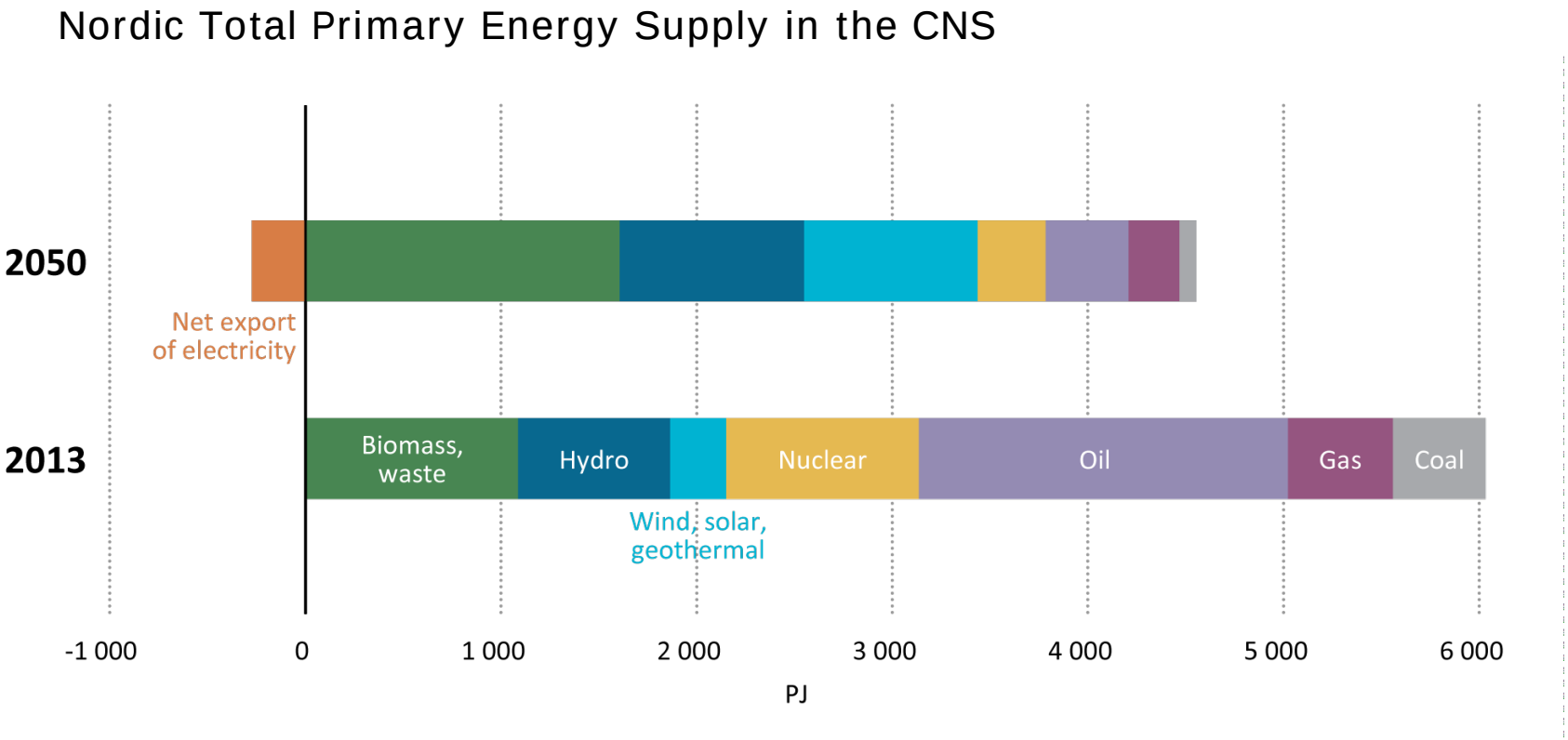
Presentation of key results

(Markus Wråke slides)

https://www.iea.org/etp/nordic/


Dispatchable
Variable
Trade
Heat
Electricity
Gas/fuel
Buildings
Industry
Transport

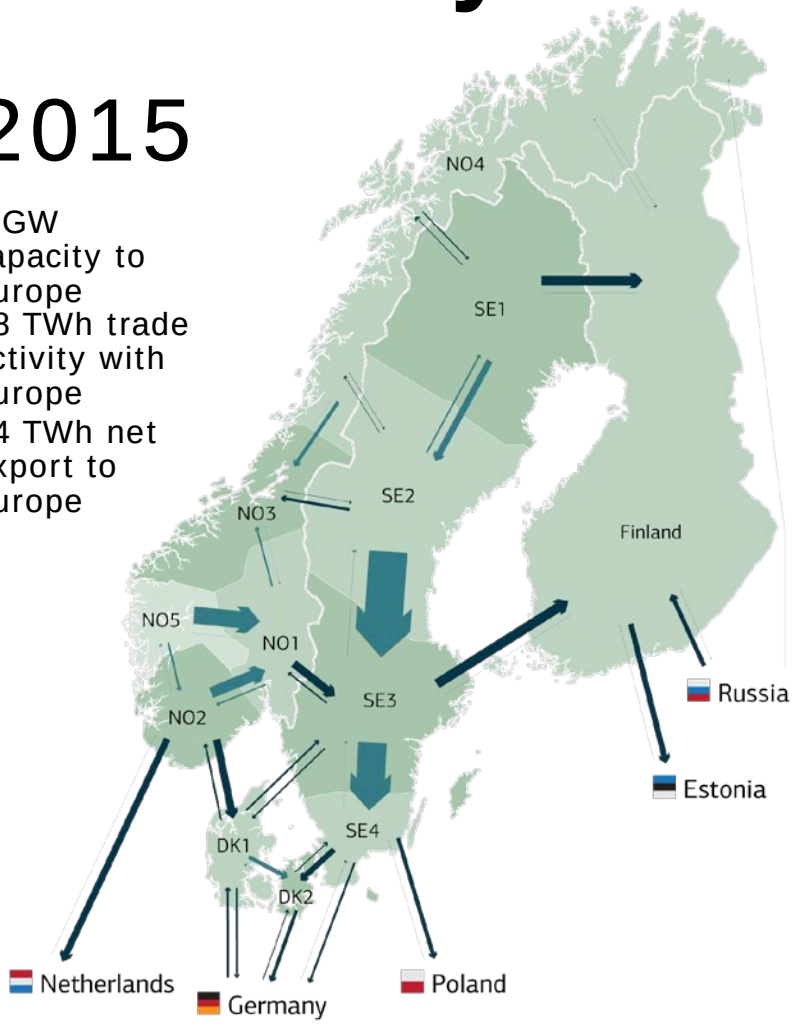
Transforming the energy system



Electricity trade

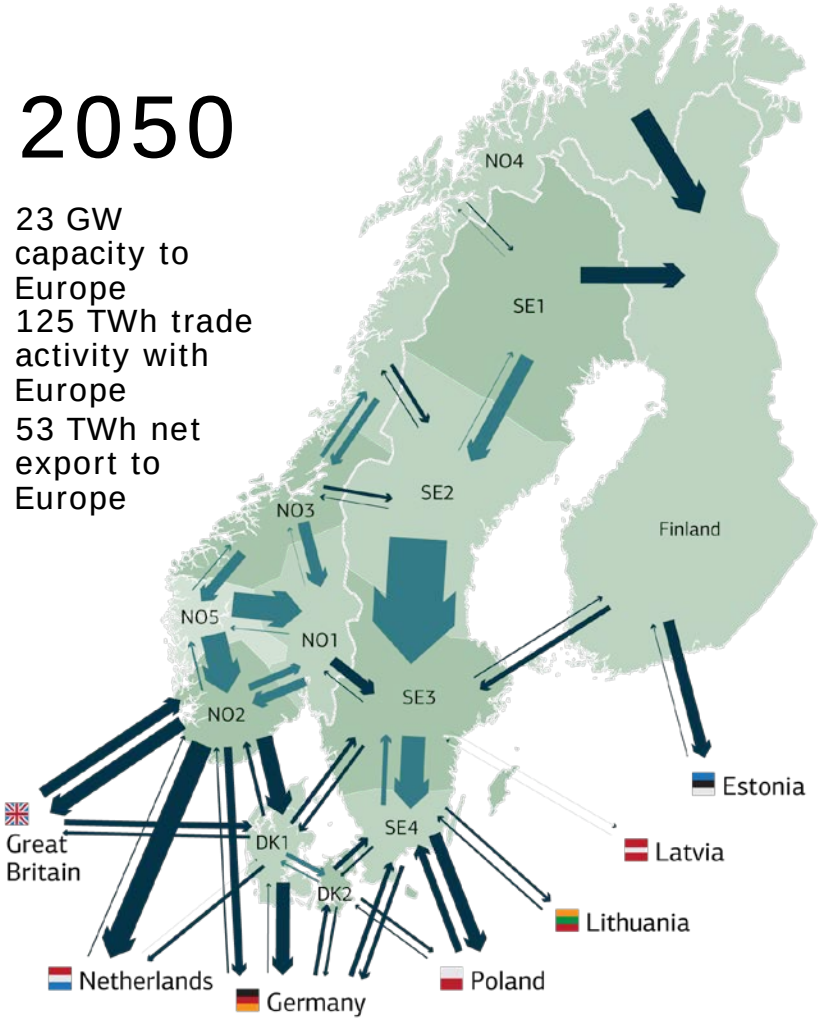
2015

5 GW capacity to Europe
28 TWh trade activity with Europe
14 TWh net export to Europe

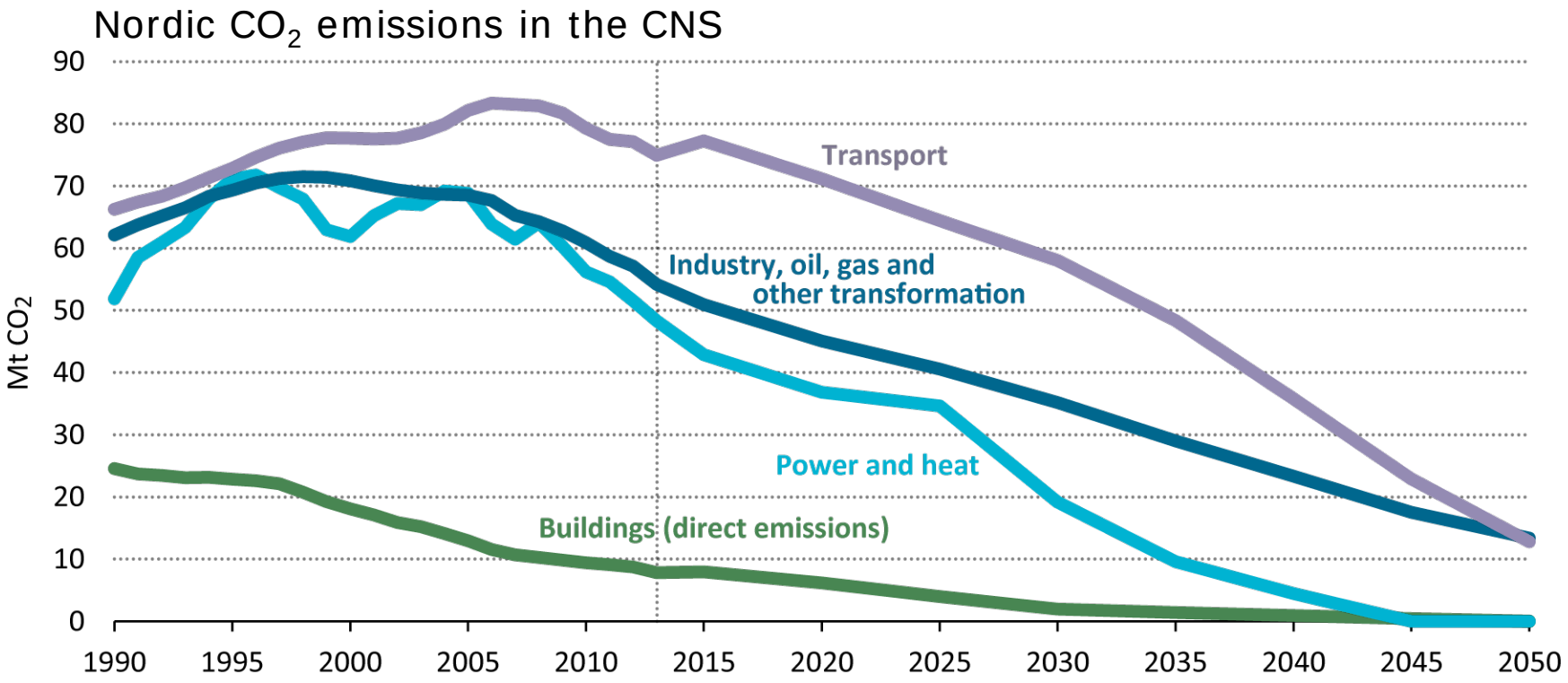


2050

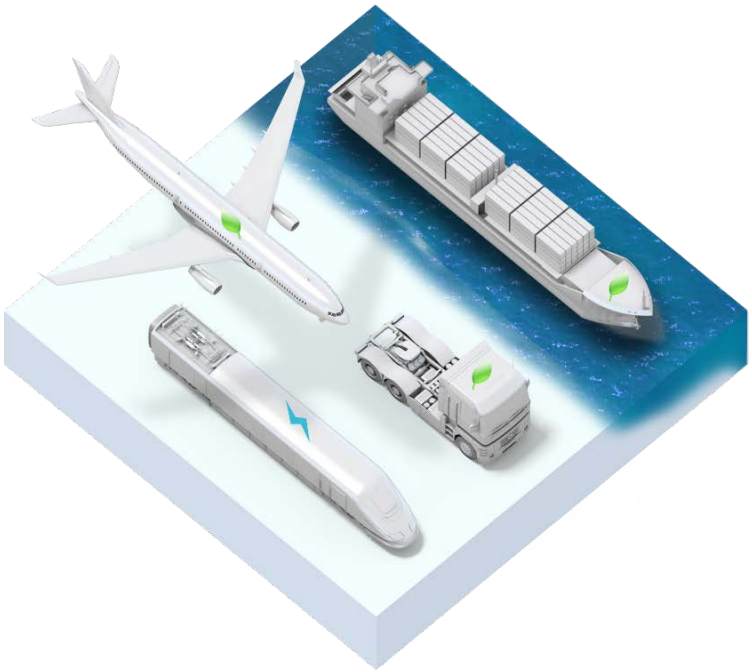
23 GW capacity to Europe
125 TWh trade activity with Europe
53 TWh net export to Europe

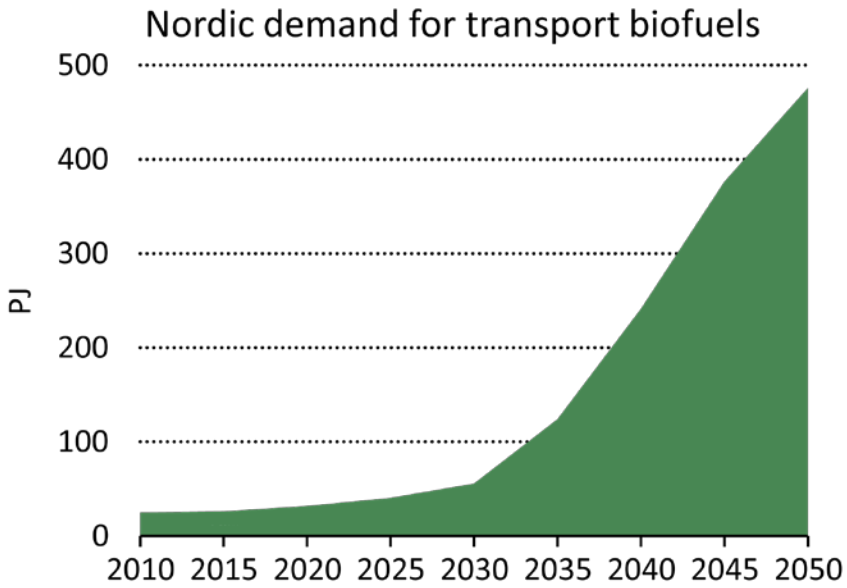


Demand sectors most challenging



Long-distance transport



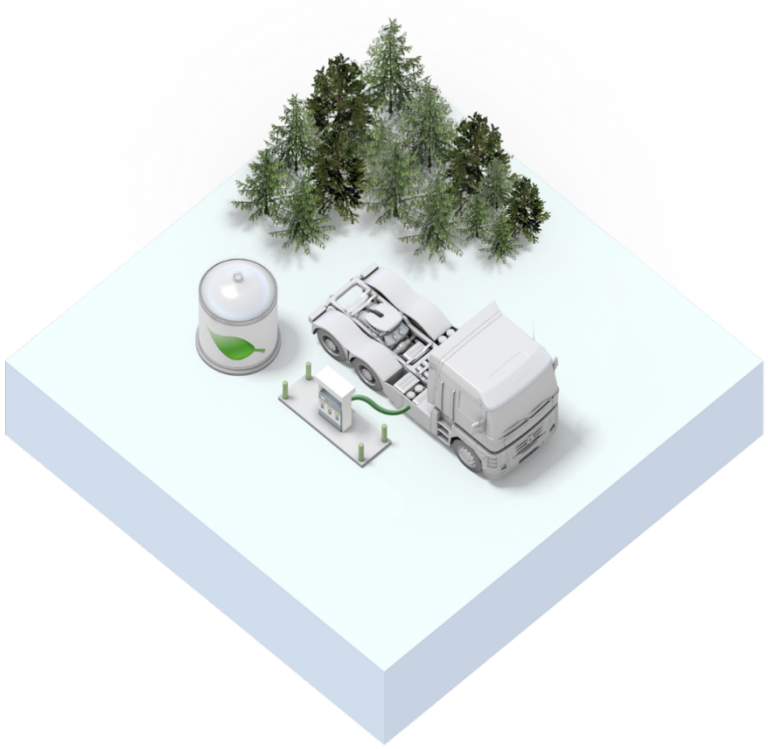


15%

import dependency

for biomass in 2050,

up from 8% in 2013



Three strategic actions

1. Incentivise and plan for a more **distributed, interconnected and flexible** energy system

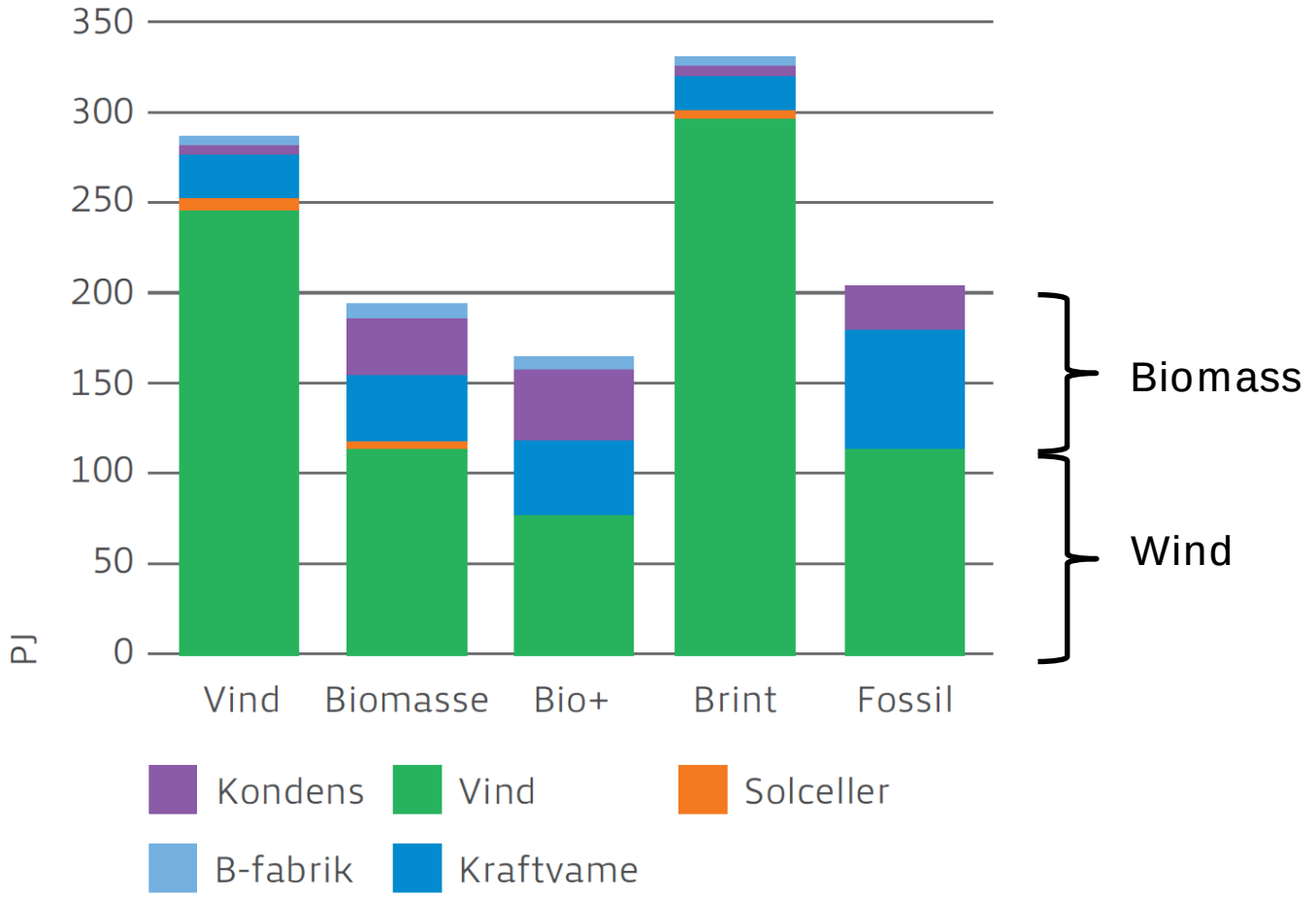
2. Tap into the positive momentum of cities in **transport and buildings**

3. Ramp up decarbonisation of **long-distance transport and the industrial sector**

DEA scenarios

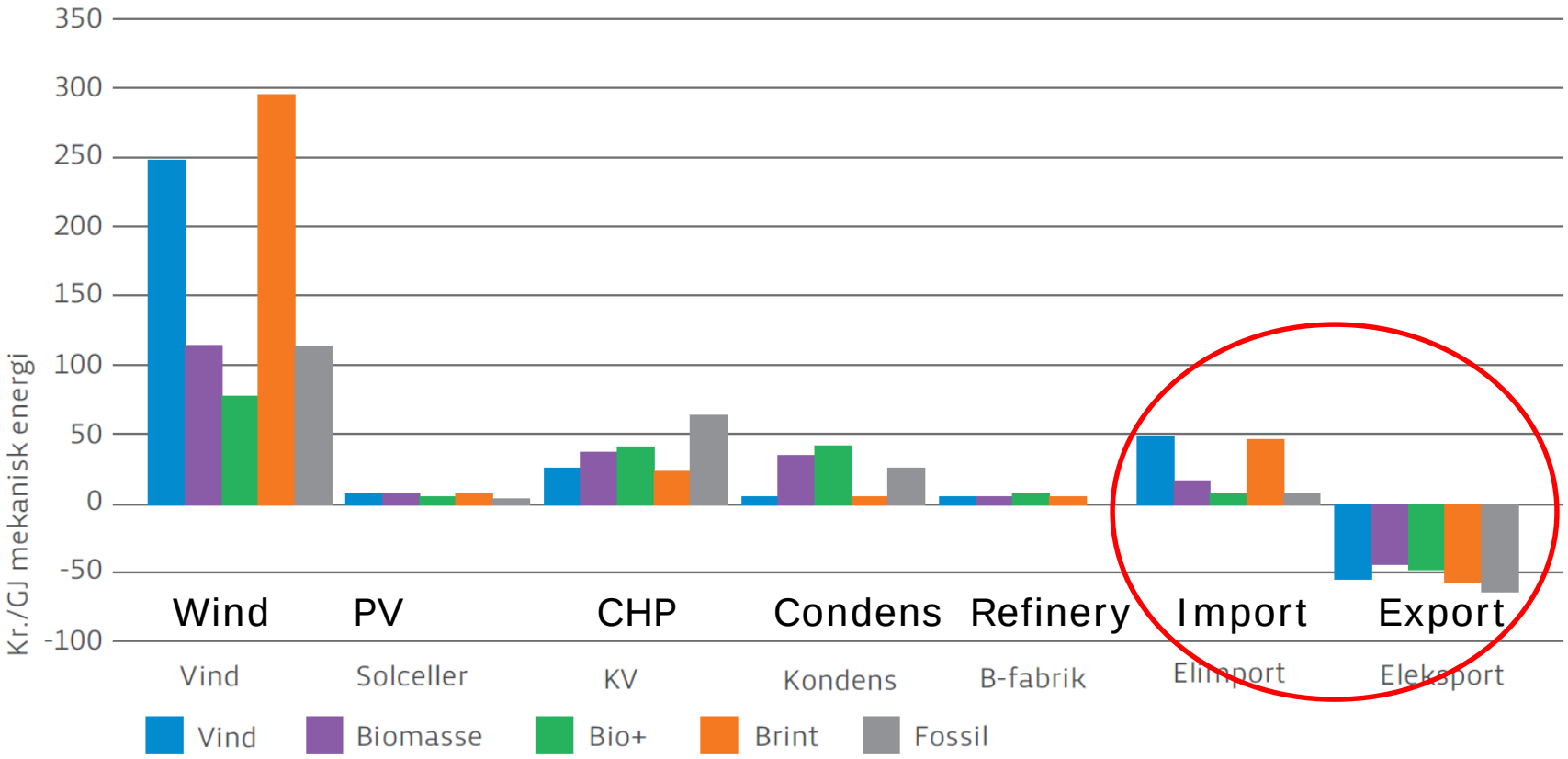
https://ens.dk/service/fremskrivninger-analyser-modeller/scenarieanalysen

Electricity production (DK 2050)



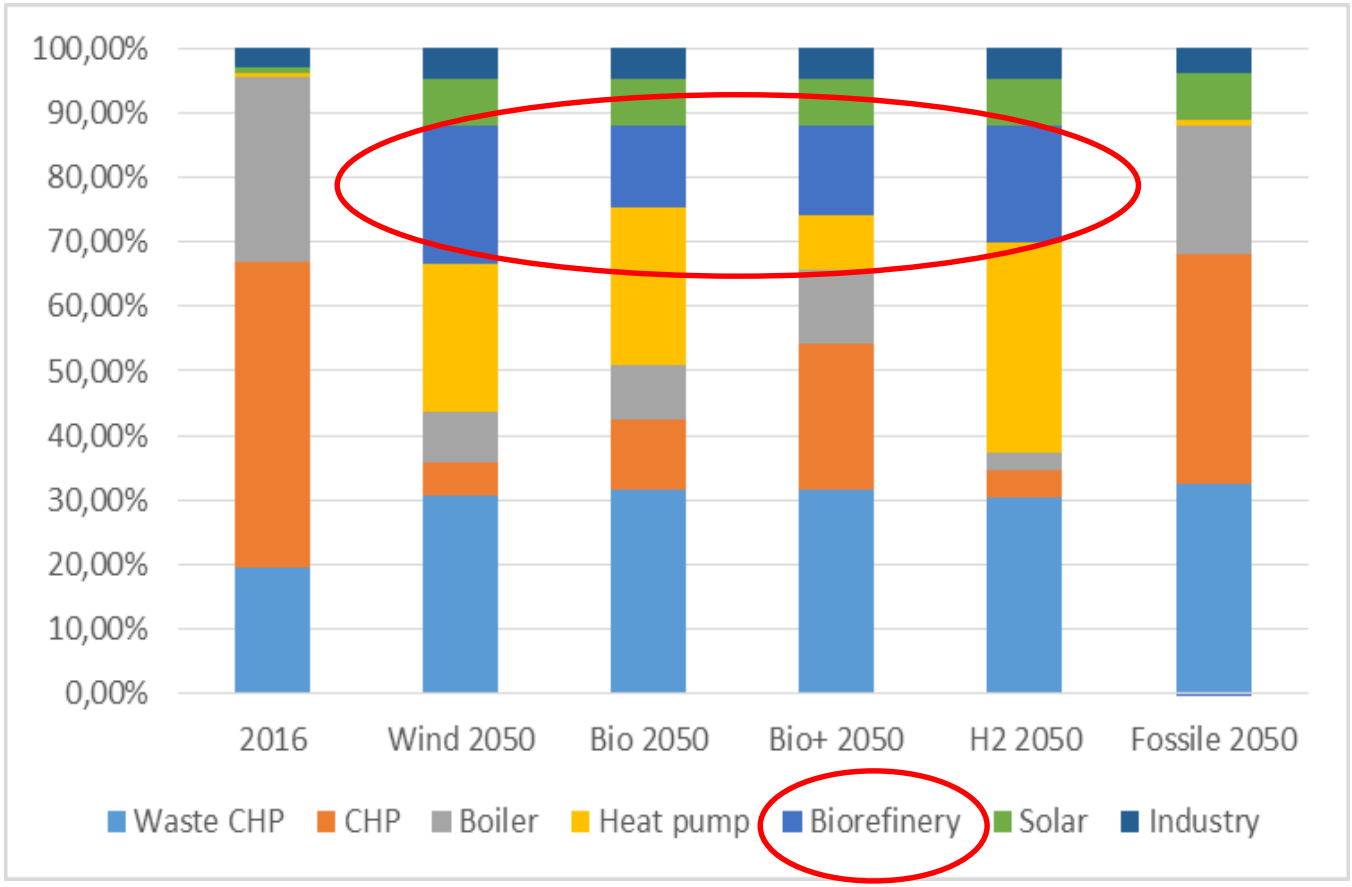
Energistyrelsen. Energiscenarier frem mod 2020, 2035 og 2050 . Marts 2014. ISBN: 978-87-93071-64-3

Electricity production and import/export



Figur 11.11. Elproduktionens sammensætning og elimport/eleksport i de fem scenarier. Grafisk illustration af tabel 11.5.

Danish district heating supply in 2050

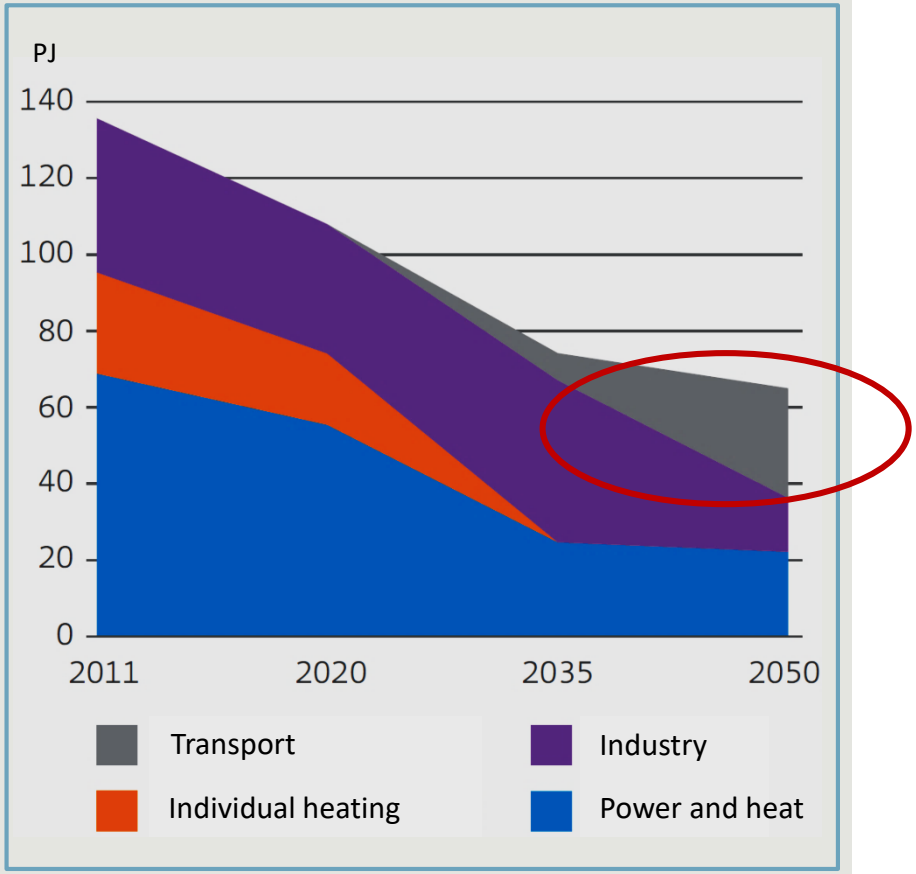


Danish Energy Agency. Energy scenarios towards 2020, 2035 and 2050 (in Danish). March 2014

Gas consumption 2011-2050

Danish Energy Agency – Wind scenario: Future development of the Danish gas consumption.

- Overall use of gas is declining
- Use of gas for individual heating is phased-out by 2035
- Use of gas for transportation is increasing
- By 2050, gas is used in the transport-, industry- and power & heat sector

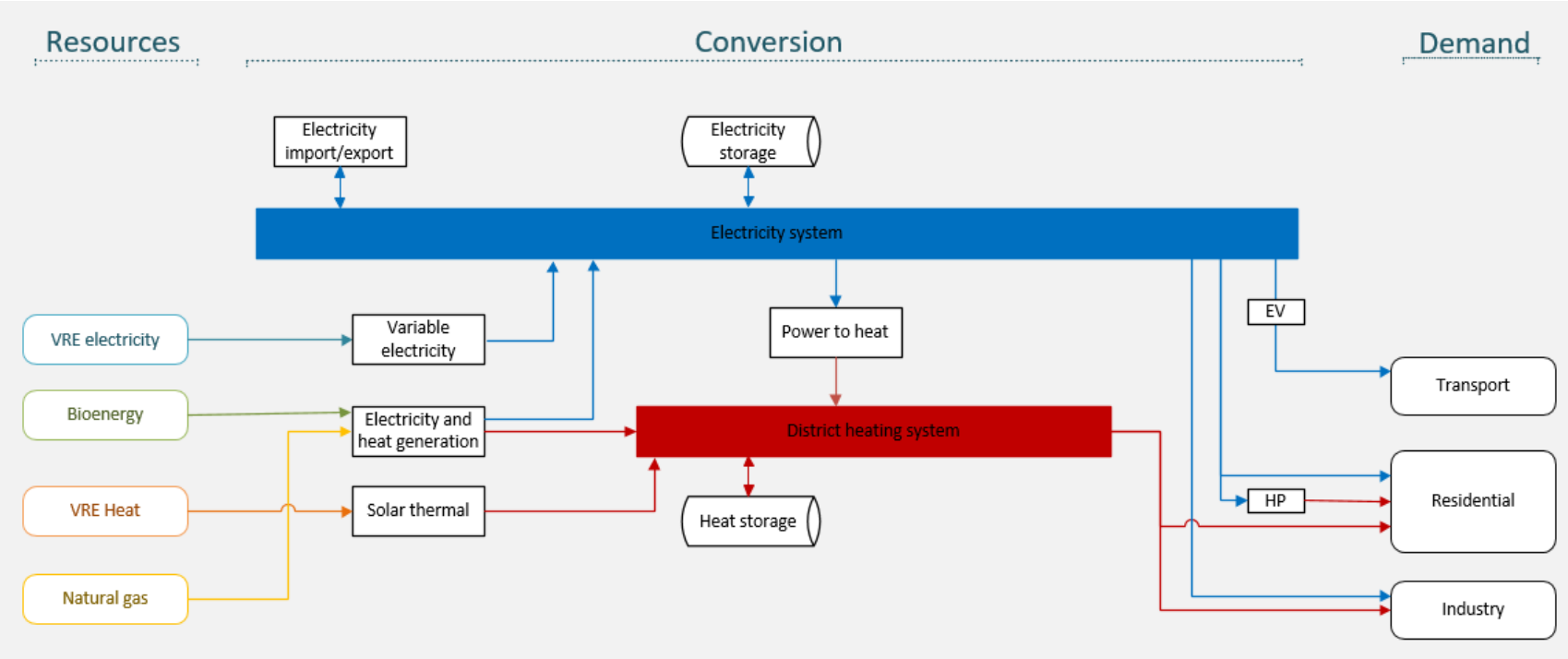


Source: Gasinfrastrukturen. Den fremtidige anvendelse af gasinfrastrukturen. (Danish Energy Agency, 2014)

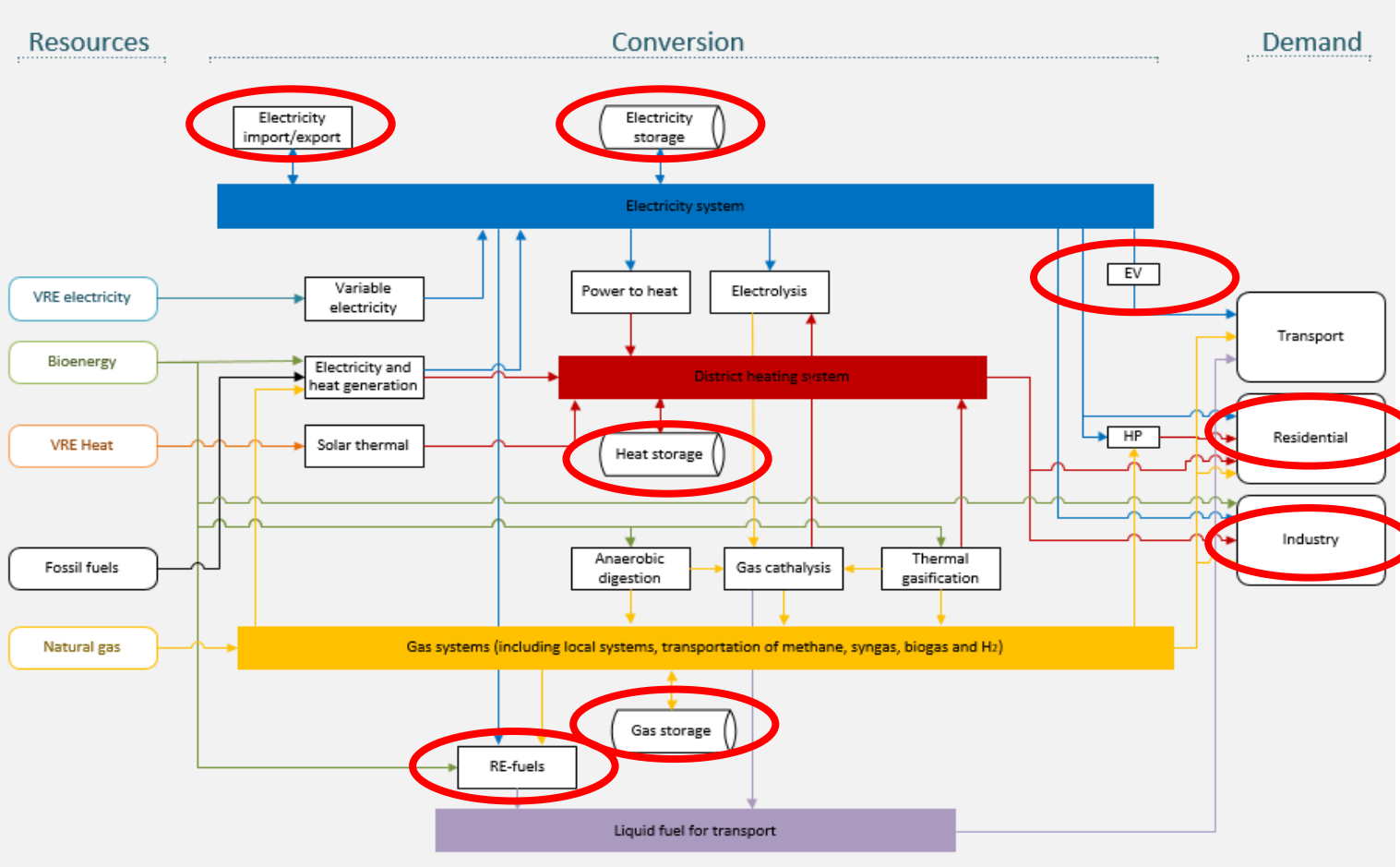
DTU Scenarios

- FutureGas (www.futuregas.dk)

Integrated energy systems



Integrated energy systems



Balmorel

Input

Heat and electricity demand
Fuel prices and emissions
Efficiencies and costs
Hourly distribution of demands
and production from RE sources
Capacities of existing plants and transmission
Time aggregation

Output

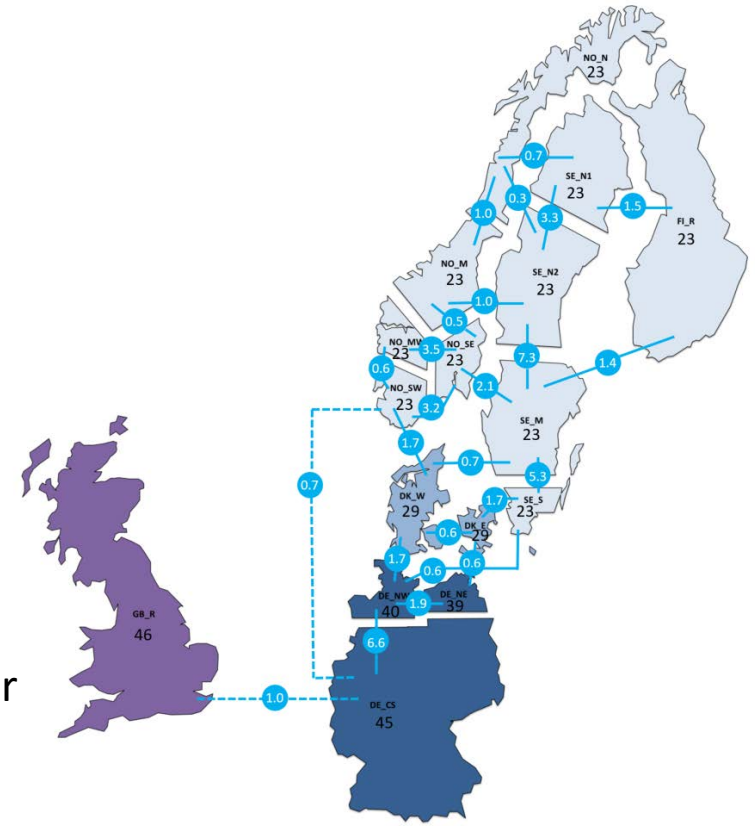
Energy conversion
Fuel consumption
Electricity import/export
Emissions
Investments in plants
and transmission lines
Prices on traded energy
Total costs

Modes

Myopic investments or
Rolling horizon
LP or MIP
(e.g. economy of scale)

Assumptions

Economic rationality
Perfect markets



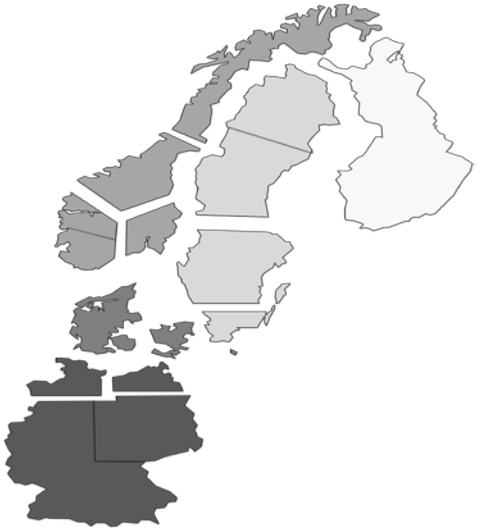
Access

Open code (GAMS)
www.Balmorel.com

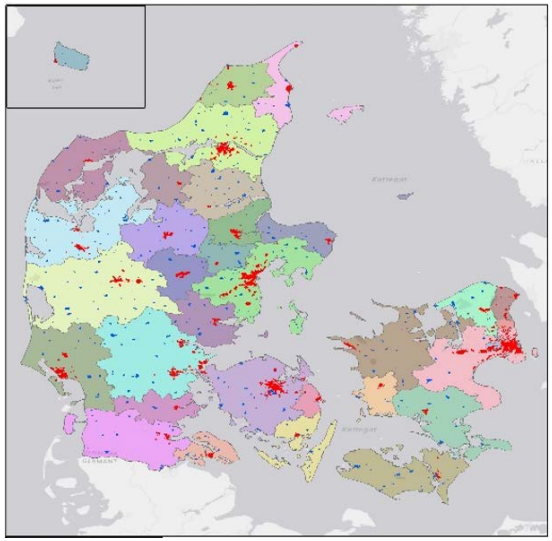
Spatial resolution

Spatial resolution in Balmorel and OptiFLow

Energy system optimization model covering the Nordic power and district heating sectors. Optimizes (operation and investments in) generation, transmission and consumption of the power and district heating sectors.



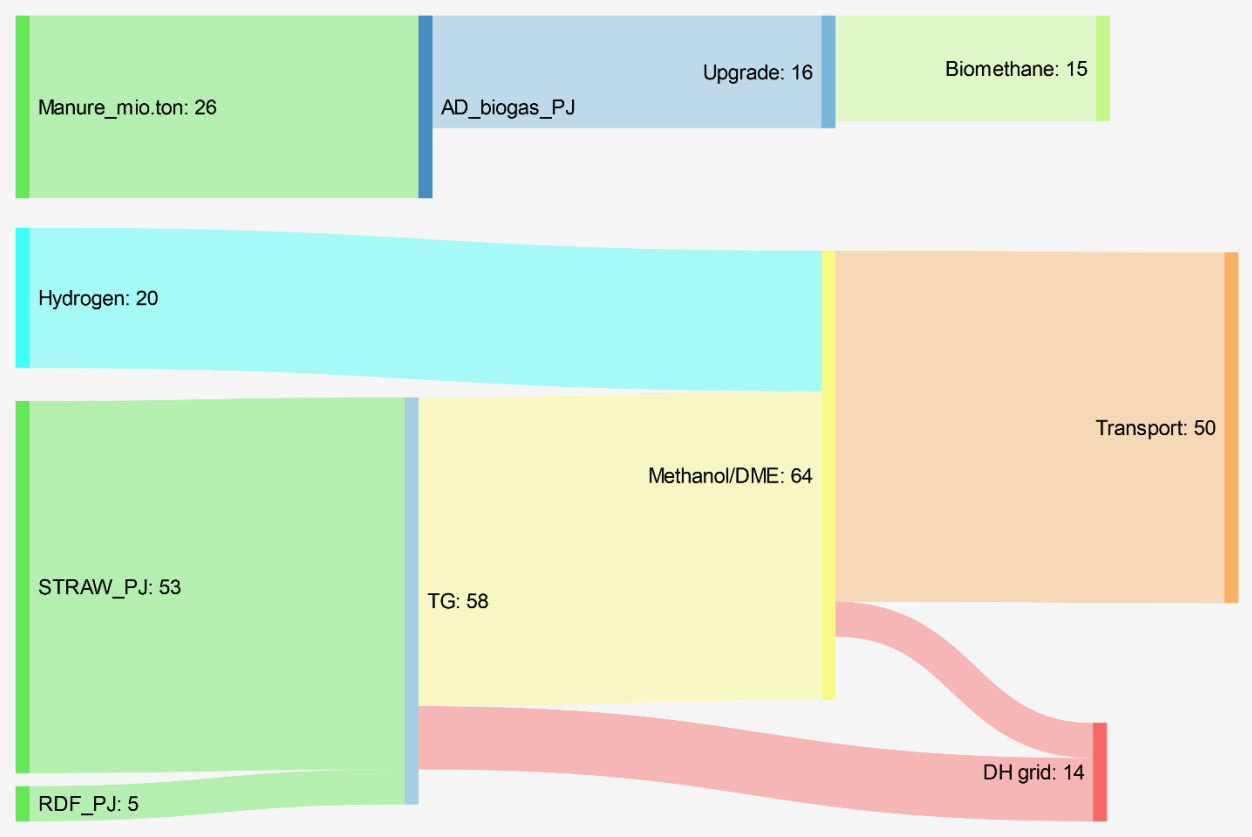
Power regions in Balmorel



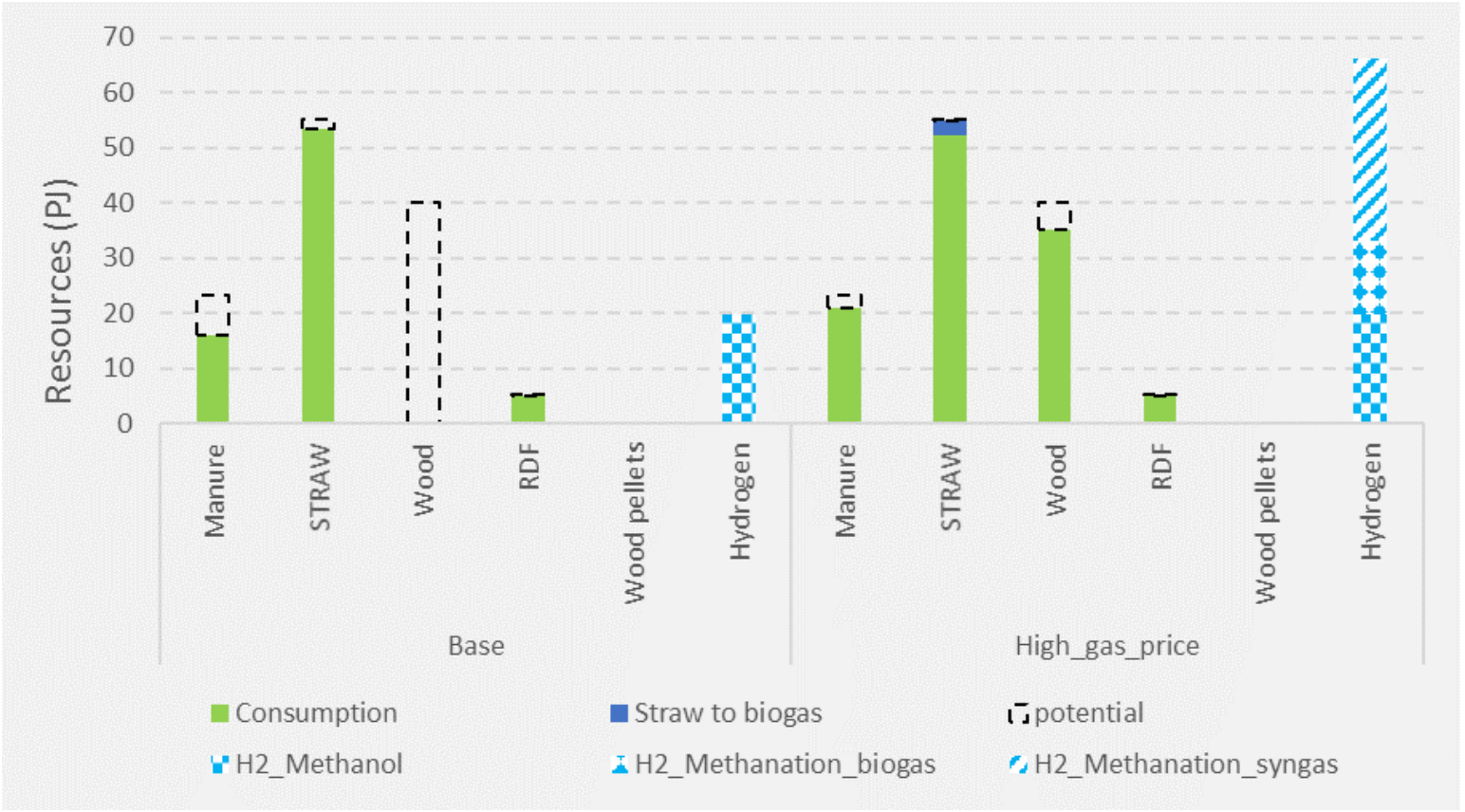
District heating areas in Balmorel and OptiFlow

Renewable gas and fuel production - Base 2050

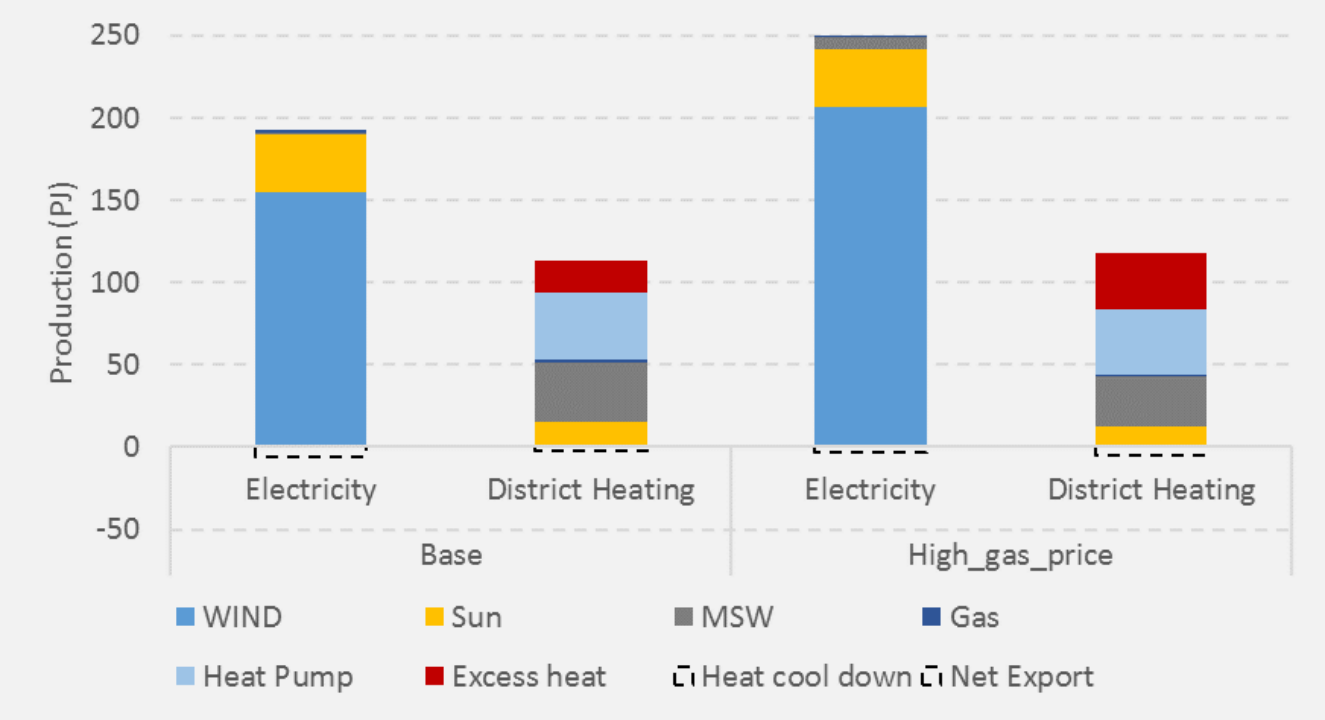
Unit: PJ (except manure (in mio. tons))



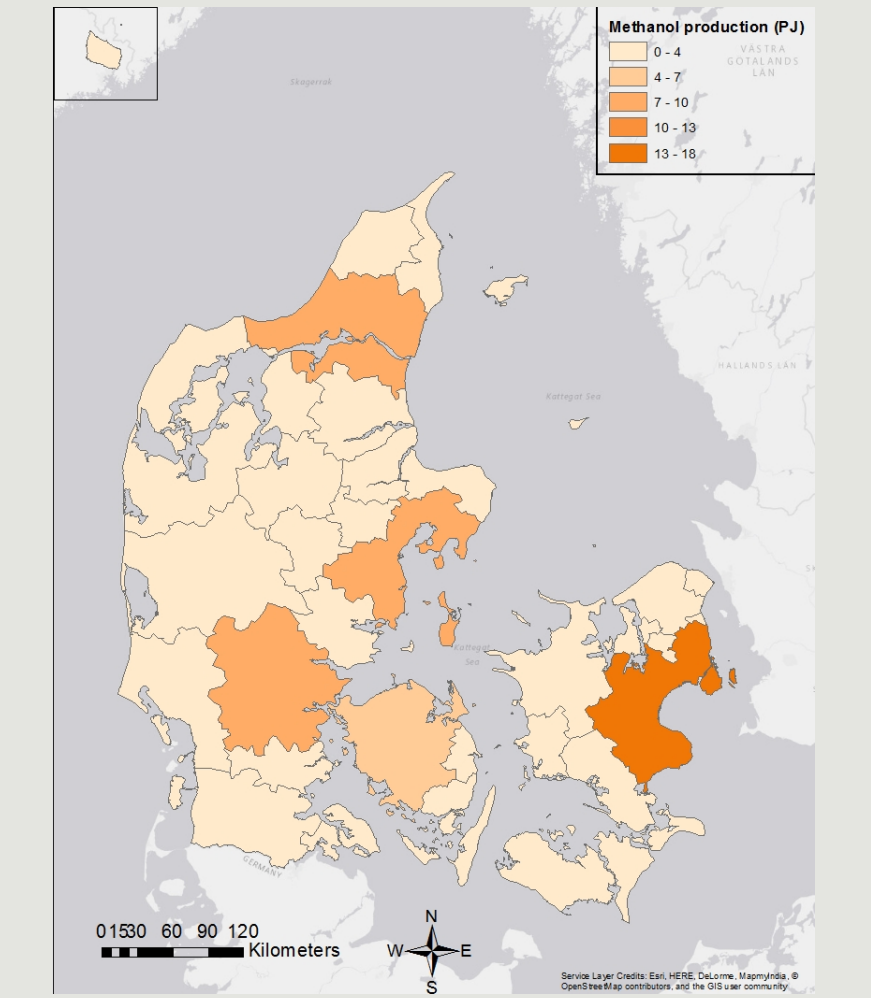
Bioenergy resources - 2050

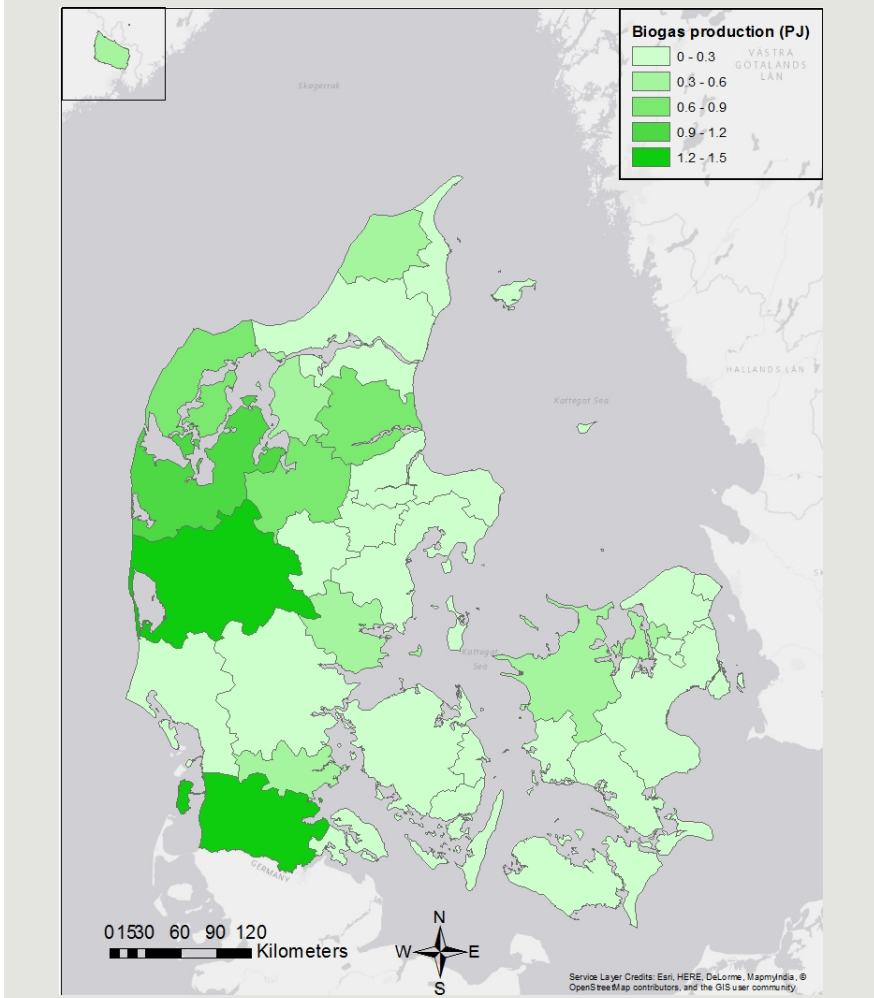


Electricity and District heating systems - 2050



Biofuel and biogas production - 2050





Conclusion

- For future **flexibility** challenges we need **integrated energy system** modeling
  - Power, heat, gas and **transport fuels**
  - Detailed spatial and time representation

- **Electricity transmission** (for net export) and **storages** will be important

- **Electricity** can help reduce greenhouse gas emissions through sector integration:
  - Power to heat
  - EV's
  - Power to gas (to fuels)

- We need district heating to collect **excess heat** (and power) and store energy

Thank you for your attention!

Questions or comments?
maem@dtu.dk