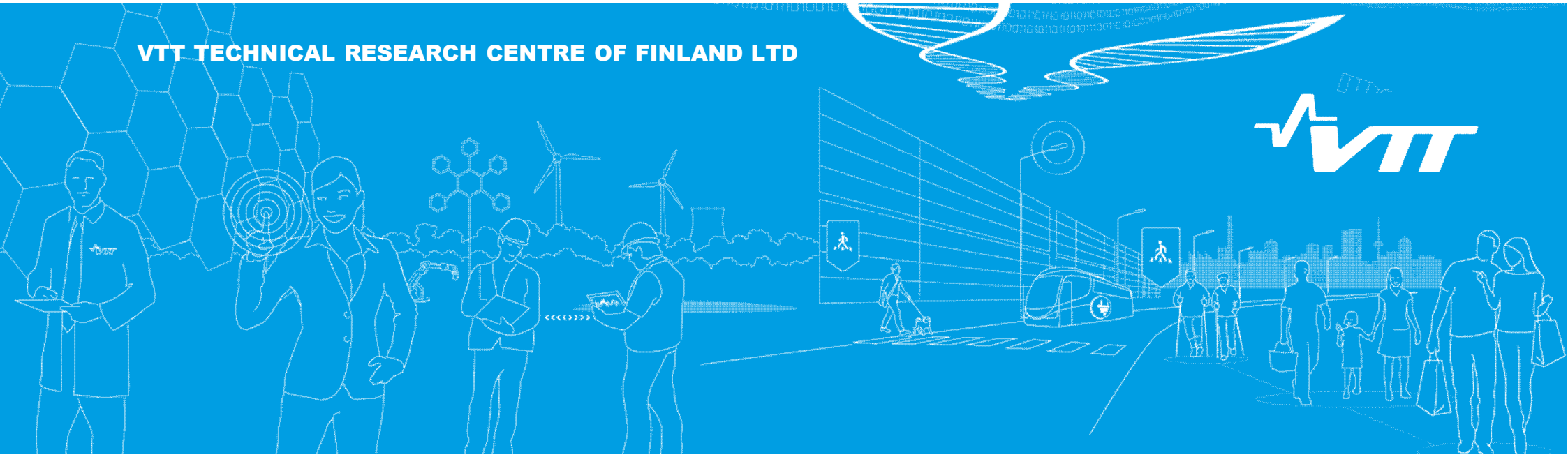


NEO CARBON ENERGY

TRUST IN RENEWABLE.

100% RES in 2050
TIMES energy model analysis

Esa Pursiheimo

VTT

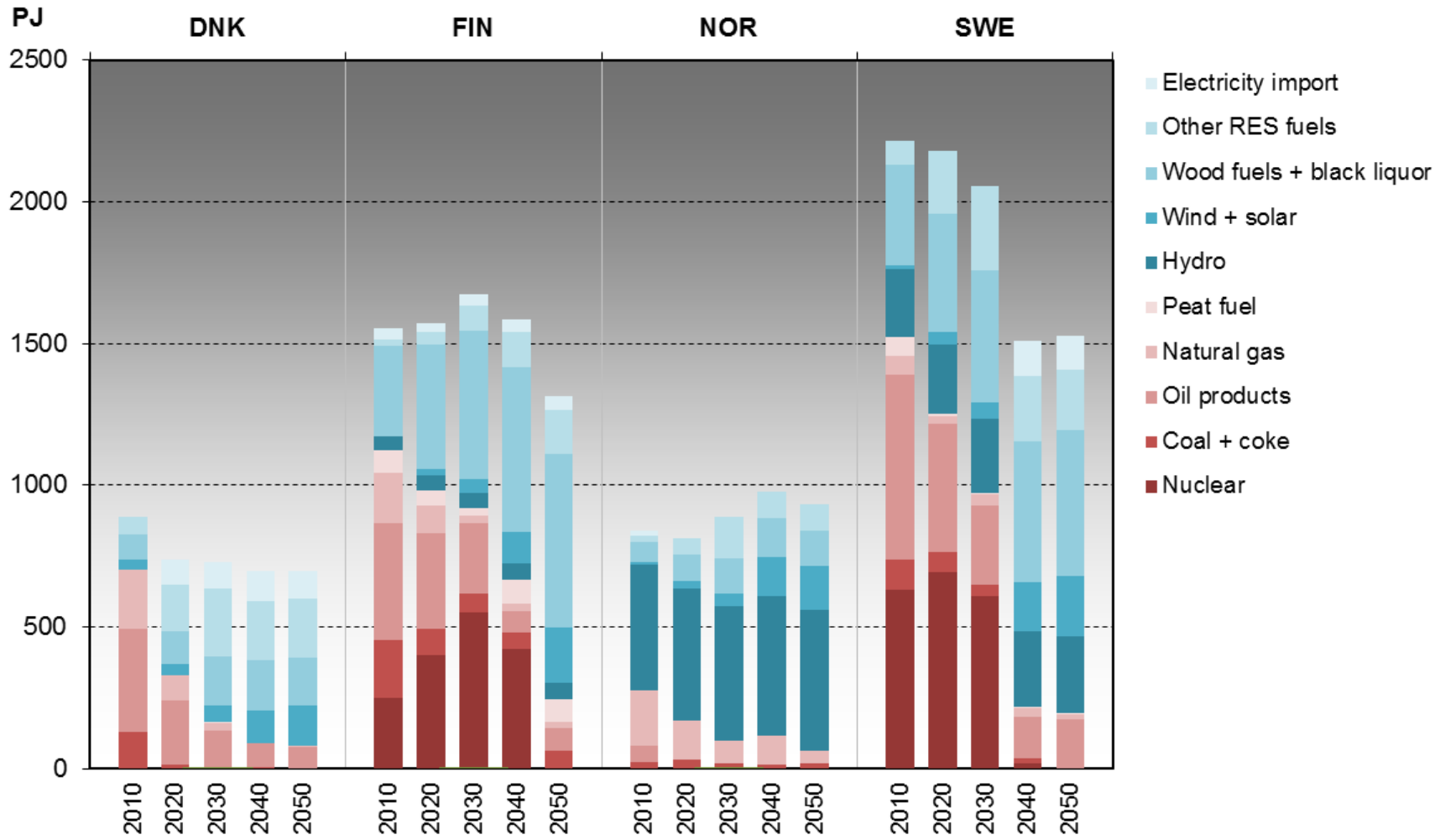
The TIMES Paradigm

- TIMES is a model for the prospective analysis of possible futures by scenarios (TIMES is not a forecasting model)
- Calibrated to energy statistics for a base year
- A Scenario consists of:
  - Demand Curves: reference energy service demand projections + demand elasticities to own prices
  - Supply Curves: primary reserves, annual potentials, expressed as stepped supply curves
  - Technology data-base: large amounts of technical and economic data (with optional penetration bounds)
  - Policy scenario: technology or fuel policies (taxes, subsidies, etc.) emission policies (caps, taxes)

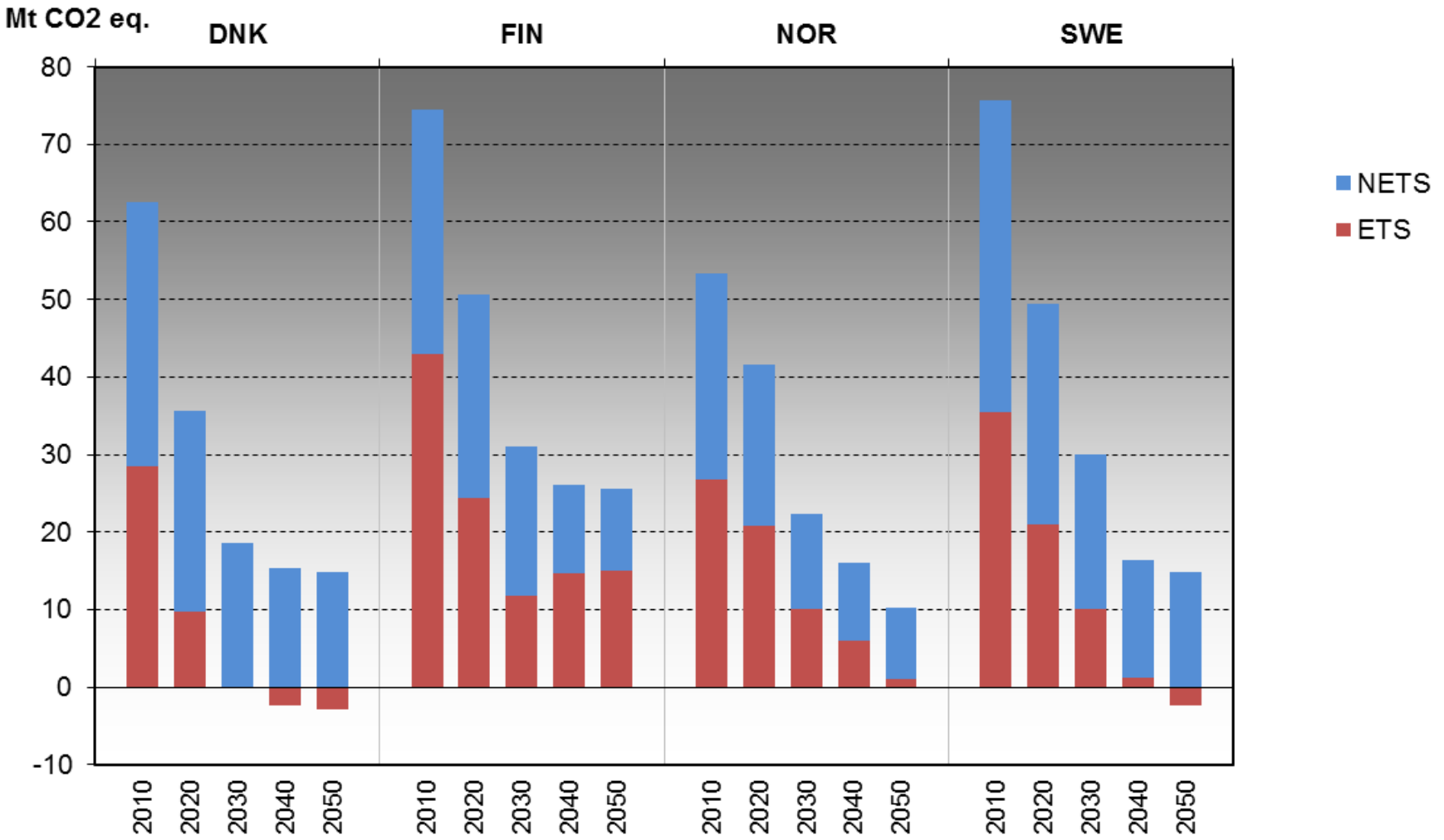
Target: 100% RES in 2050

- Analysed regions: Finland, Sweden, Norway and Denmark
  - Other regions included in the model without RES target
- Model finds cost-optimal path to 2050
- Target is implemented by excluding non-renewable energy sources from the energy supply
  - For feasibility reasons, high tax based cost is set for non-RES fuels
  - No RES based restrictions or taxes prior 2050
  - Target may not be reached in some cases due to industrial structure and other constraints
  - Imported electricity cannot be considered non-RES
  - Nuclear power is suspended in 2050 regardless of prior investments

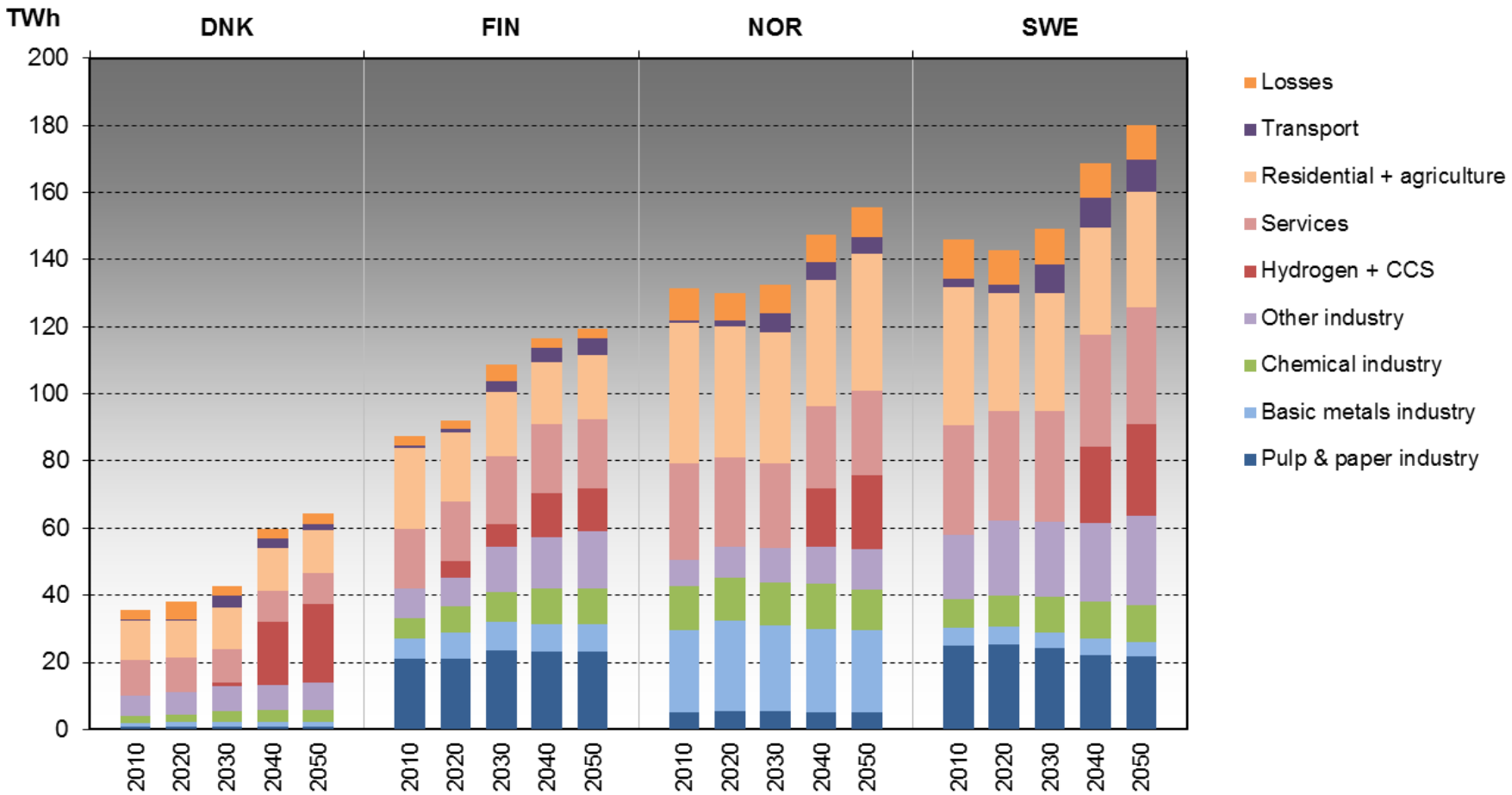
Primary energy supply



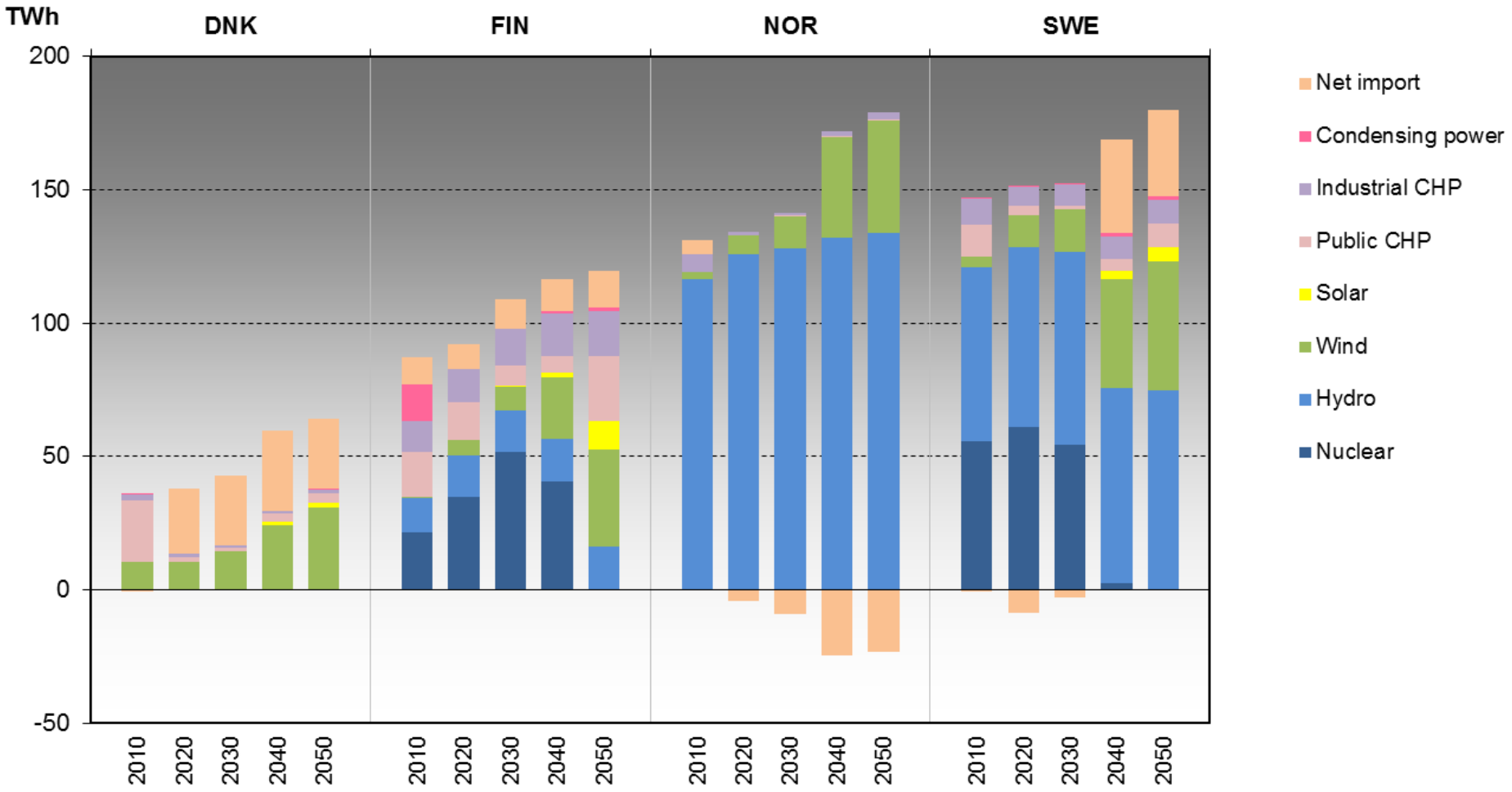
Emissions


Mt CO2 eq.
DNK
FIN
NOR
SWE
80
70
60
50
40
30
20
10
0
-10
2010
2020
2030
2040
2050
NETS
ETS

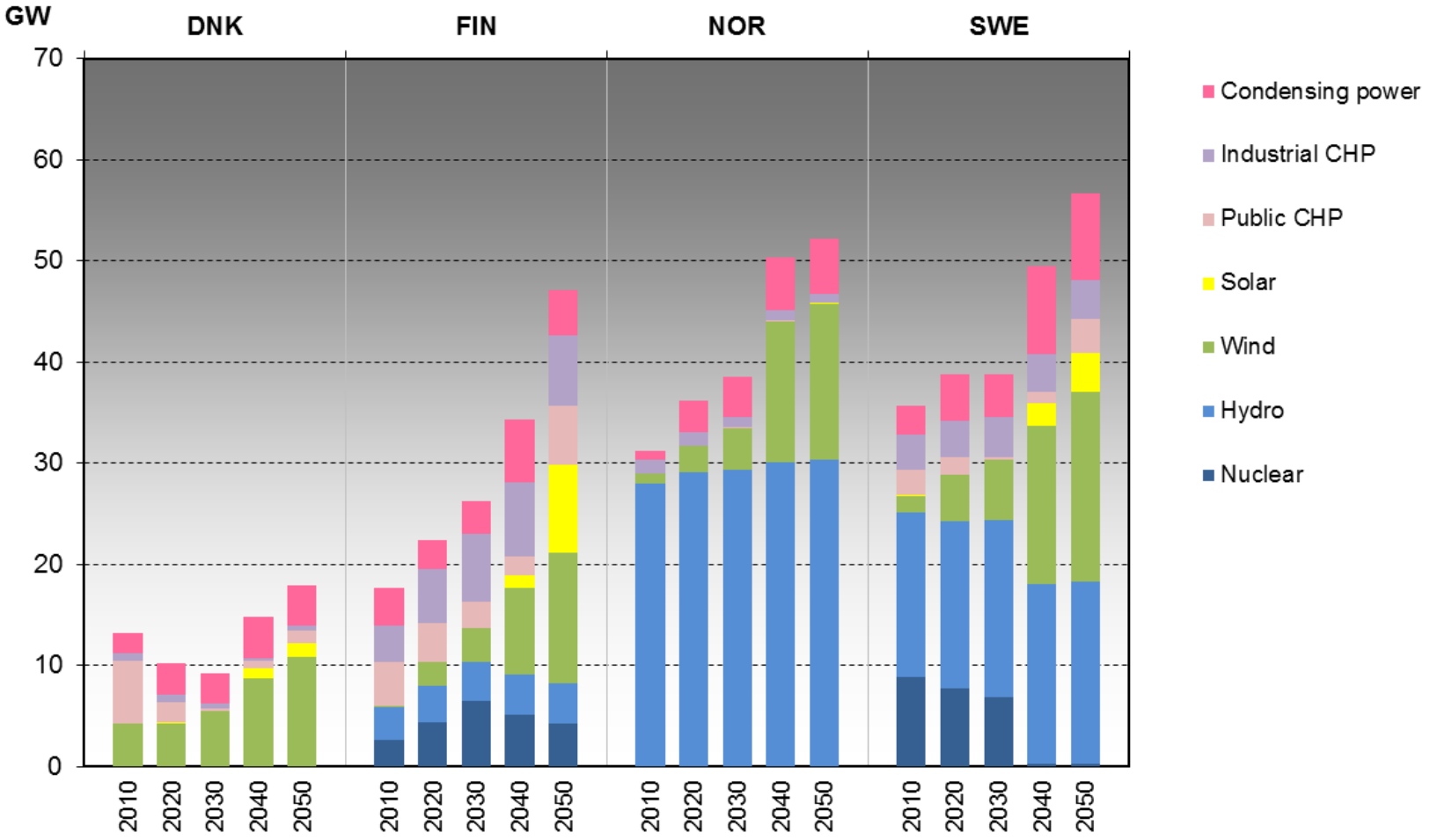
Electricity consumption



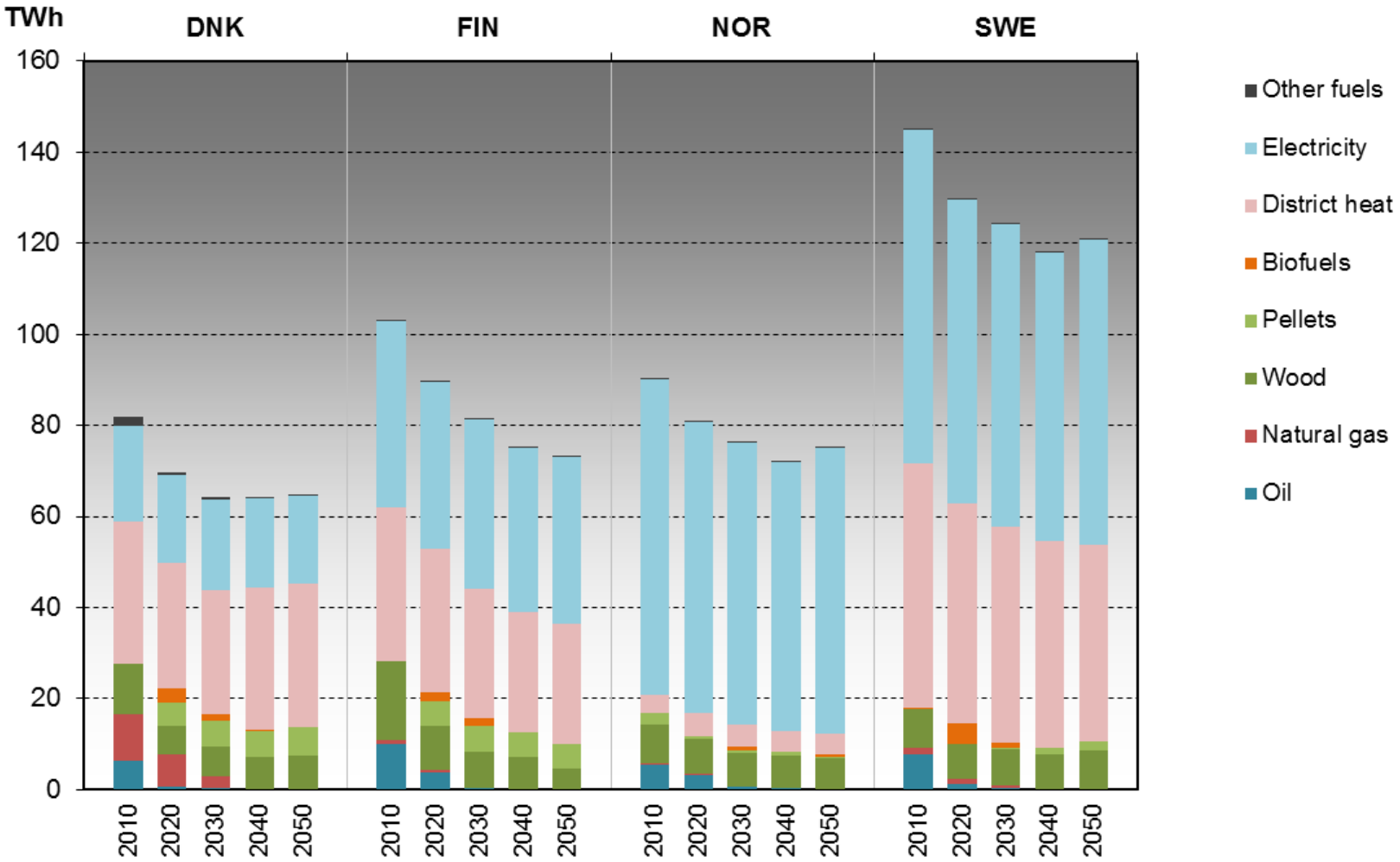
Electricity supply



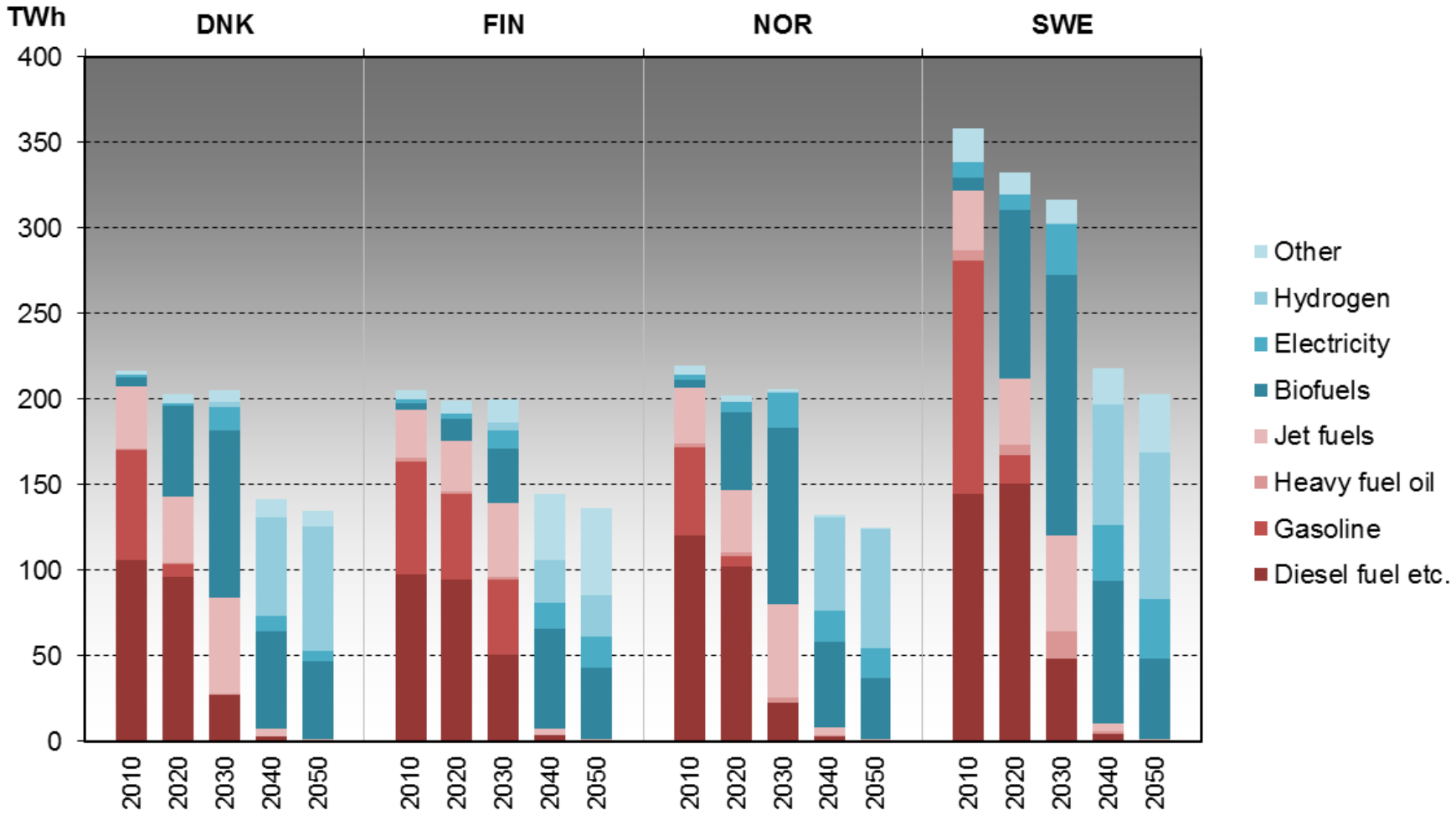
Electricity production capacity



Residential and commerical sector end use



Transport sector end use



Conclusions

- Further model adjustment is required in certain sectors in order to reach 100% RES target
  - Especially non-RES based processes in industrial sector
- Dramatic increase in electricity consumption based on electrification of the energy system
  - Electrolysis based hydrogen supply increases
  - Electricity import significant except in Norway
- High production capacity of wind and solar power
  - Investments in condensing power is required to balance supply
- P2G not currently profitable due to robust modelling of time slices
  - Other methods of gasification (biomass) used instead
  - Model should be adjusted