Energy transition towards a low carbon future

- a Norwegian perspective

Prospective for Energy-Climate Issues
MINES ParisTech, 22 November 2017

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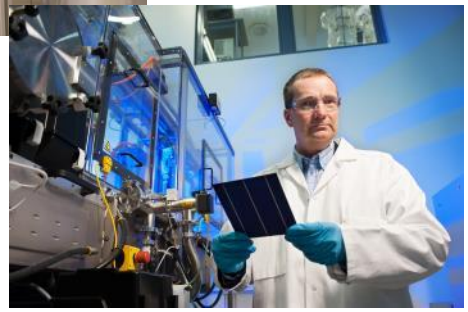
Institute for Energy Technology

- Independent foundation established in 1948
- R&D in a broad scope of energy technology
  - Nuclear research
  - Renewable energy
  - Petroleum
- 600 employees (Kjeller and Halden)
- Turnover: NOK 1 billion
- Contract research
- Laboratory
- Internationally oriented



Content of presentation

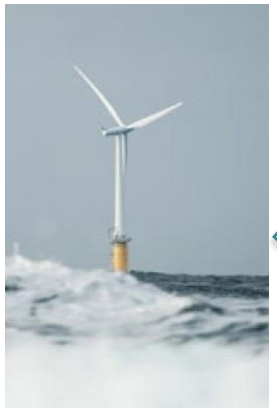
1. The Norwegian energy system and climate policy
2. Analysis
   - Nordic Energy Technology Perspectives
   - Low carbon future: Norwegian and Scandinavian analysis
   - Energy and Climate analysis for the city of Oslo

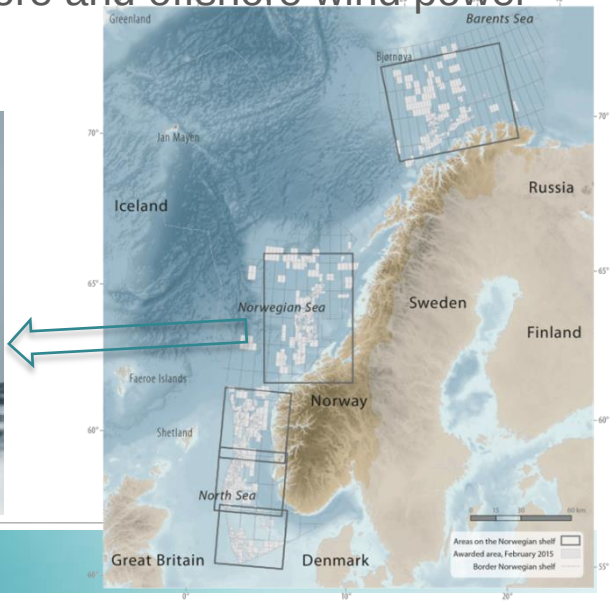
The Norwegian energy system

- Electricity production is mainly based on hydropower >95%)
  - Huge water reservoirs
  - Potential for new run-of-river hydropower
- Petroleum sector – exports of oil & gas
- Huge potential for both onshore and offshore wind power

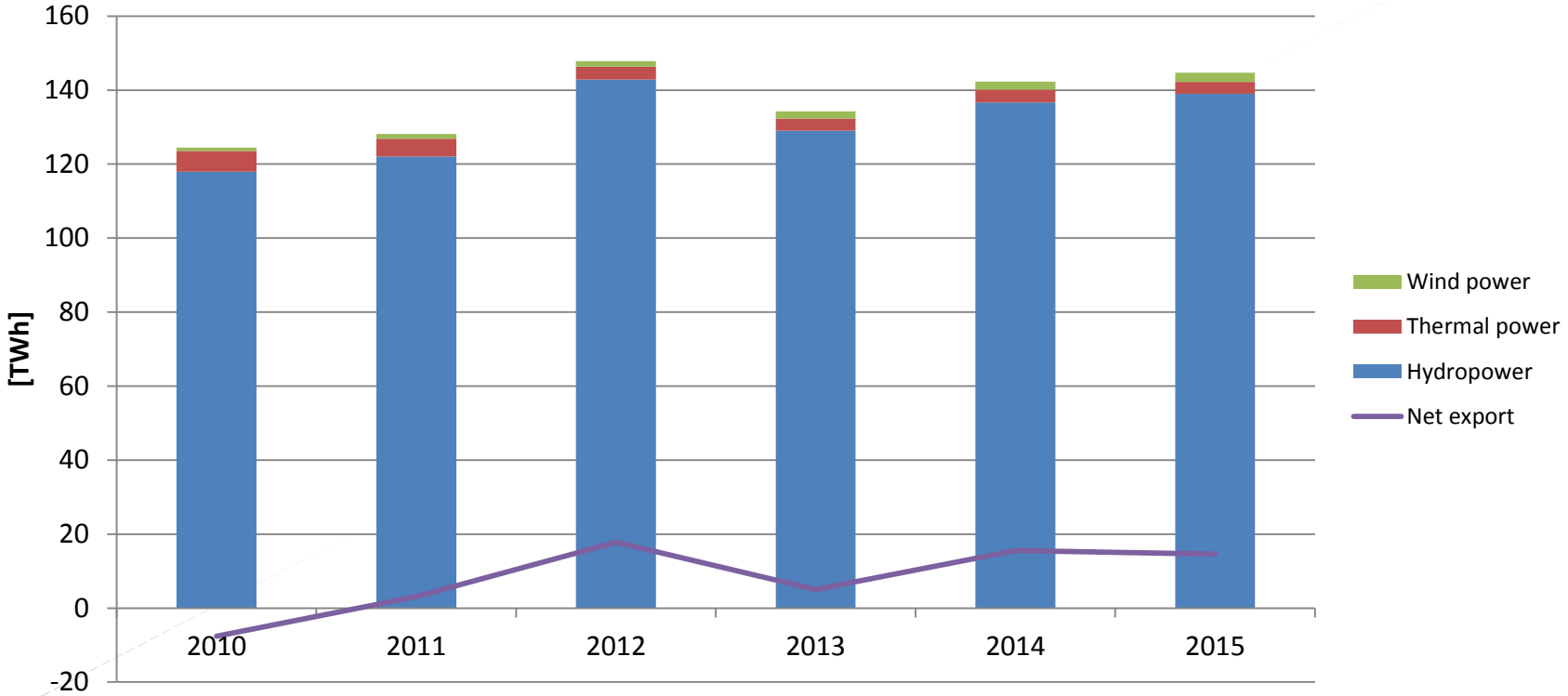
- Cold climate -> High demand for space heating
- Historically electricity has been relatively inexpensive
  - Energy-intensive industry
  - Electricity based heating system

Future

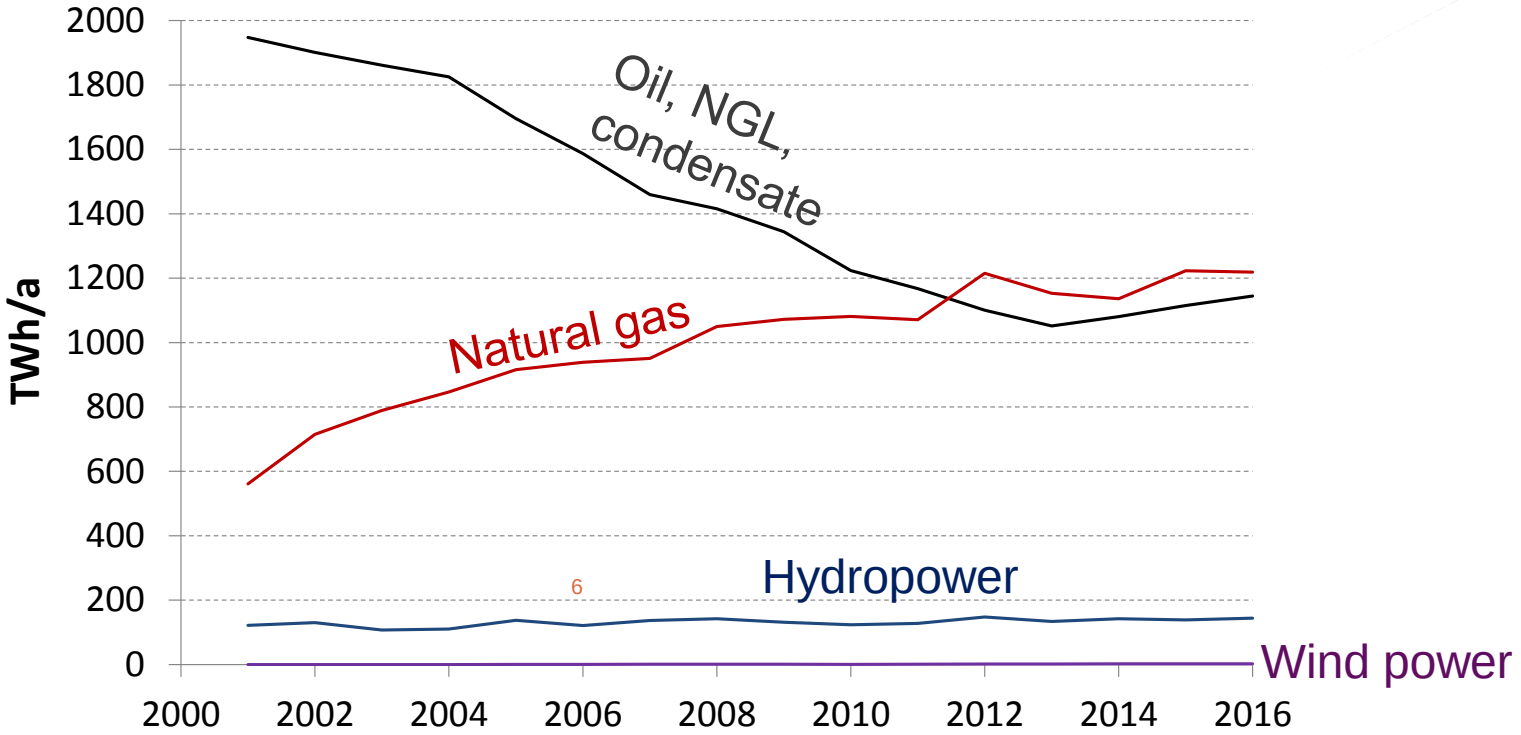




Norwegian electricity production



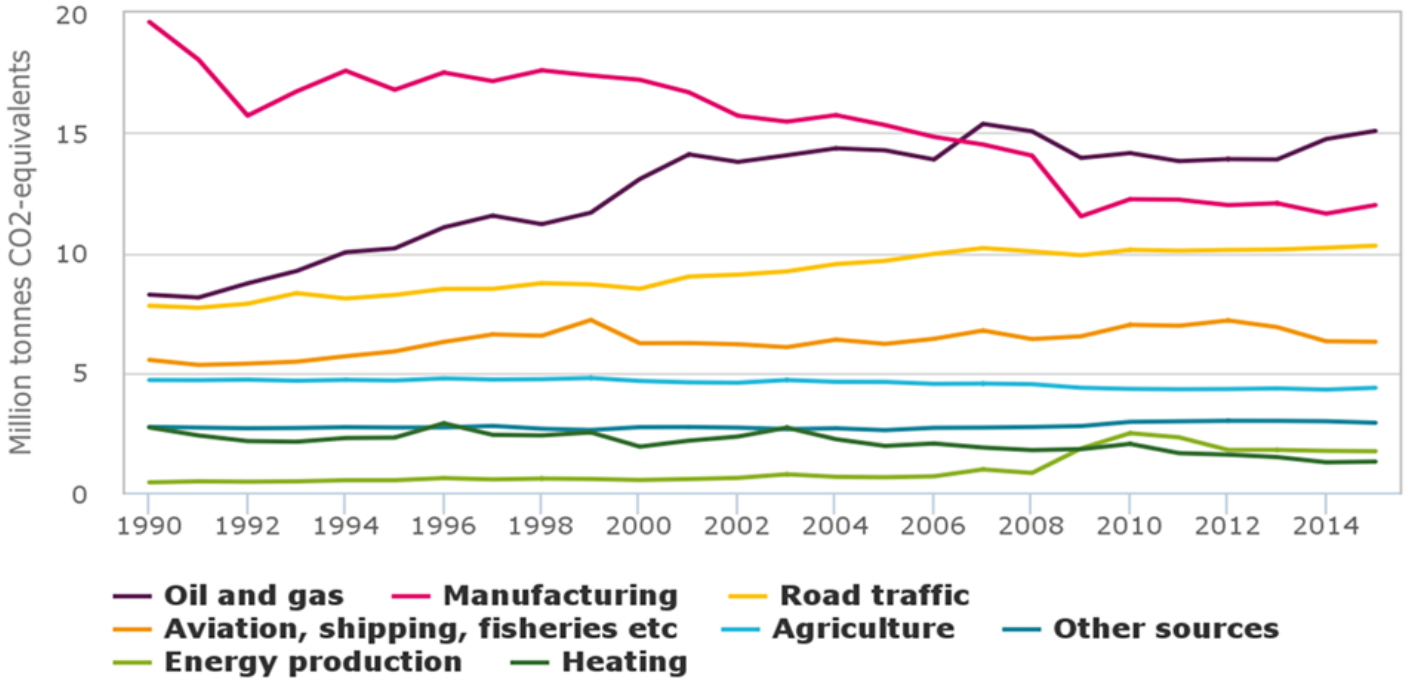
Primary energy sources in Norway



Data source: Statistics Norway, Norsk Petroleum

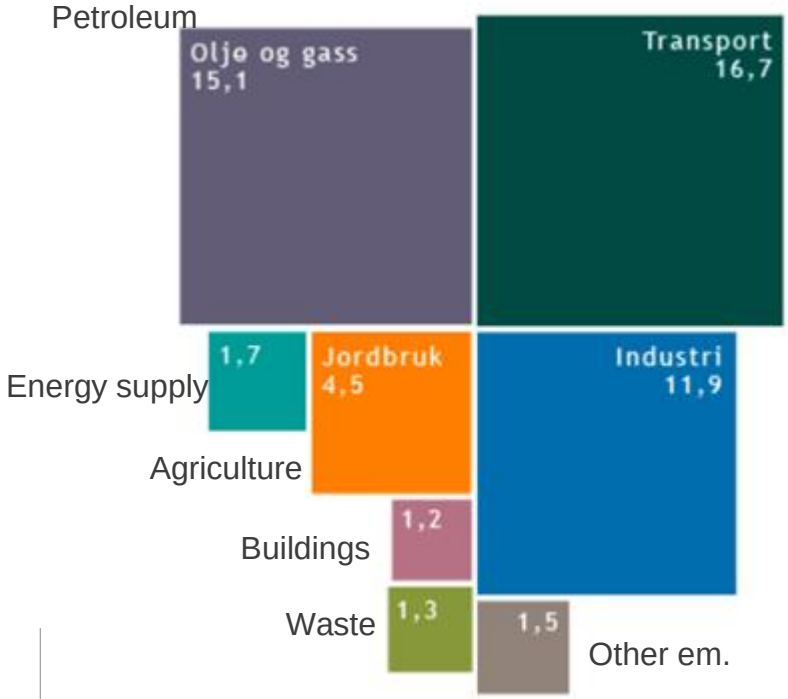
GHG-emissions in Norway

54 million tons of CO_2-equivalents per year



Source: Statistics Norway

Transition to a low emission society



2015: 10 ton CO_2/capita

2050: 2 ton CO_2/capita

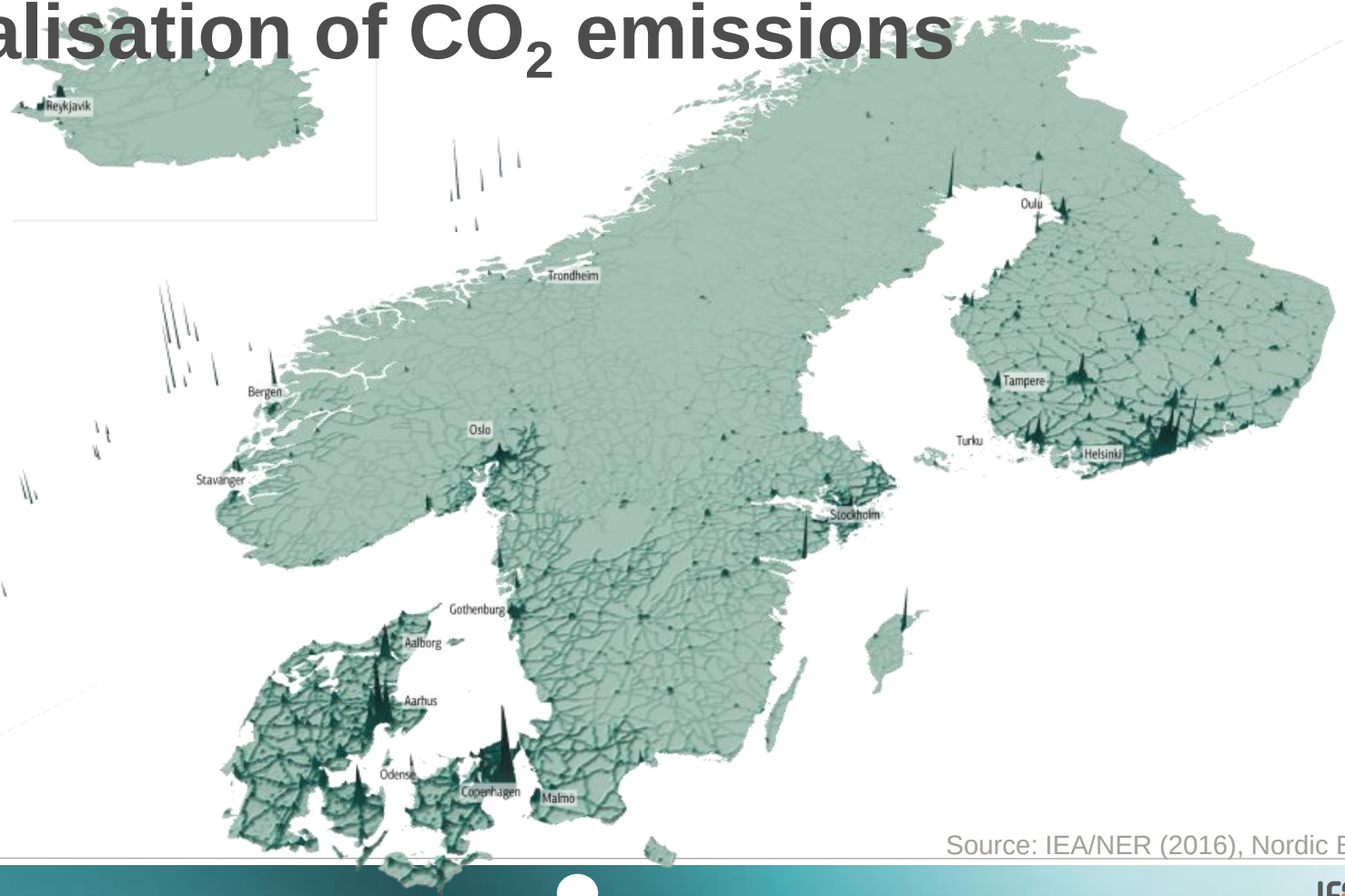
2050: 1 ton CO_2/capita

Source: Norwegian Environmental Agency

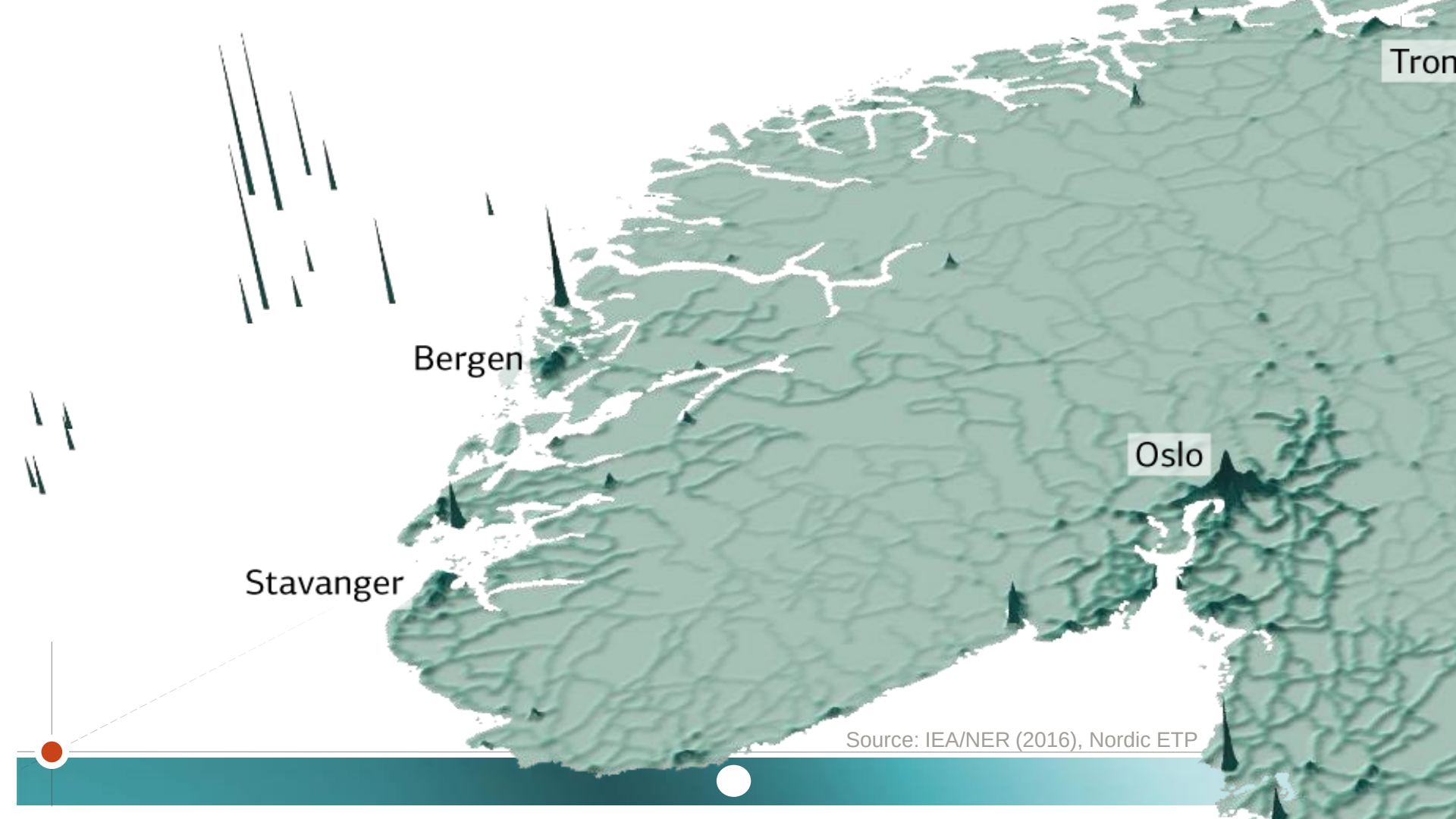
Map of the Nordic region

Source: IEA/NER (2016), Nordic ETP

Visualisation of CO_2 emissions



Source: IEA/NER (2016), Nordic ETP

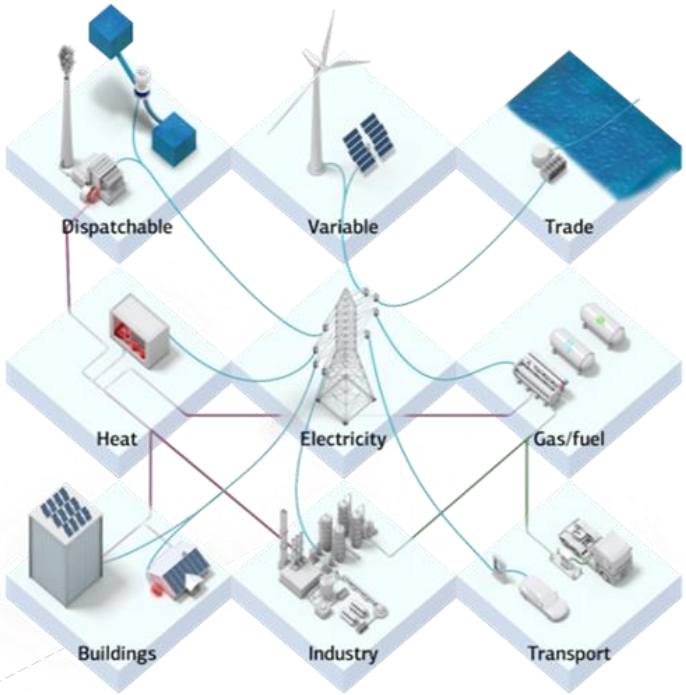


Source: IEA/NER (2016), Nordic ETP

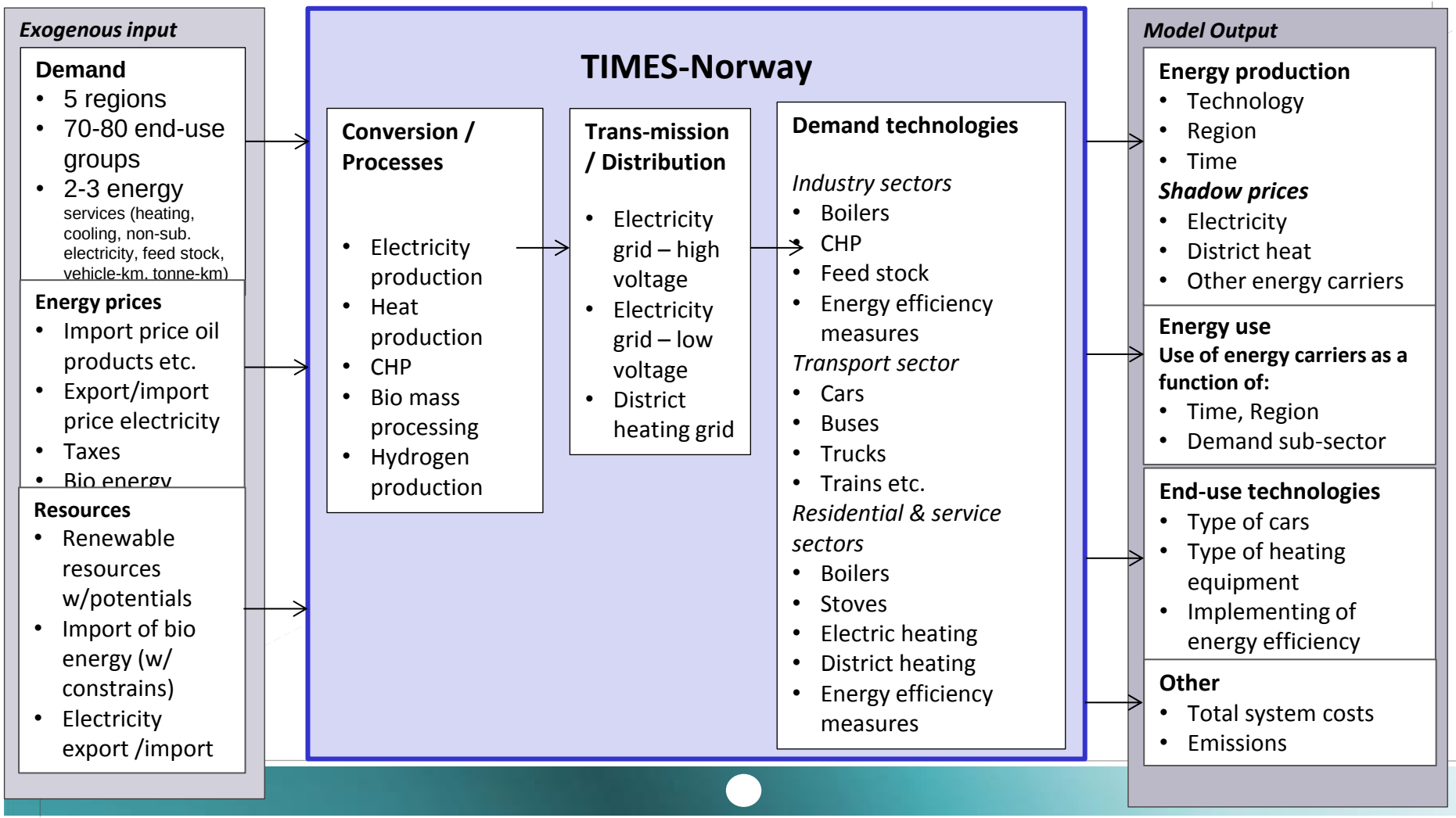
Focus areas for decarbonization

1. Electrification of petroleum sector
2. Distributed, integrated and flexible energy system
3. Electrification of transport
   - Challenging to decarbonize long-distance
4. Cities
5. Industrial processes

The energy system is analyzed within the TIMES modelling framework

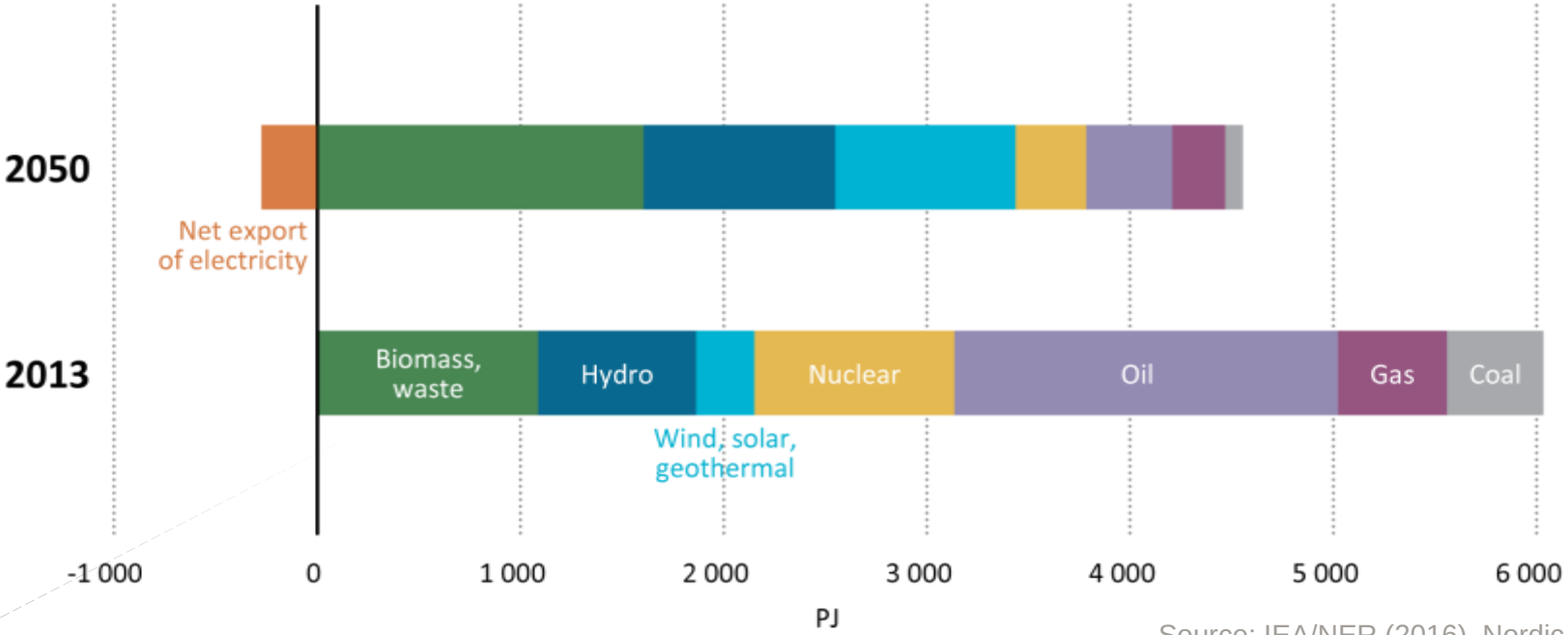


- We model the interconnection between energy production, distribution and demand for energy
- Interplay between different demand sectors and energy carriers
- Calculate needed investments in the energy system to cover future demand to the lowest cost / lowest emissions


Exogenous input
Demand
5 regions
70-80 end-use groups
2-3 energy services (heating, cooling, non-sub. electricity, feed stock, vehicle-km, tonne-km)
Energy prices
Import price oil products etc.
Export/import price electricity
Taxes
Bio energy
Resources
Renewable resources w/potentials
Import of bio energy (w/ constrains)
Electricity export /import
TIMES-Norway
Conversion / Processes
Electricity production
Heat production
CHP
Bio mass processing
Hydrogen production
Trans-mission / Distribution
Electricity grid – high voltage
Electricity grid – low voltage
District heating grid
Demand technologies
Industry sectors
Boilers
CHP
Feed stock
Energy efficiency measures
Transport sector
Cars
Buses
Trucks
Trains etc.
Residential & service sectors
Boilers
Stoves
Electric heating
District heating
Energy efficiency measures
Model Output
Energy production
Technology
Region
Time
Shadow prices
Electricity
District heat
Other energy carriers
Energy use
Use of energy carriers as a function of:
Time, Region
Demand sub-sector
End-use technologies
Type of cars
Type of heating equipment
Implementing of energy efficiency
Other
Total system costs
Emissions

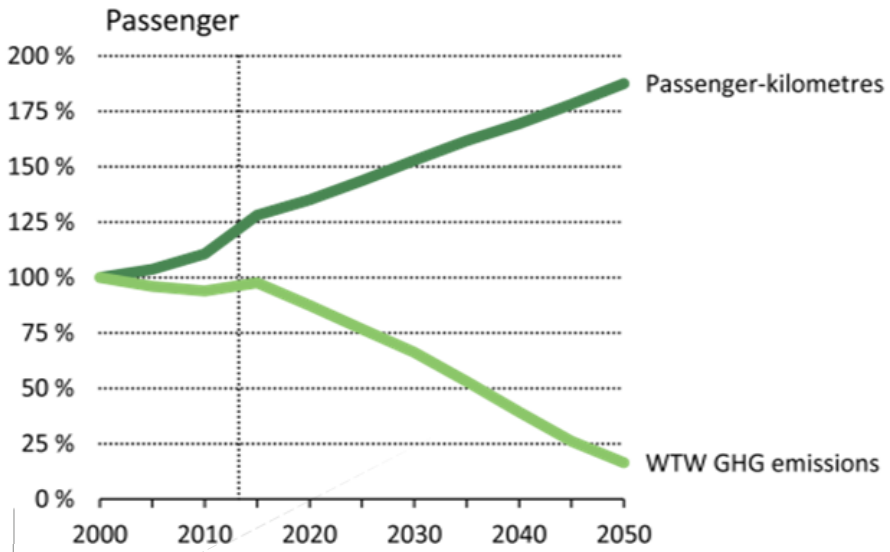
Transforming the energy system

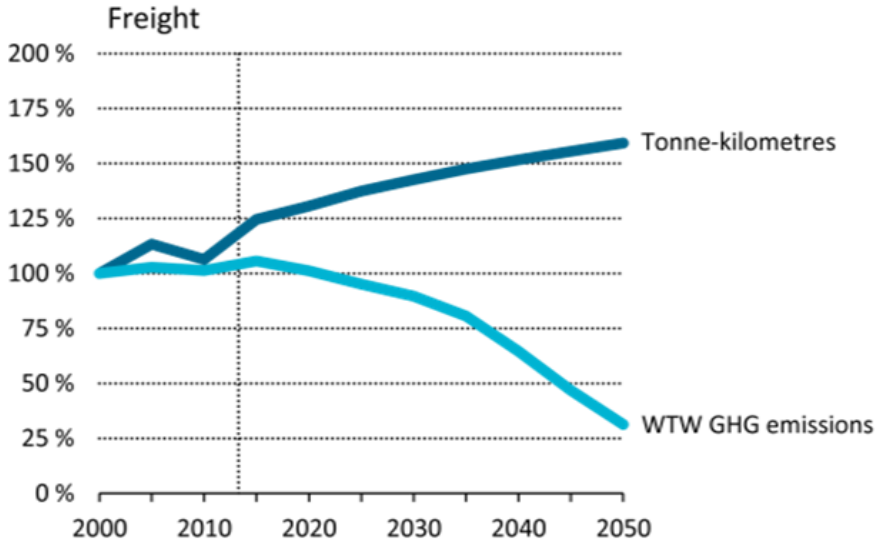
Total Nordic Primary Energy Supply in a Carbon Neutral Scenario



Source: IEA/NER (2016), Nordic ETP

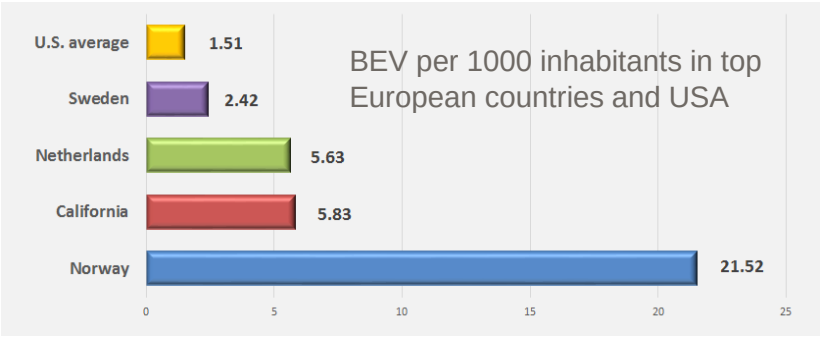
A decoupling of transport activity from emissions





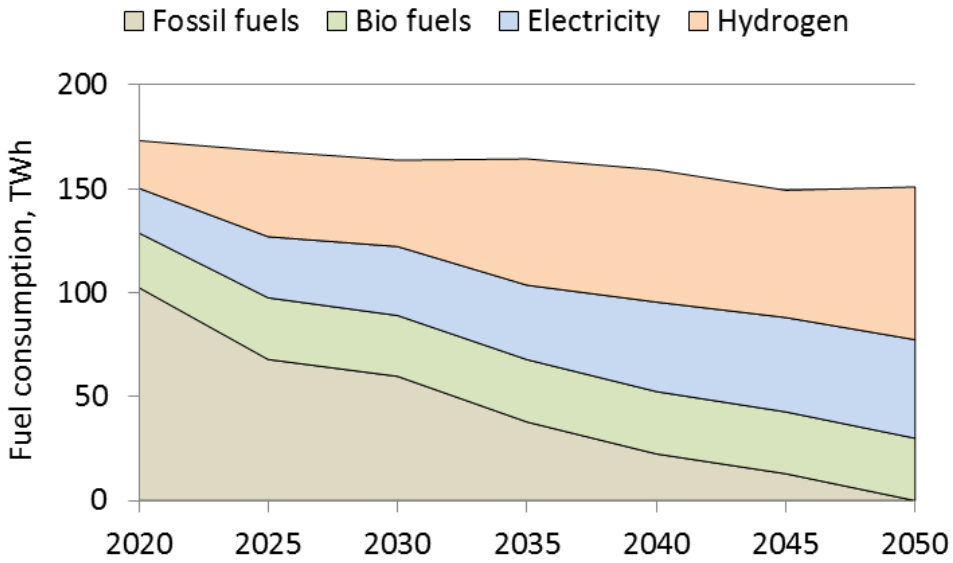
Norwegian policy supports zero emission vehicles (BEV and FCEV)

- Economic incentives
  - Exempted from non-recurrent tax
  - Reduced annual fee
  - Reduced (or no) road toll
  - Free parking in public parking
  - Free public charging
- Other incentives
  - Access to bus lane



Decarbonisation of transport

Carbon neutral scenario for Scandinavia (Norway, Sweden, Denmark)

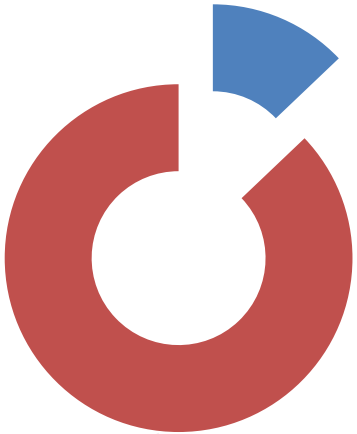


IFE: 2017

Electrification of transport

Electrification in Norway

2015



Electric

ICE

2050

13 % electric vehicles in 2015

80 % electric vehicles in 2050

IFE: 2017

Passenger transport

- Public transport: local and national government organize open tendering on zero emission alternatives:
  - Passenger ferries
  - Busses

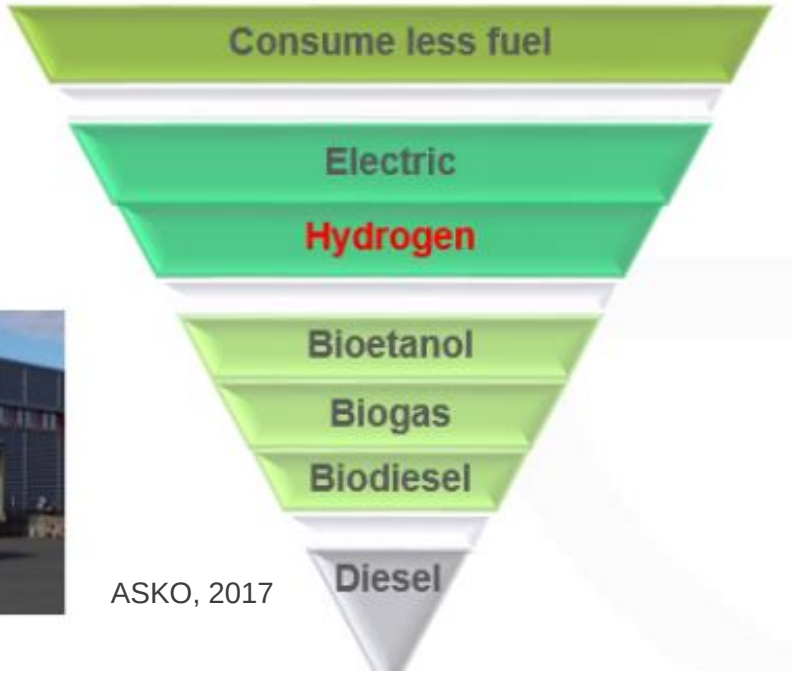
Ampere: battery ferry in operation in Sognefjorden

Hydrogen bus in operation in Oslo

Freight transport

Depends more on local / private initiatives

- 100% Renewable Fuel by 2020 by using a mix of fuels
- Example: ASKO
  - Fresh food distribution



ASKO, 2017

- Policies need to be improved

Oslo: Capital of Norway

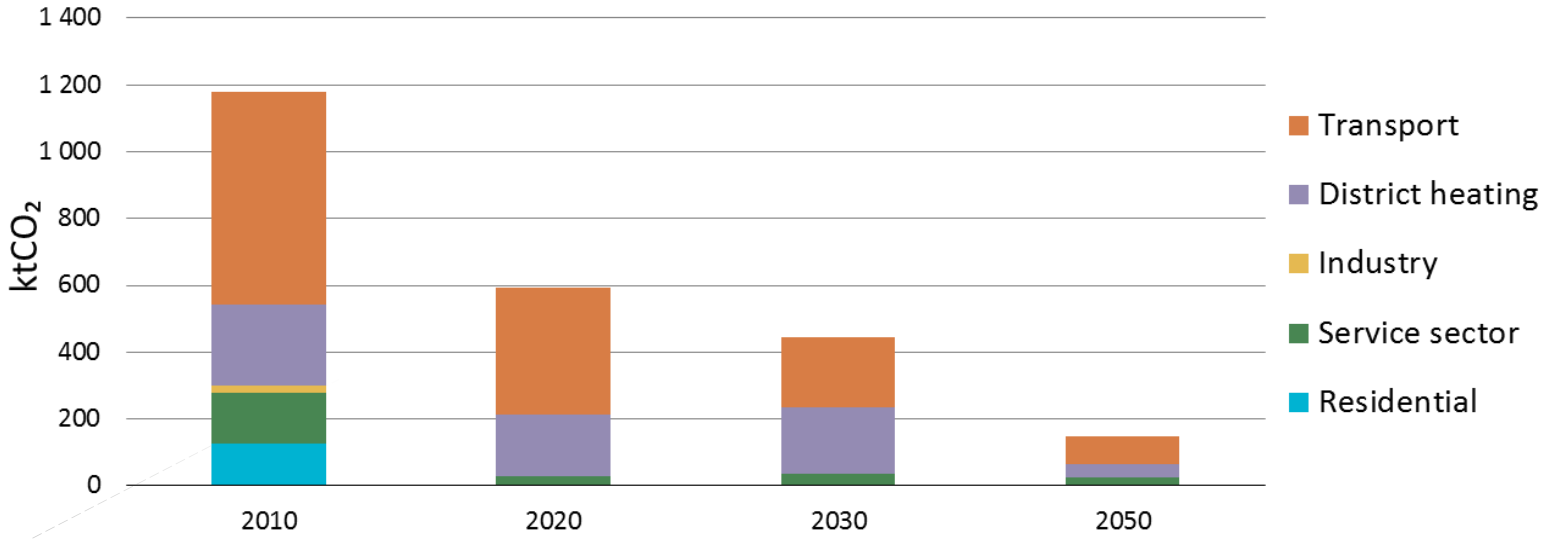
- Climate targets in Oslo are ambitious:
  - No use of fossils in public transport after 2020
  - 50 % emission reduction before 2030
  - No use of fossil fuels by 2050

- Oslo is world leading in EV roll-out
  - > 2000 public charging points

Oslo, 2016

Emissions in transport decrease significantly

but continues to be the main contributor to CO_2 emissions



Note: Emission from district heating is from waste incineration

Closing remarks

Action needed to achieve the challenging climate targets:

1. Utilise and strengthen *proven policies* in transport
2. Focus on sustainable development in *cities*
3. International cooperation on *grids* and markets
    - *Flexibility* in energy production and demand
4. Industrial decarbonisation: *innovation* is necessary (incl. CCS)
5. *Electrification* of petroleum

Thank you for the attention

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