Norwegian insights on low carbon growth

Webinar: Behavioural Dimensions to DSM in Indian Power sector

Panel discussions on “Low carbon growth”

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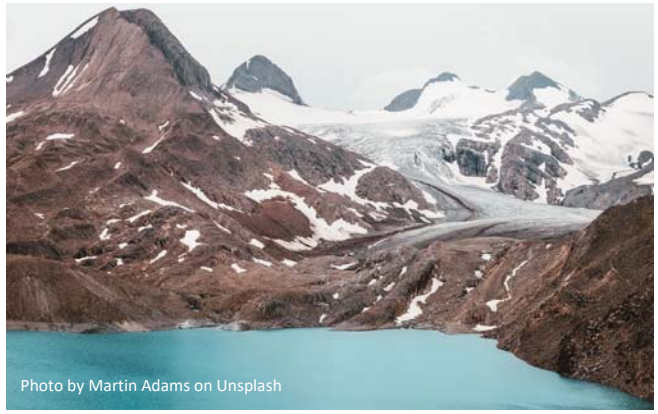
2018

Population:	5.4 million
Area:	323 802 km^2
GDP:	0.40 trillion USD
CO_2 emissions:	45 million-ton
CO_2 emissions per capita:	8.3 ton

2018

Population:	1352.6 million
Area:	3 278 263 km^2
GDP:	2.7 trillion USD
CO_2 emissions:	2435 million-ton
CO_2 emissions per capita:	1.8 ton

The Norwegian energy system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- Electricity generation mainly based on hydropower
  - 2017: 96%
  - Large water reservoirs - 50% of European capacity
- Cold climate → High demand for space heating
- Historically electricity has been inexpensive
  - Energy-intensive industry
  - Electricity based heating system
- Large potential for onshore and offshore wind power
- Petroleum export
  - 25% of EUs gas demand (2017)
  - 2 % of global oil demand in (2017)

Why energy system models?

- Tool to systemize complex energy systems
  - Long-term planning
  - Sector coupling
- A low carbon system is more integrated and consume more electricity than a fossil-based system
- Understanding energy system dynamics is necessary to design energy systems
  - at an affordable cost
  - with a low carbon footprint
  - with energy security

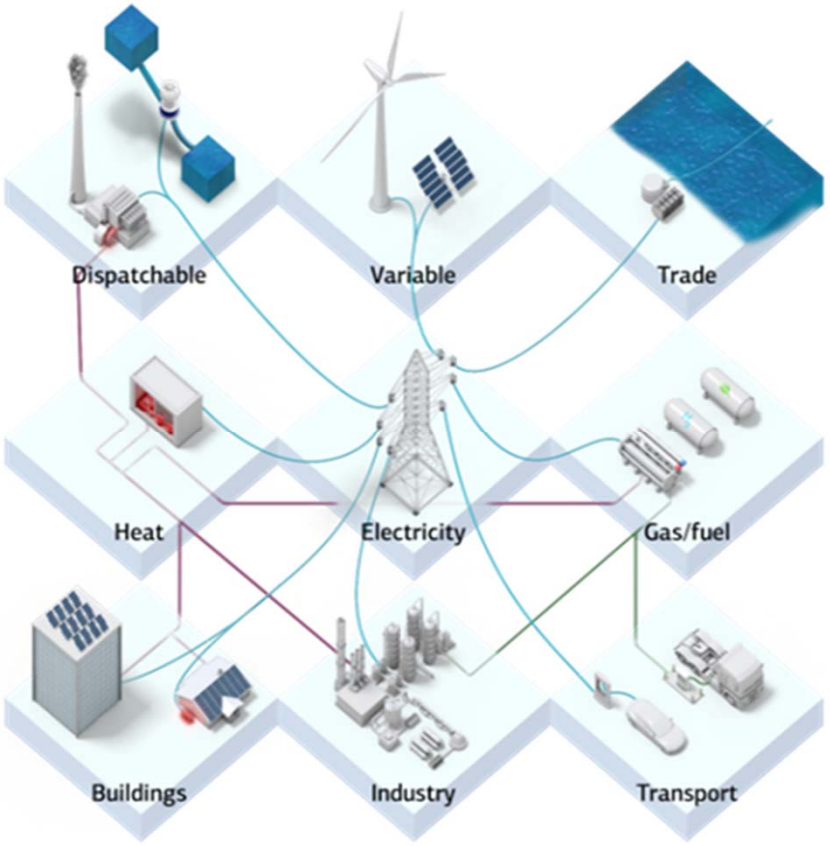
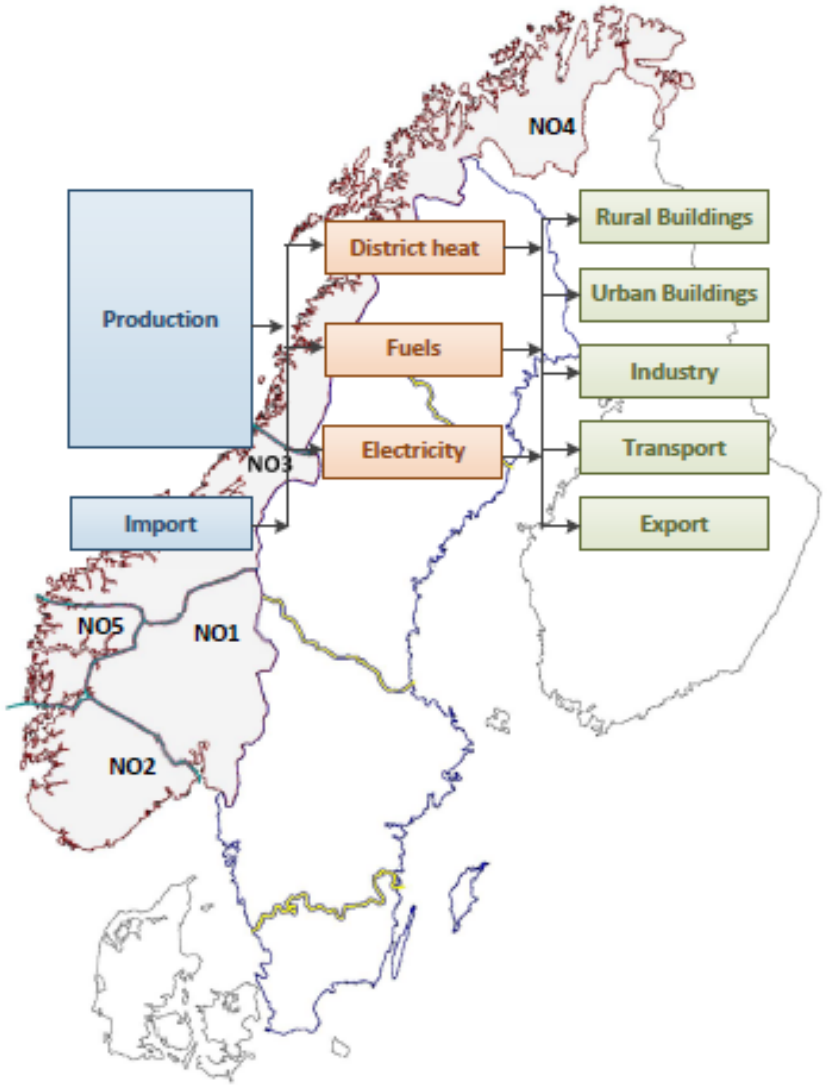


Figure: IEA, NETP 2016

IFE-TIMES-Norway 2015-2050

- Developed in cooperation with the Norwegian Water Resources and Energy Directorate
- Regions = 5 Norwegian spot price regions
- Electricity trade between Norwegian regions and European countries
- Detailed end-use sectors and power sector
- Flexible temporal resolution
  - Example: 4 seasons with representative days of 24 hours
- Model development challenge: What detail levels are necessary to provide good model insights

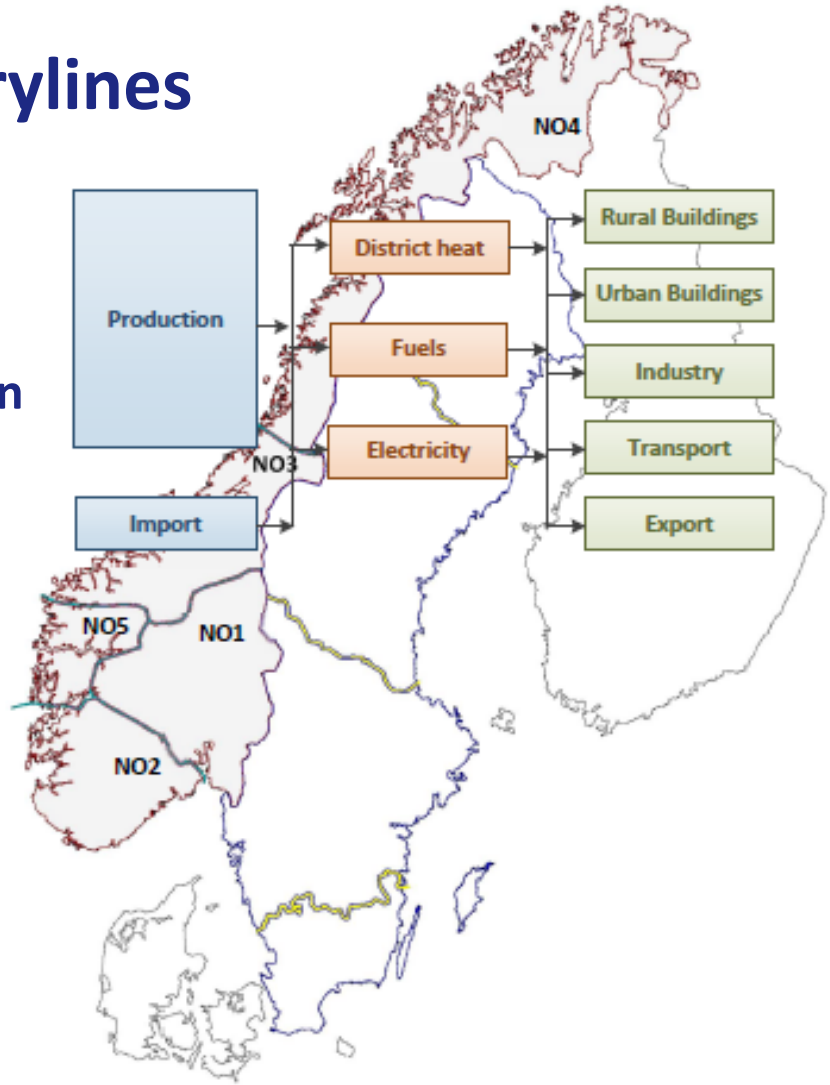


Example of decarbonization storylines

The future is uncertain, also the energy system!

TIMES-analysis on Norwegian decarbonization storylines:

1. **Oil nation** – transformation of the Norwegian oil and gas sector
1. **Energy nation -** export of electricity and power-intensive products
2. **Nature nation**- limit intervention to Norwegian nature

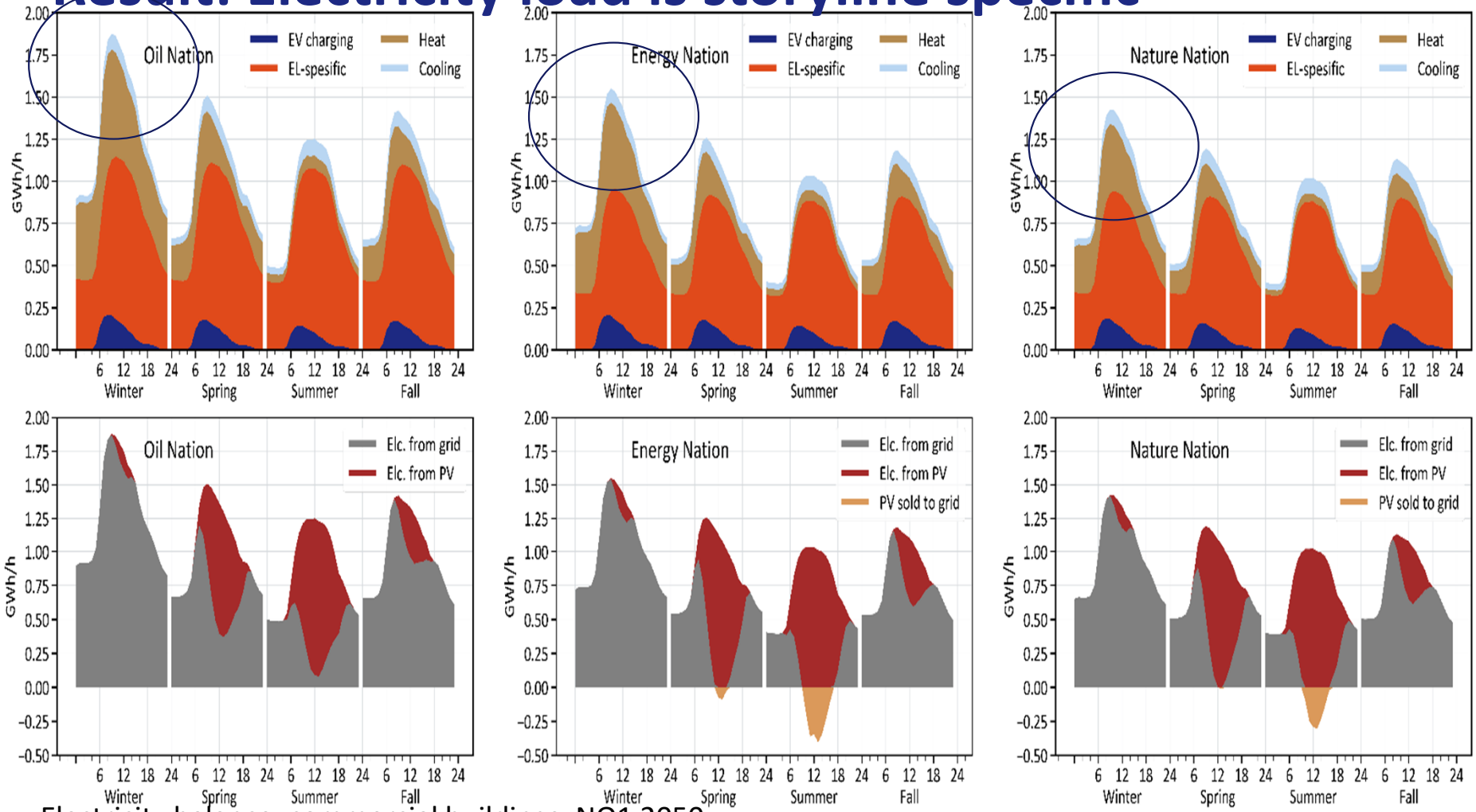


Results: Norwegian electricity generation and use 2050

Results	Storyline	2020	2050
Hydropower (TWh)	Oil	135	157
	Energy	135	156
	Nature	135	157
Wind (TWh)	Oil	14	25
	Energy	14	37
	Nature	14	0
PV Residential (TWh)	Oil	0	4
	Energy	0	9
	Nature	0	7
PV Commercial (TWh)	Oil	0	4
	Energy	0	6
	Nature	0	5

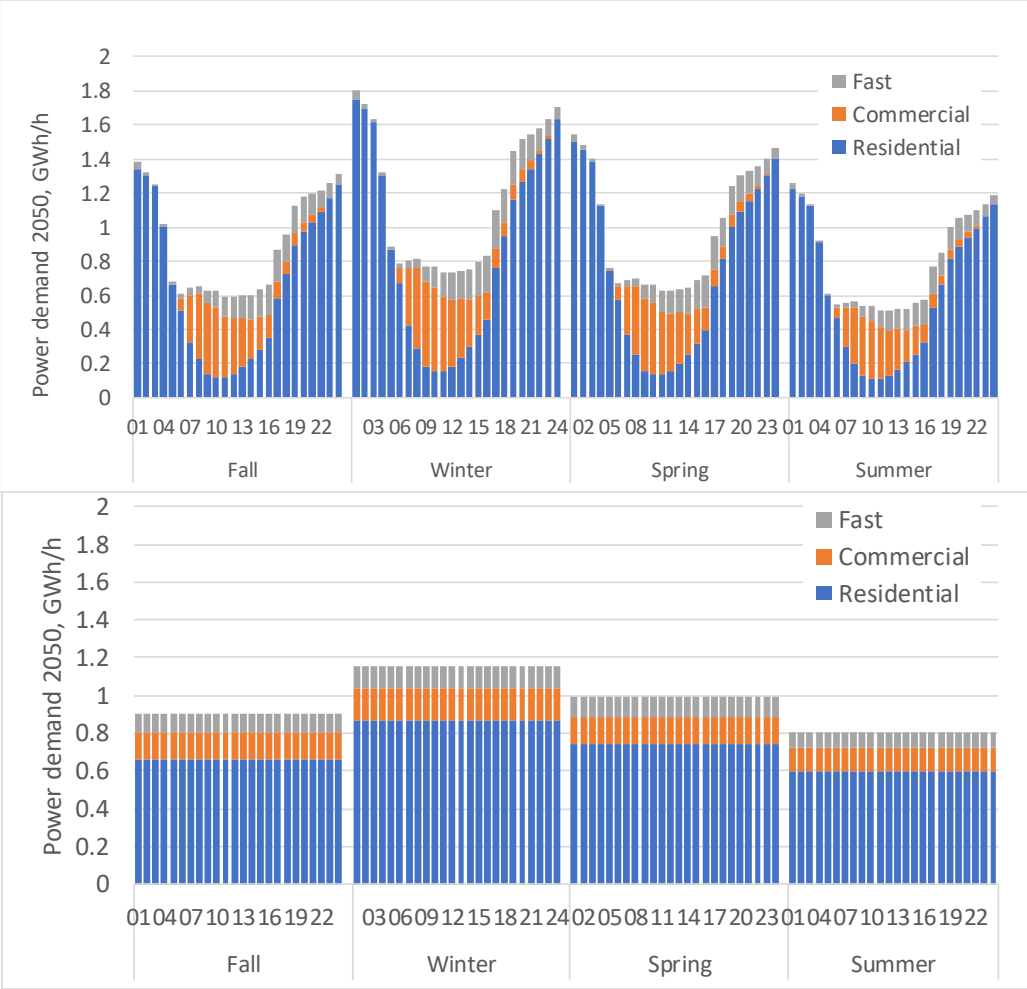
Results	Storyline	2020	2050
Industry (TWh)	Oil	66	88
	Energy	66	78
	Nature	66	65
Transport (TWh)	Oil	2	20
	Energy	2	38
	Nature	2	35
District heat (TWh)	Oil	1	3
	Energy	1	1
	Nature	1	2
Residential (TWh)	Oil	39	42
	Energy	39	35
	Nature	40	30
Commercial (TWh)	Oil	23	21
	Energy	25	17
	Nature	24	15

Result: Electricity load is storyline specific



Electricity balance, commercial buildings, NO1 2050

Result: EV charging profile influences PV integration



- Charging profile influences cost-optimal PV integration

Results	Storyline	2050
PV generation (TWh)	Oil	7.7
	Oil-Flat	7.9
	Energy	14.7
	Energy-Flat	15.1
	Nature	12.2
	Nature-Flat	13.3

Increase in PV with a flat profile

- Oil = 3%
- Energy = 3%
- Nature = 9%

Result: Distribution grid cost model influences local PV

- Norwegian authorities are currently proposing a new model for distribution grid cost
- Purpose: Distribution grid cost shall facilitate electrification
- Small customers < 100 000 kW/h
  - Previous: Cost per electricity use
  - Proposed: Fixed fee and time of use
- Large customers > 100 000 kW/h
  - Cost per effect use, e.g. monthly
  - + Fixed fee

- New proposed tariffs disbenefits PV and local storage
- Previous grid model/ *proposed grid model*

Oil 2050 :	8.7 TWh/ *7.7 TWh*
Energy 2050:	19.5 TWh/ *14.7 TWh*
Nature 2050:	14.6 TWh / *12.2 TWh*

Concluding remarks

- Long-term energy system models
  - tool for long-term planning of the low carbon transition
  - captures the effect of integrating supply and demand side, with more intermittent generation and electrification
  - can provide decision support but cannot predict
    - the future is uncertain
    - actors do not necessarily act according to cost-optimality for a nation
  - basis for discussions

Thank you

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