# The role of Norway in the European energy transition

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CenSES
Centre for Sustainable Energy Studies

Norway's role as a flexibility provider in a renewable Europe

A position paper prepared by FME CenSES

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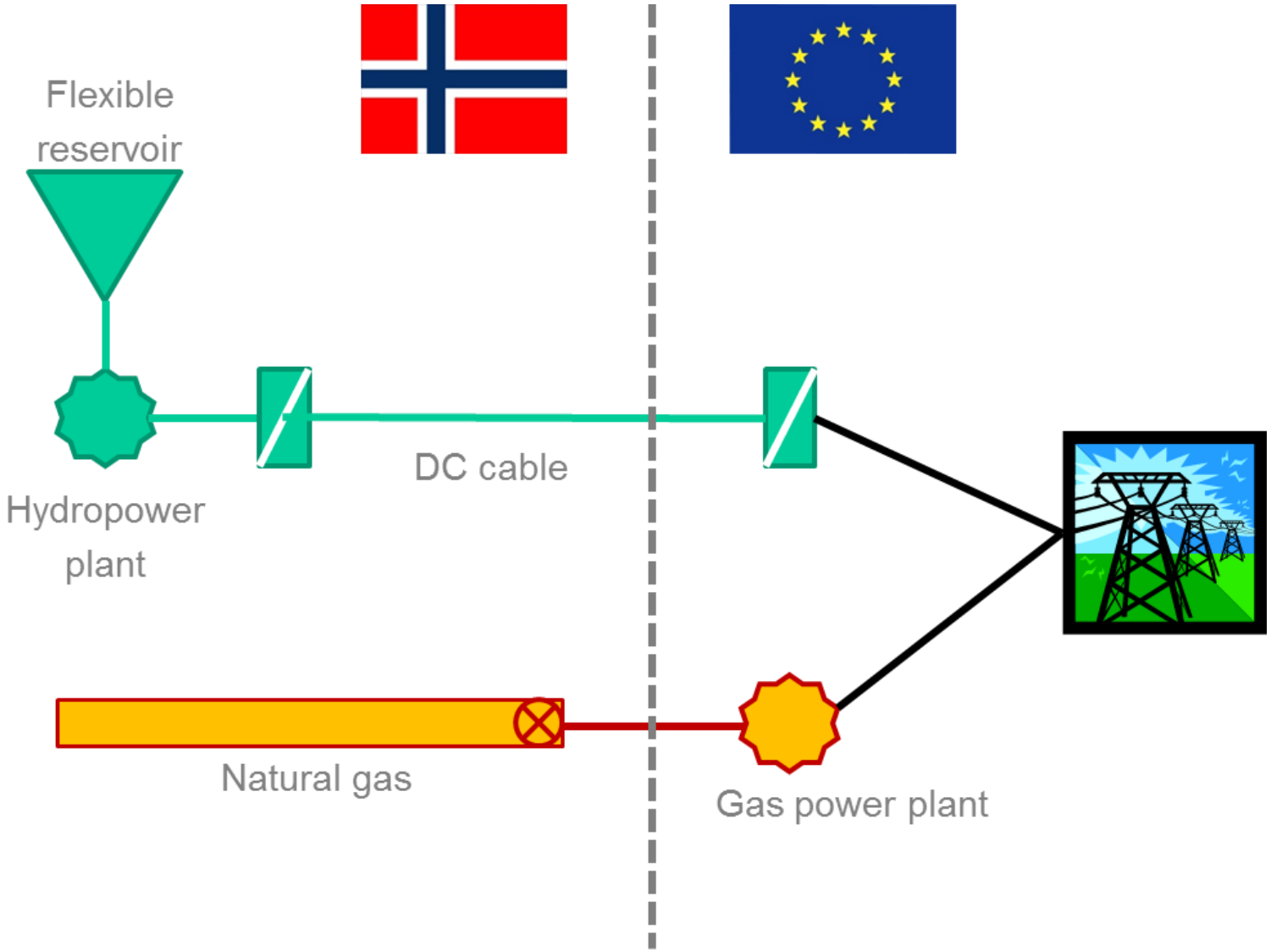
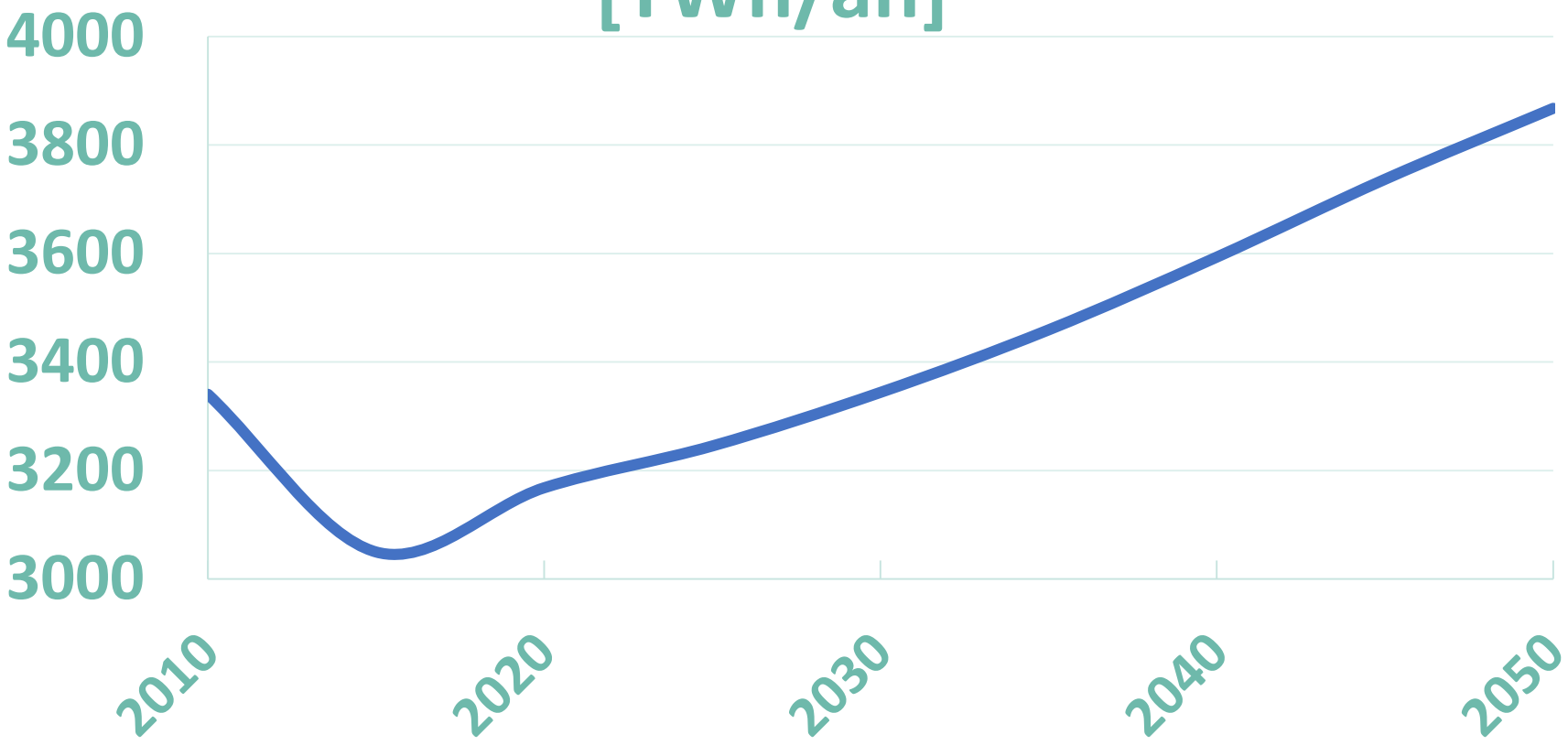
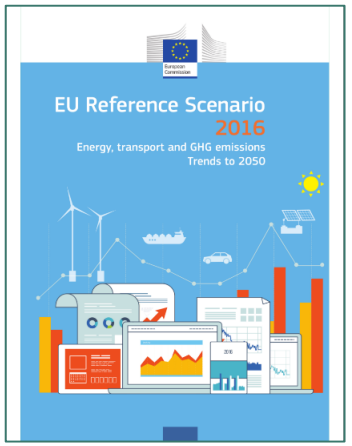

Flexible reservoir
Hydropower plant
DC cable
Natural gas
Gas power plant

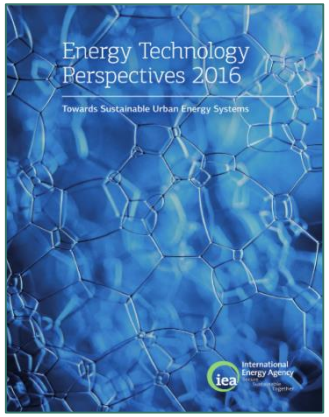
# Assumptions

## European demand for electricity [TWh/an]




EU reference scenario 2016

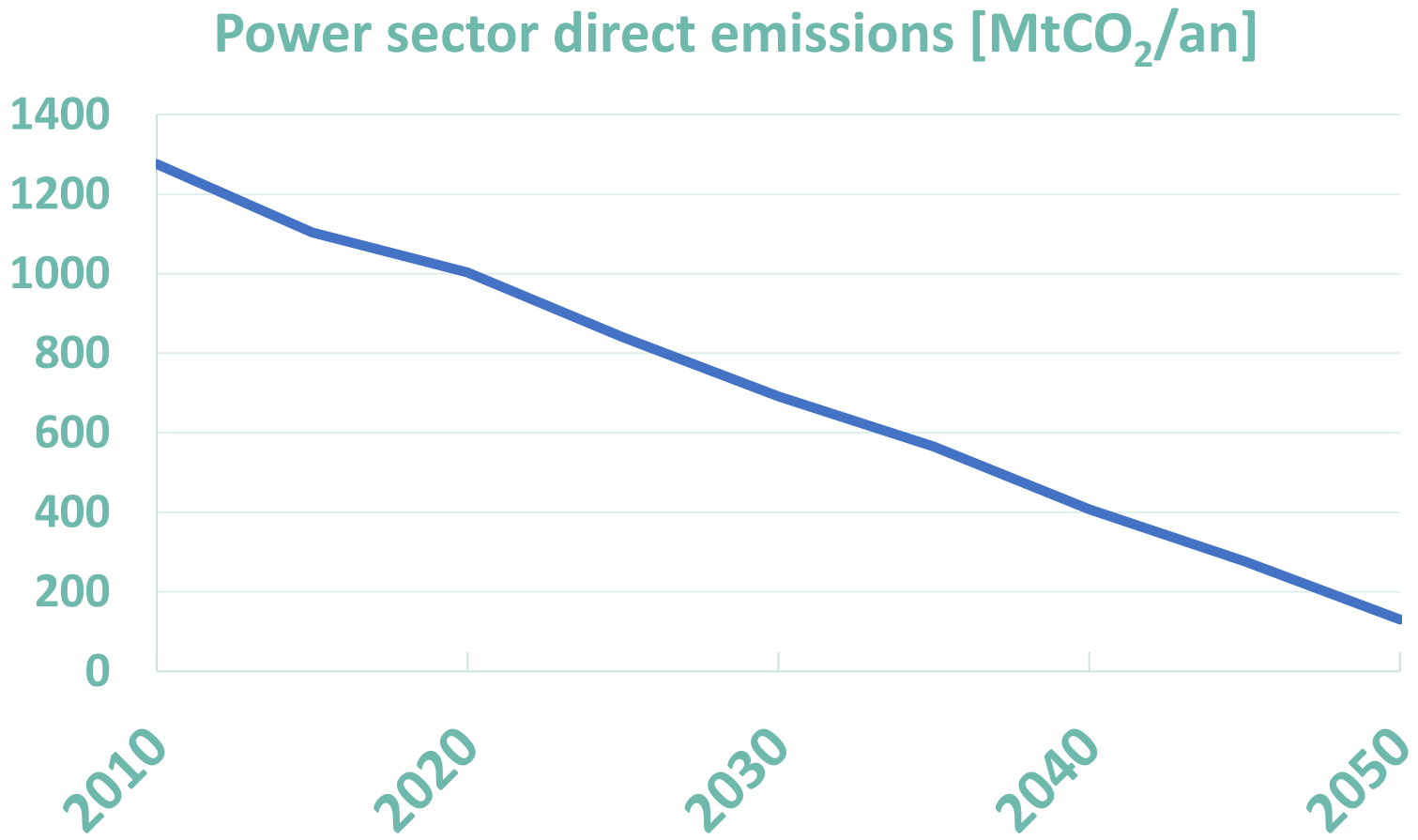



IEA Energy Technology Perspective 2016

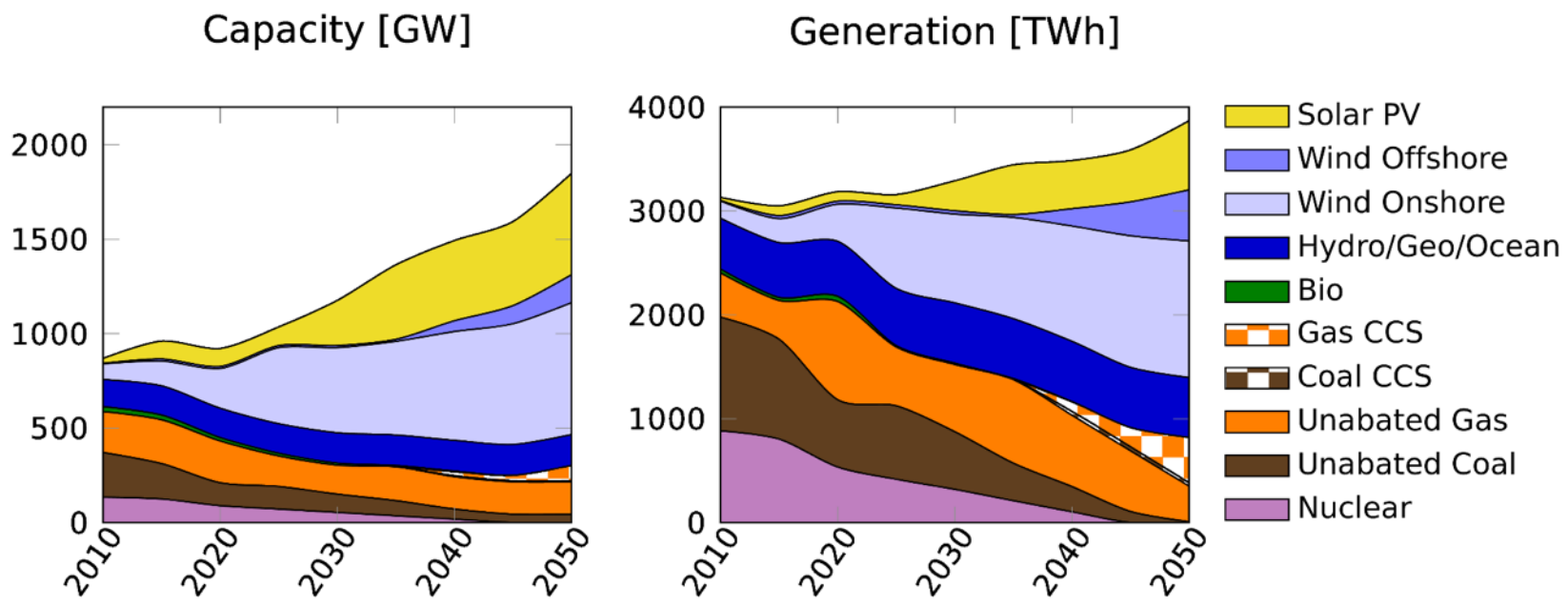
# 90 % emission reduction

**Baseline scenario:** CCS available as a commercial technology

Alternative scenario **NoCCS**: same as baseline but no carbon capture and storage available



# **Baseline scenario:** 90 % emission reduction




| Technology/fuel (2050) | Capacity [GW] (% share) | | Generation [TWh] (% share) | |
|---|---|---|---|---|
| Solar | 536 | (29%) | 665 | (17%) |
| Wind onshore | 698 | (38%) | 1314 | (34%) |
| Wind offshore | 149 | (8%) | 492 | (13%) |
| Gas CCS | 81 | (4%) | 436 | (11%) |
| Coal CCS | 6 | (0%) | 33 | (1%) |
| Fossil unabated | 215 | (12%) | 350 | (9%) |
| Others (Hydro, Geo, etc.) | 164 | (9%) | 577 | (15%) |

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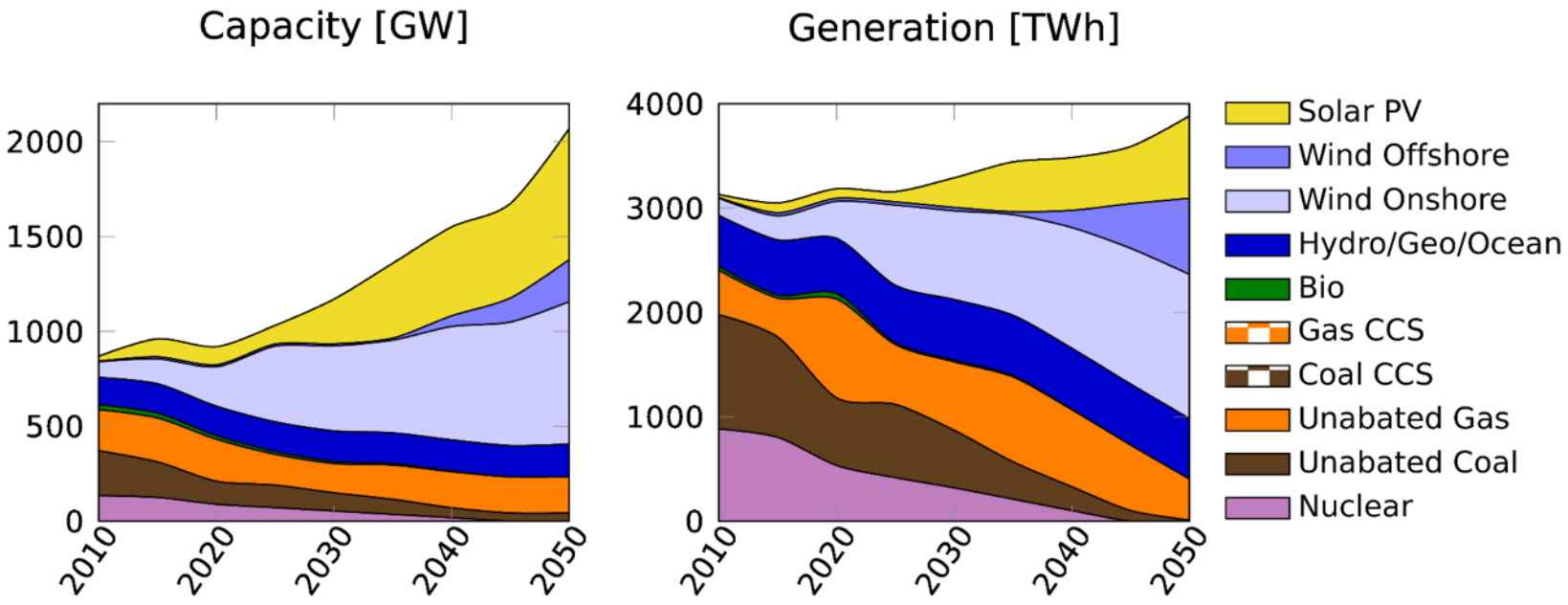
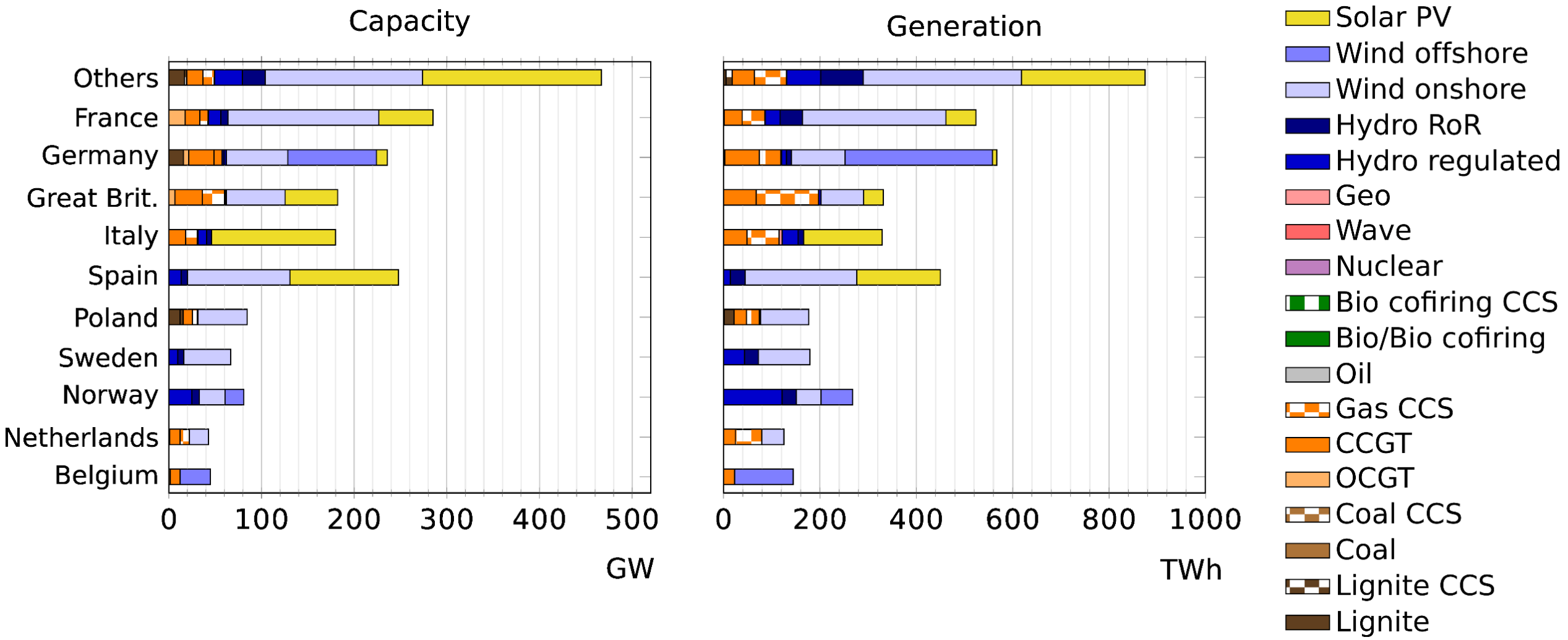
# **NoCCS scenario:** 90 % emission reduction

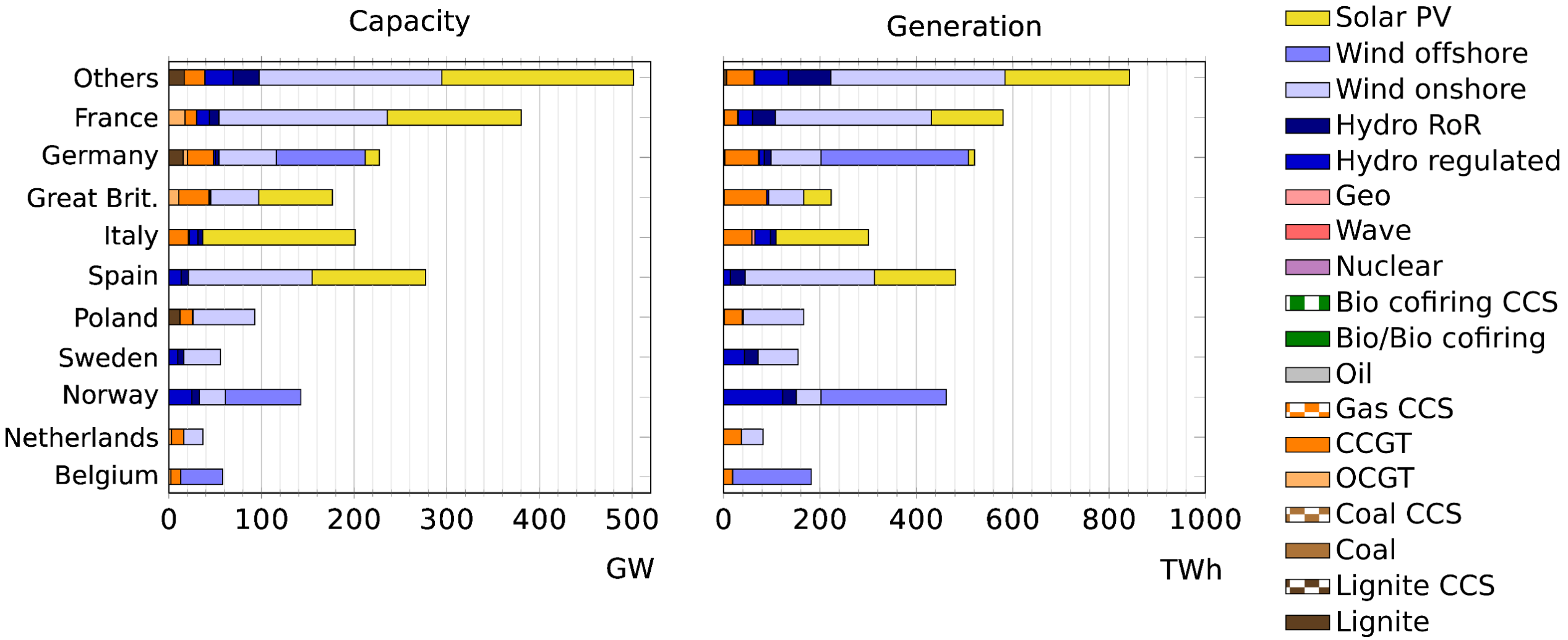



| Technology/fuel (2050) | Capacity [GW] (% share) | | Generation [TWh] (% share) | |
|---|---|---|---|---|
| Solar | 690 | (33%) | 788 | (20%) |
| Wind onshore | 751 | (36%) | 1381 | (36%) |
| Wind offshore | 222 | (11%) | 730 | (19%) |
| Coal (unabated) | 43 | (2%) | 11 | (0%) |
| Natural gas (unabated) | 190 | (9%) | 393 | (10%) |
| Others | 173 | (8%) | 580 | (15%) |

# Baseline country results 2050

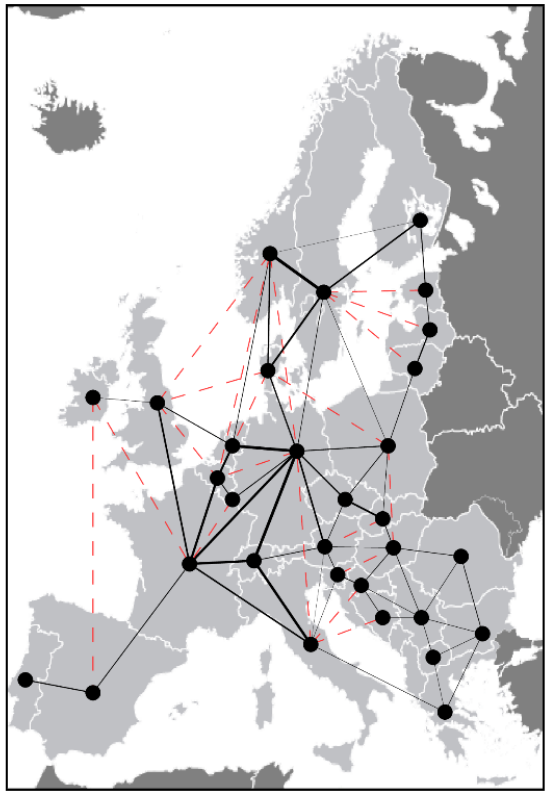


# NoCCS country results 2050

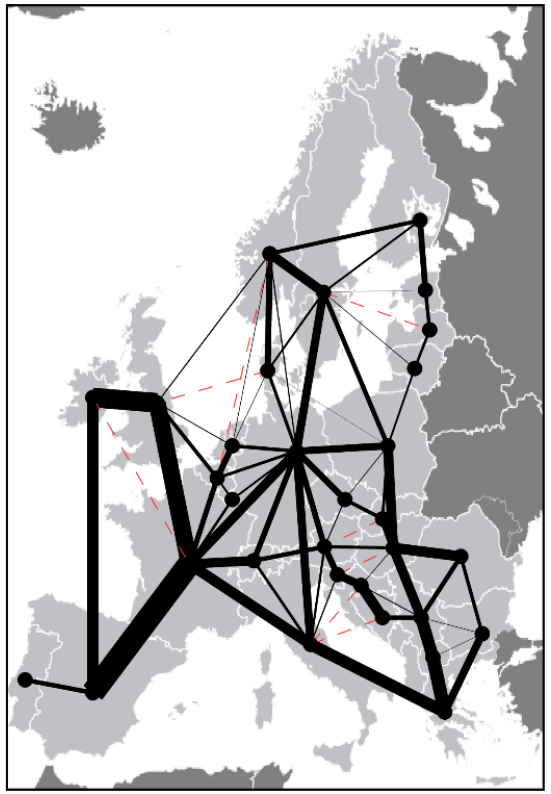


# Transmission

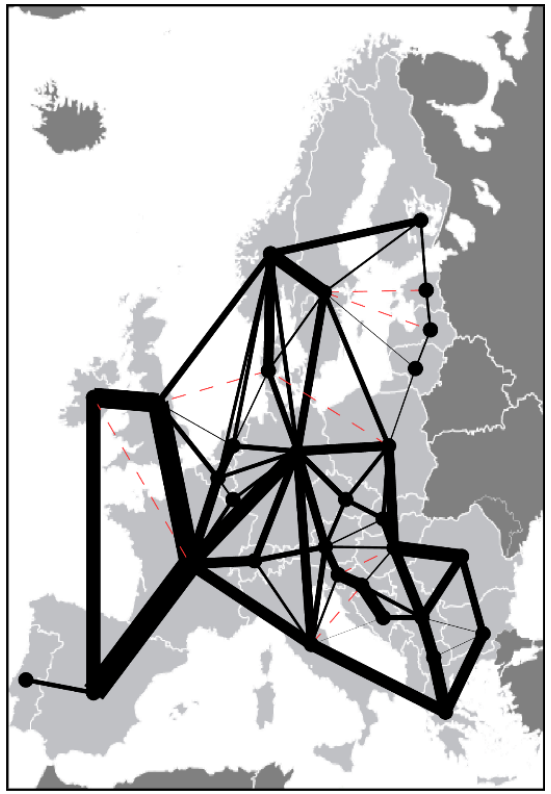
2010



Baseline 2050



No CCS 2050



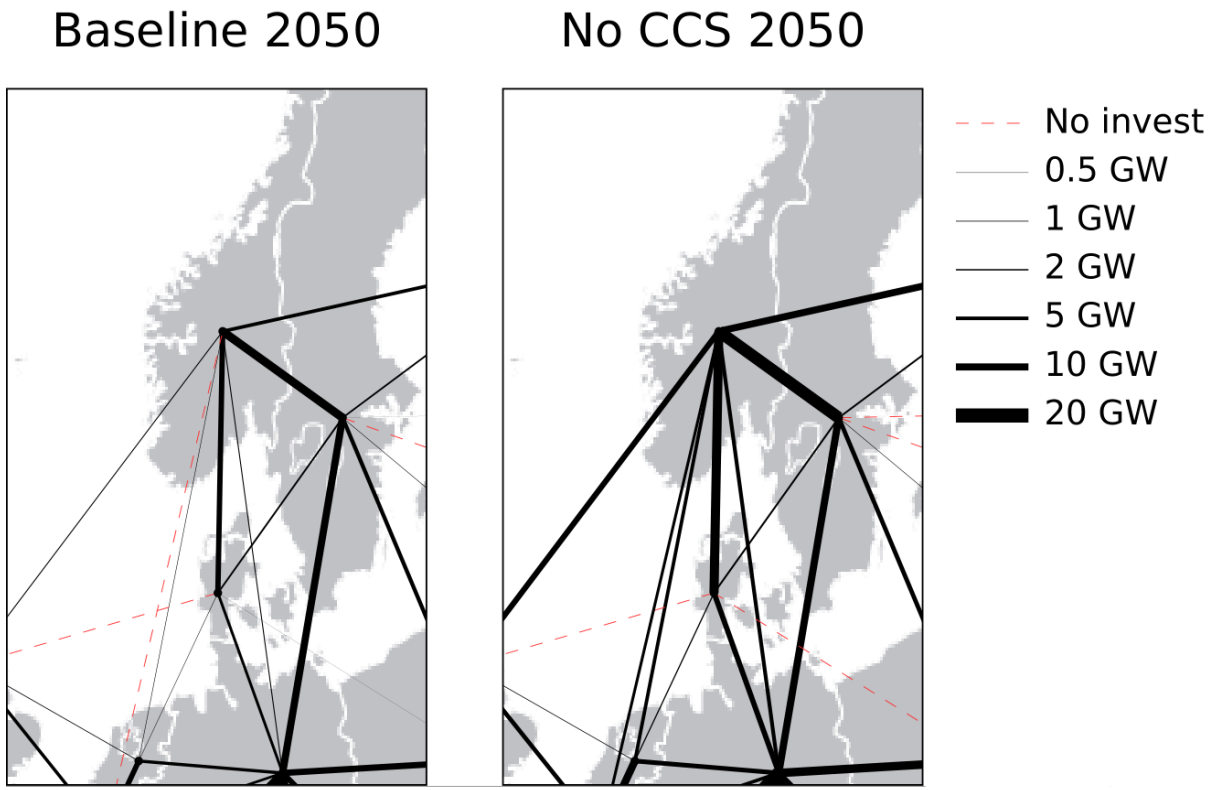
**Baseline**
cross-boarder expansion: increases by 701% from 2010 to 2050

**NoCCS**
Capacity increases by 811% from 2010 to 2050

No invest | 0.5 GW | 1 GW | 2 GW
5 GW | 10 GW | 20 GW | 30 GW

# Norway in 2050

| Type | Baseline | NoCCS |
|---|---|---|
| Demand | 152 | 152 |
| Generation | 266 | 459 |
| *Hydro regulated* | ***120*** | ***121*** |
| *Hydrorun-of-river* | *30* | *28* |
| *Wind onshore* | ***51*** | ***50*** |
| *Wind offshore* | ***65*** | ***258*** |
| Export | 128 | 320 |
| Import | 16 | 16 |
| Net export | 112 | 304 |




**Capacity: 28 GW**

**Capacity: 62 GW**

*Energy balances in TWh*

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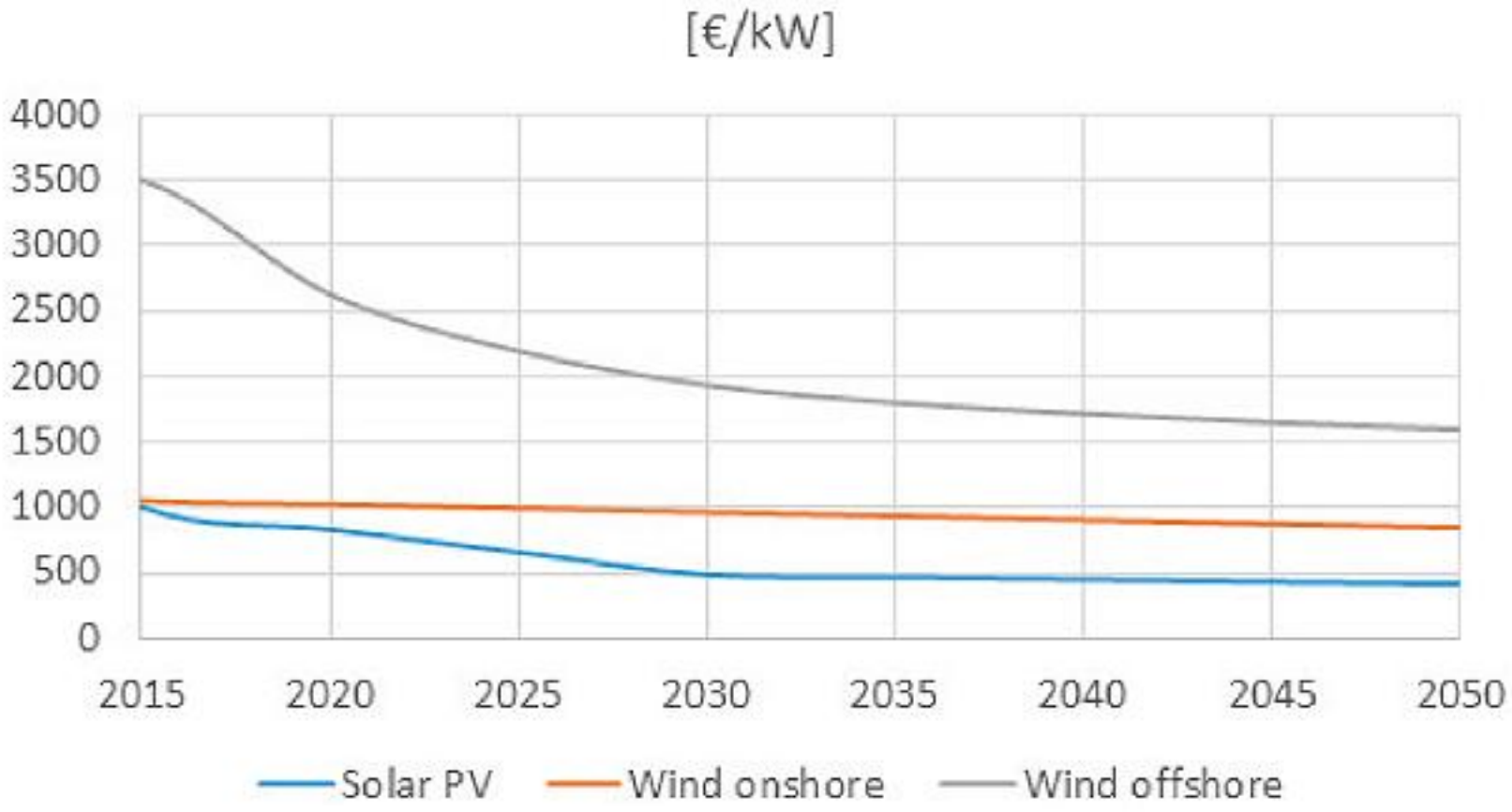
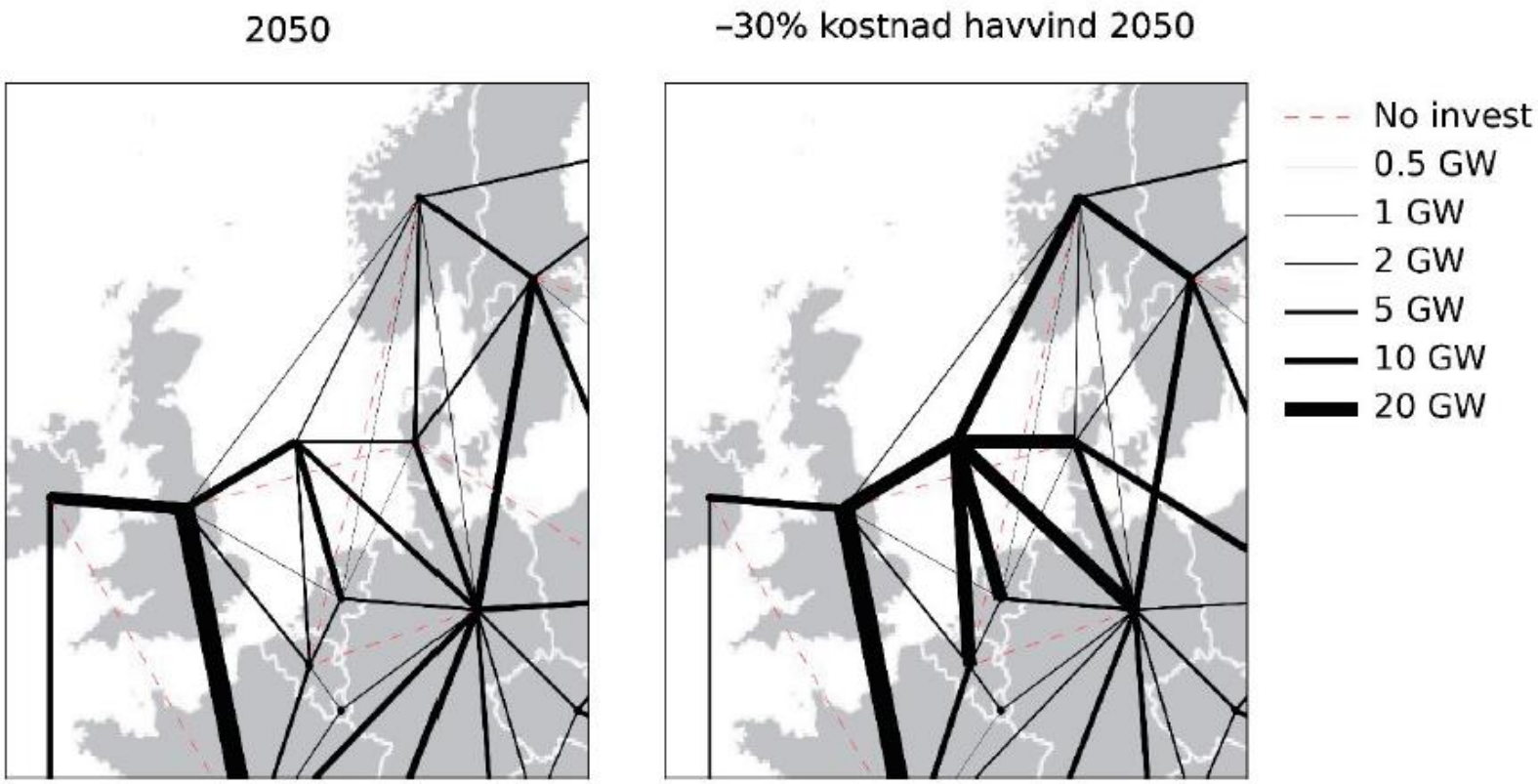
# Offshore wind study



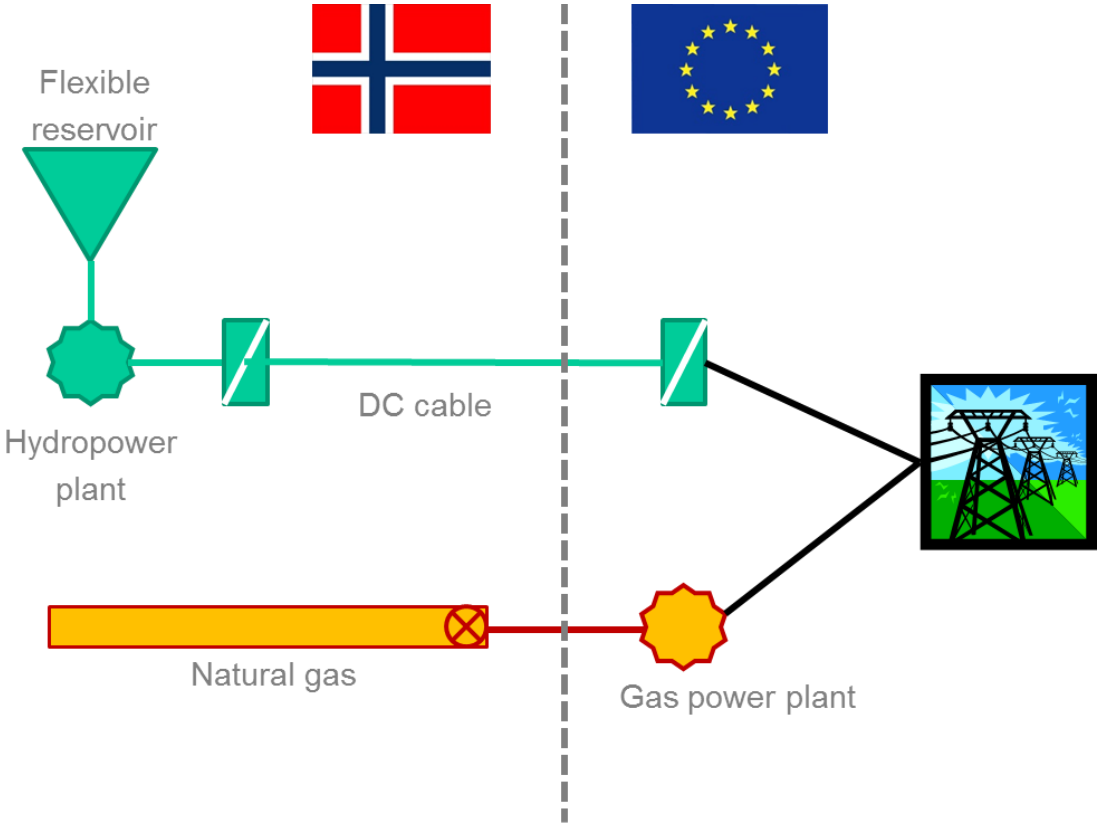
# With offshore wind region in the North-sea



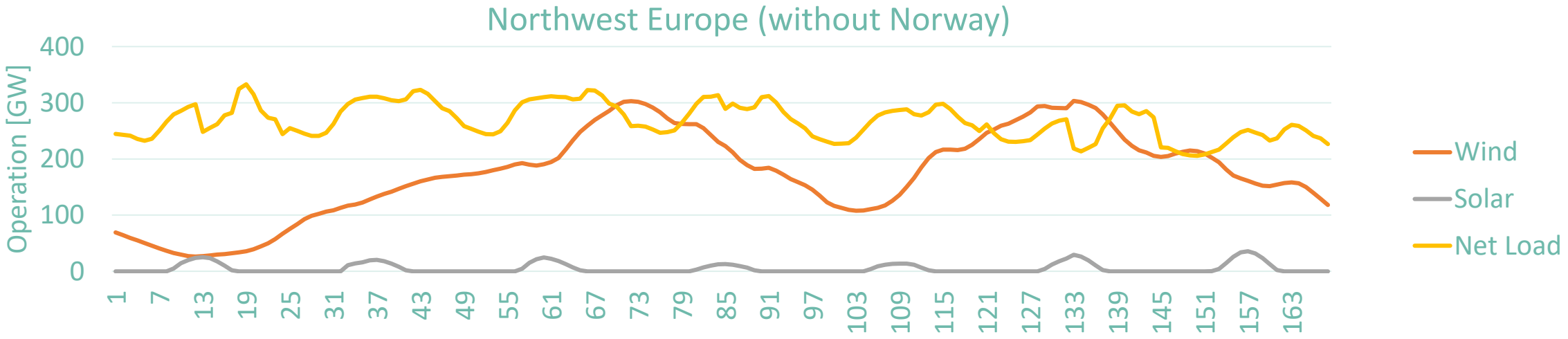

Baseline 42 GW installed wind capacity

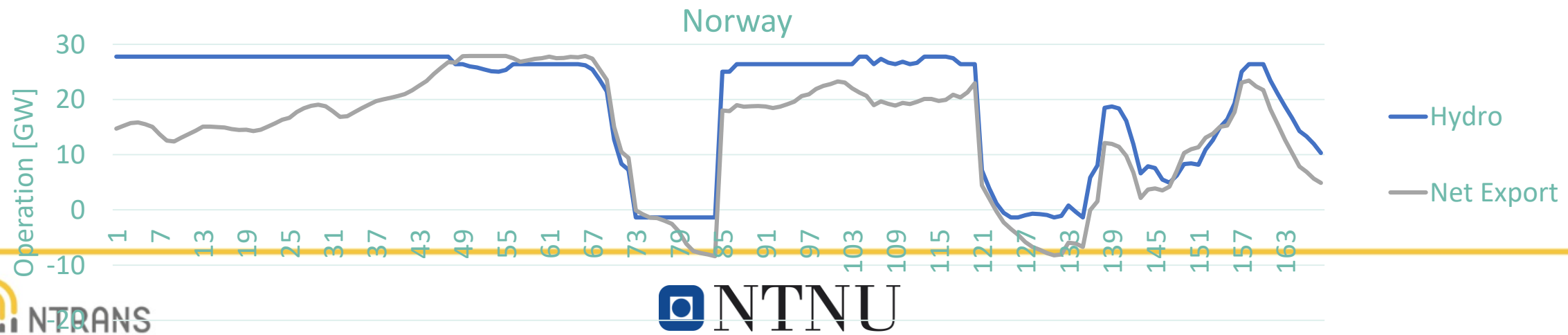
30 cost reduction: 143 GW

# Effects on the use of hydropower and natural gas



# Northwest Europe winter week 2050 (Baseline)

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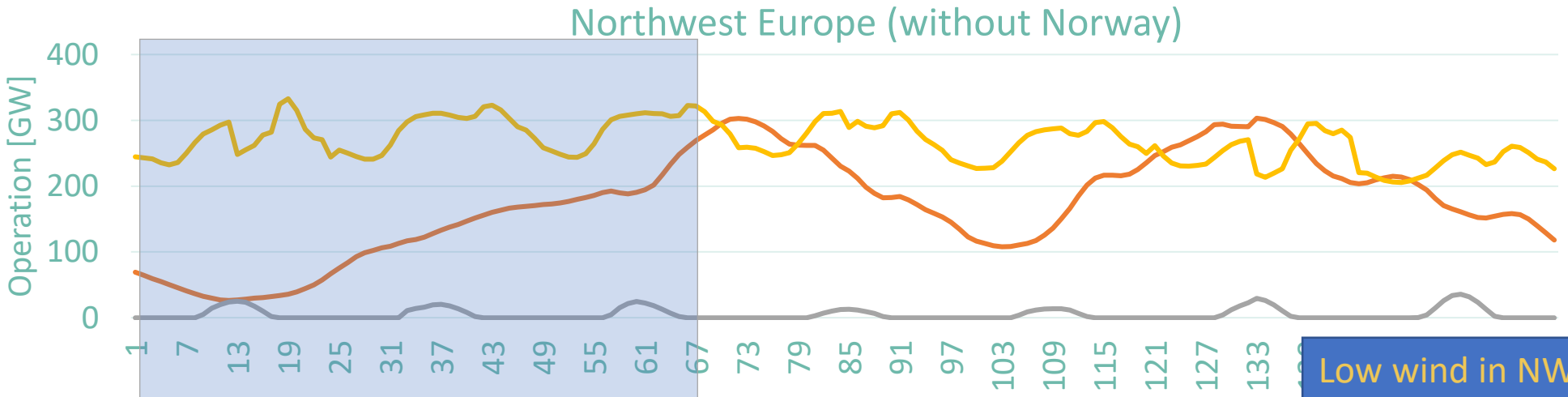
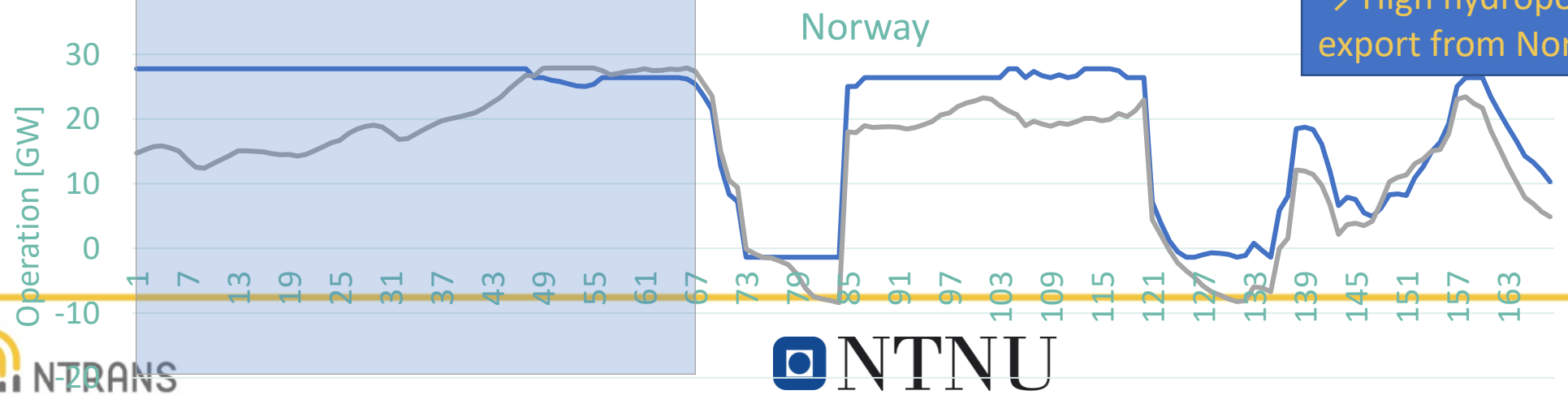
# Northwest Europe winter week 2050 (Baseline)




Low wind in NW Europe
→ High hydropower production and export from Norway

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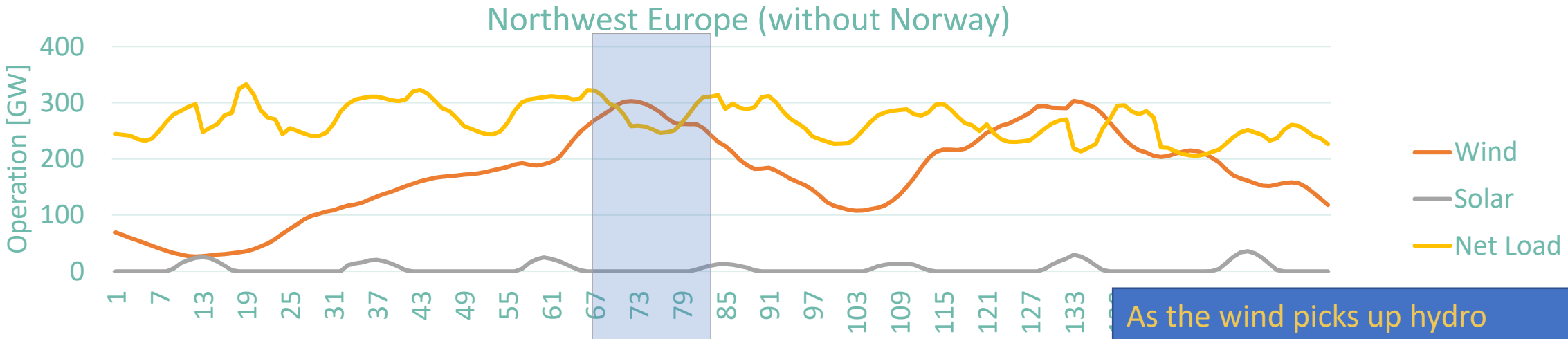
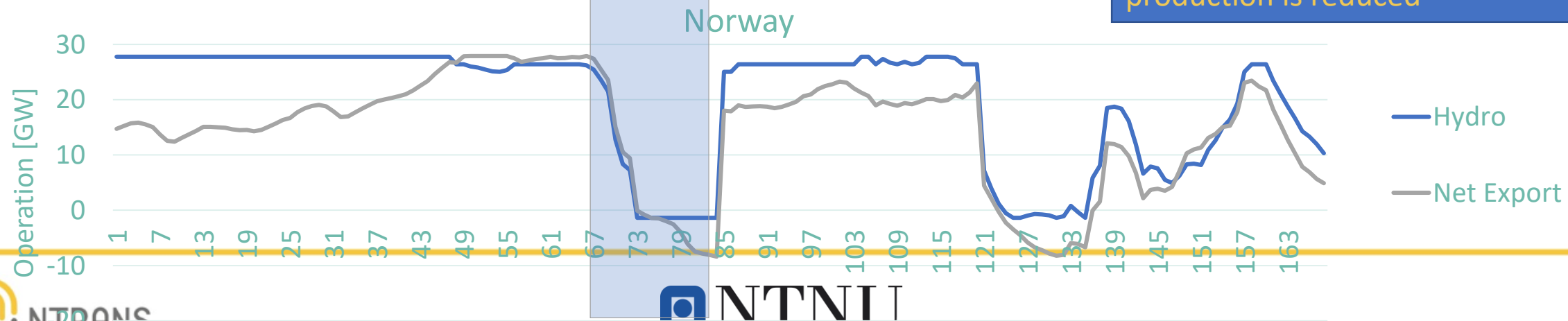
# Northwest Europe winter week 2050 (Baseline)




As the wind picks up hydro production is reduced

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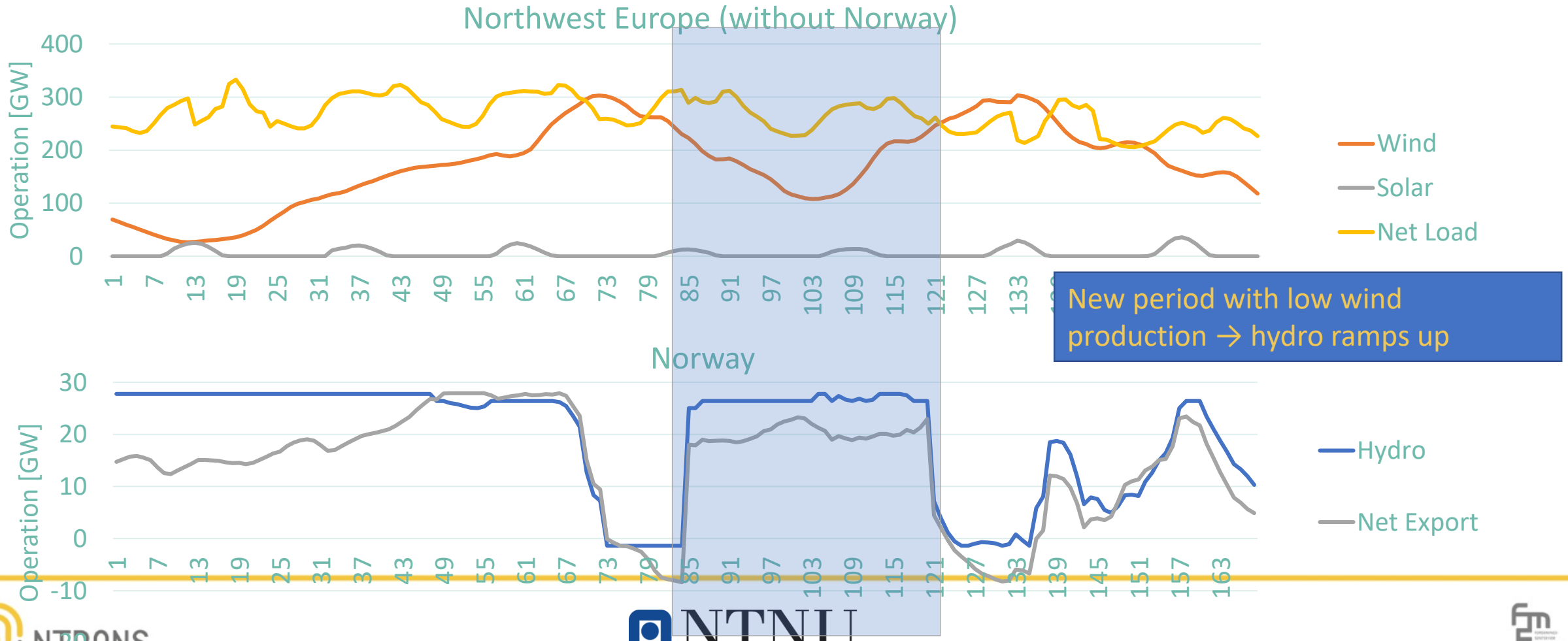
# Northwest Europe winter week 2050 (Baseline)




New period with low wind production → hydro ramps up

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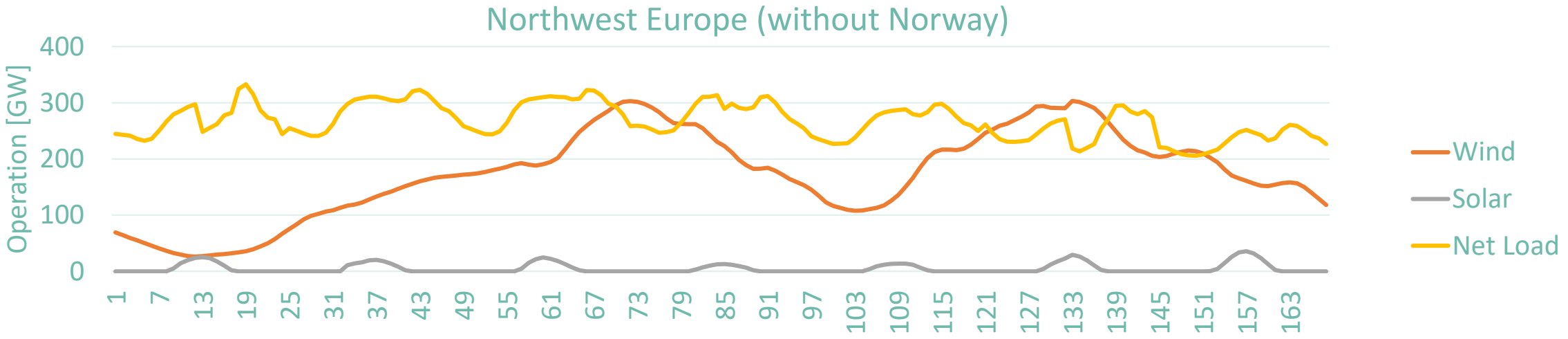
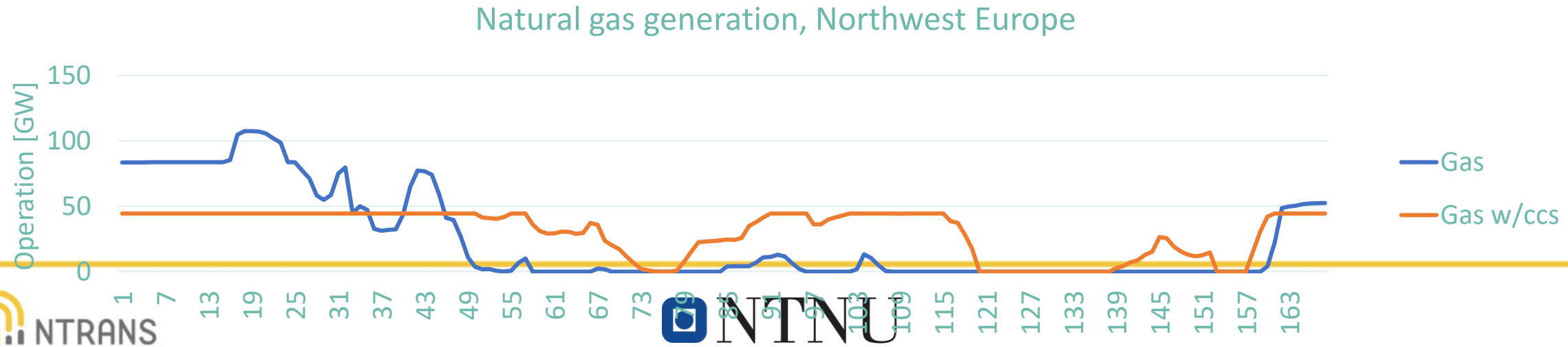
# Northwest Europe winter week 2050 (Baseline)

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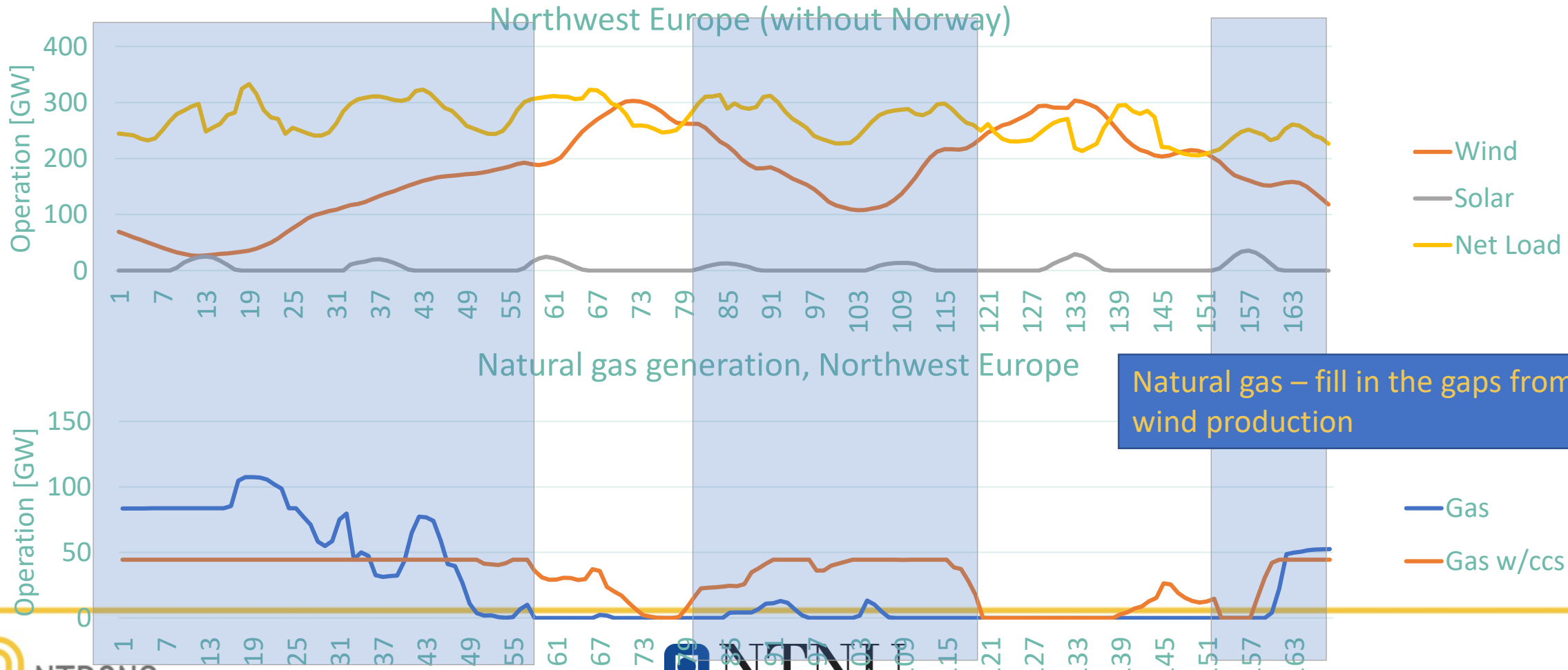


Natural gas – fill in the gaps from low wind production

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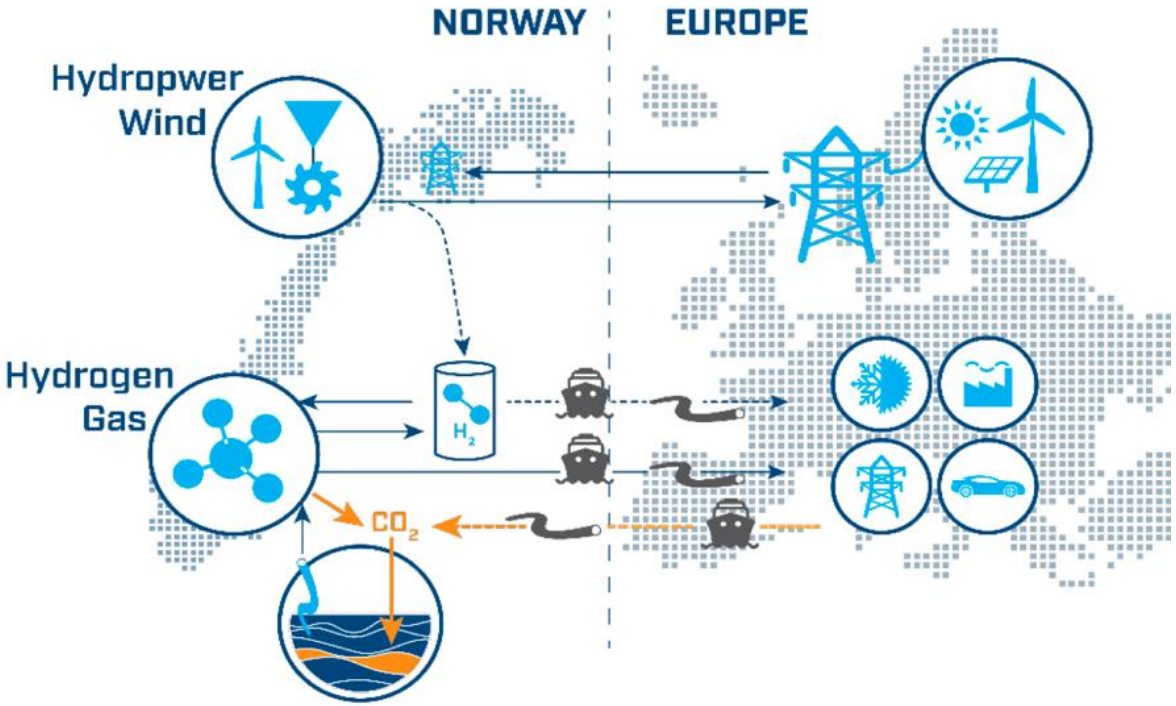
# KPN Clean Energy export


SINTEF, NTNU, Agder Energi, NEL, Equinor, Gassco, Total, Air Liquid

# Key findings

- **Natural gas** still remain in the mix to provide flexibility
  - with CCS twice as much as without
- **Onshore wind** become the most significant low carbon technology
  - 1/3 of the mix in Europe
  - more than twice the share of solar PV and offshore wind combined
- **Transmission** is the favored flexibility measure
- **Hydropower a unique resource**.

# Key findings

- **Policy needed**
  - Cooperate to avoid suboptimal local investments
    - Examples: CCS, offshore wind, infrastructure
  - Share risk, cost and benefits
  - Market design and mechanisms will be a key factor
  - **Long-term policy and cooperation needed**

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