HydroCen WP3

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HydroCen
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CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
The Research Council of Norway

Outline

- HydroCen WP3 Task 3.1
  - Objective and motivation
- HydroCen scenarios
  - Reference and Low Emission scenario
- Spot price results
- What's next?
  - Initial results PriMod

WP3 Market and Services

Task 3.1
Future market structures and prices

Task 3.2
Remaining useful life, failure probability

Task 3.3
Optimal hydro design in the future power system

Task 3.4
Environmental constraints and uncertainties – impact on revenues

Task 3.5
Water resources assessment tool

Task 3.1 Future market structures and prices

Main objective

Utilizing models, market simulations and existing literature and data to provide information about future market products, prices and structures

Motivation

- Value of hydropower and correct investments depend on the future market prices of services provided by hydropower
- Price data to be used in Task 3.3 and 3.4

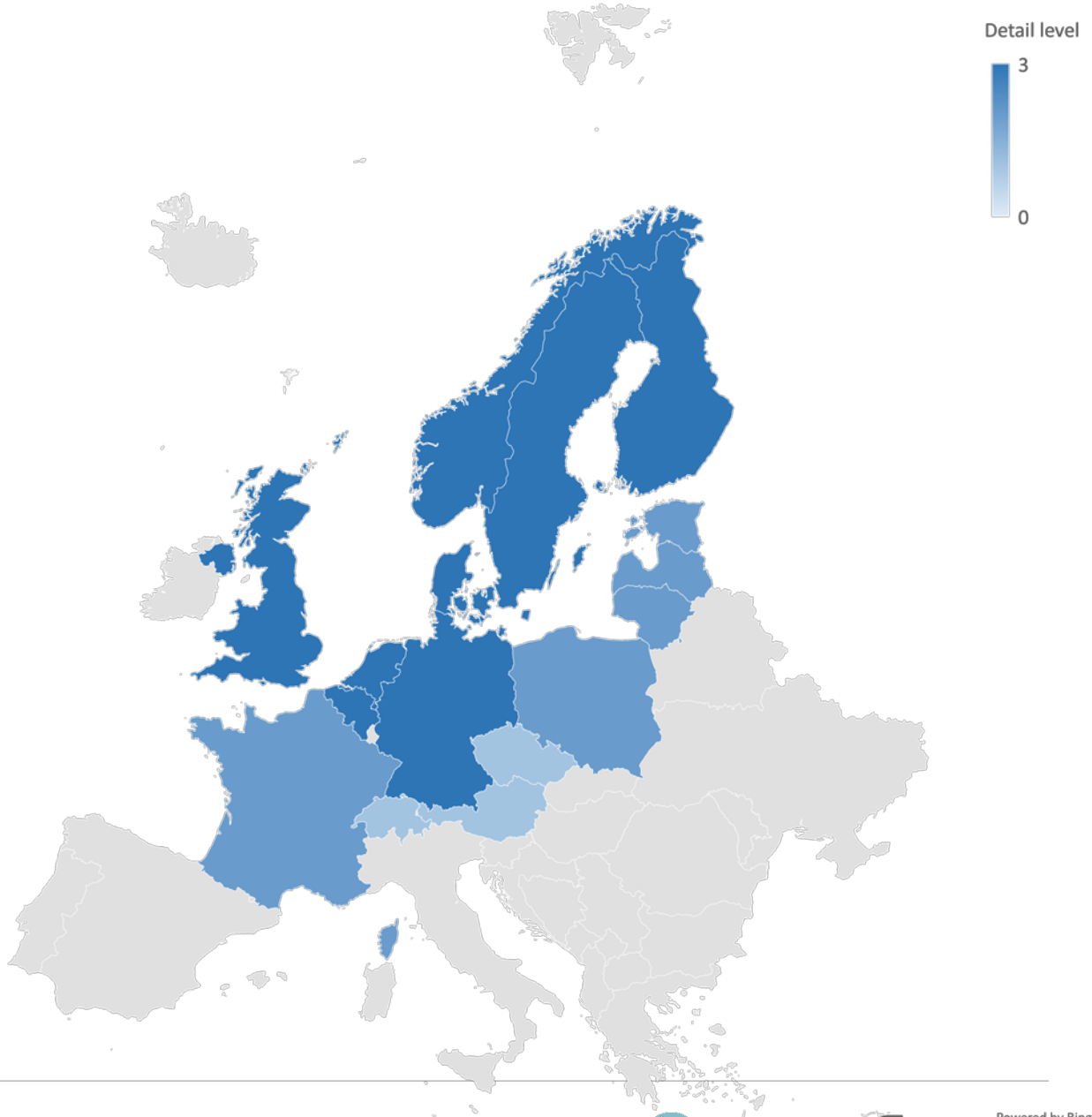
How

- Fundamentally model prices using existing models

Model set-up EMPS

- 57 areas, onshore and offshore
- 3h time steps (56 steps/week)
- 58 historical weather years

- Detailed hydro for the Nordic region
- Hourly wind and solar series
- Thermal power with start up costs
- Transmission capacities
- Wide range of assumptions for 2030



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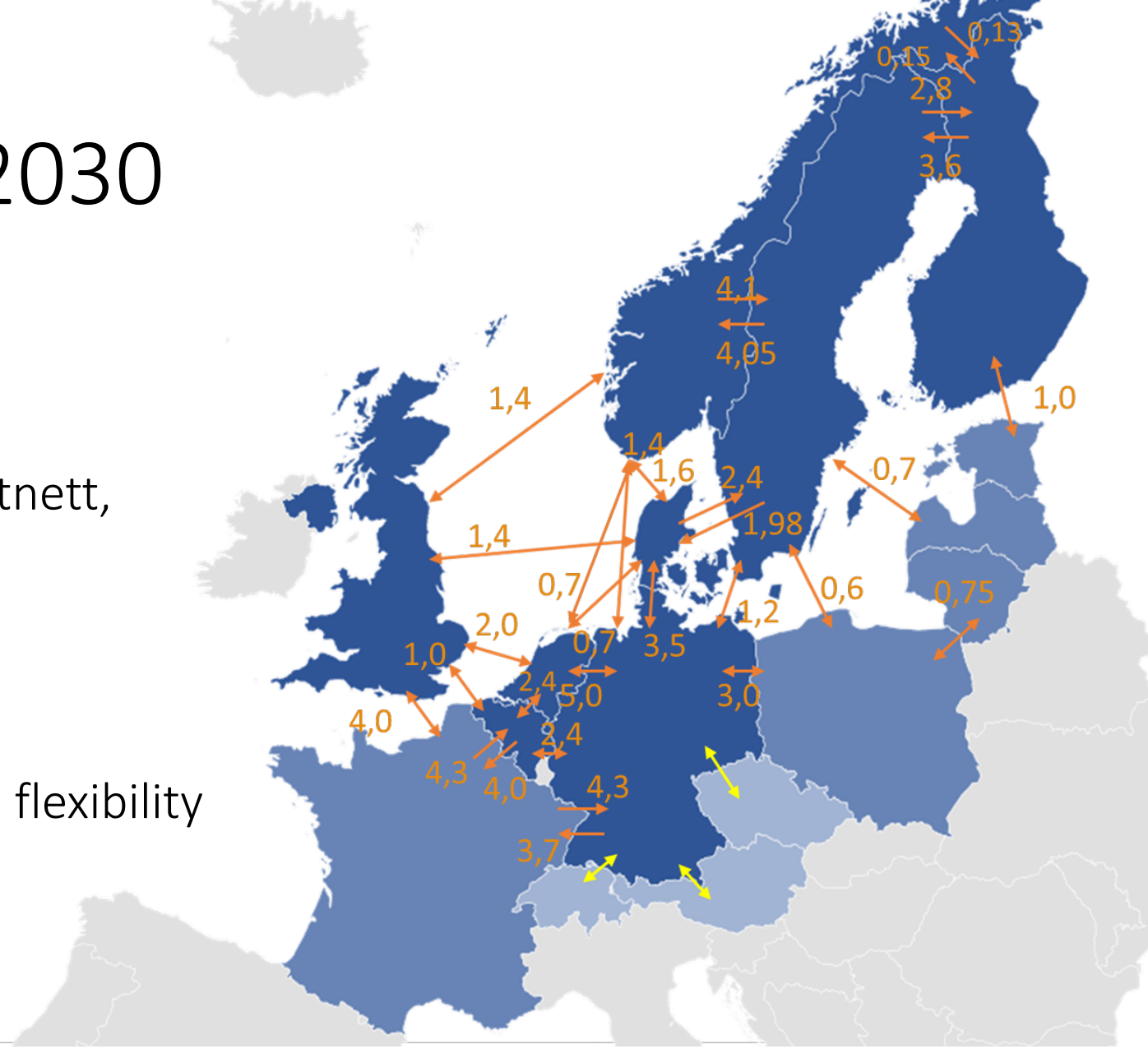
Reference Scenario 2030

- Moderate assumptions
- Follows existing plans and expected developments
- Based on previous studies (NVE, Statnett, EUCO30)

- Moderate increase in RES
- Moderate increase in load
- Traditional load profiles, no demand flexibility
- Phase out of coal in most countries
- Phase out of nuclear in Germany



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Low Emission Scenario 2030

Reference scenario

+ Increased RES
  - Nordics: wind and solar based on NVE 2018
  - GB, NL, BE: solar based on ENTSO-E DG 2030
  - Other Countries: onshore wind and solar capacity increased with 20%
+ Increased transmission capacity
  - 1400 MW NO-GB
  - 1400 MW NO-DE
+ Phase out of Lignite in Germany

Electricity generation mix

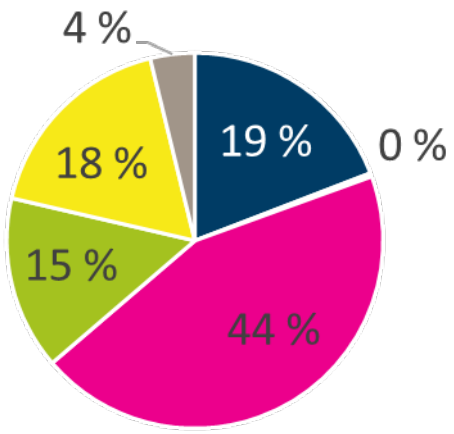
Reference Scenario 2030

Nordics: 79 % RES (19 % VRES)
Germany: 54 % RES (38 % VRES)

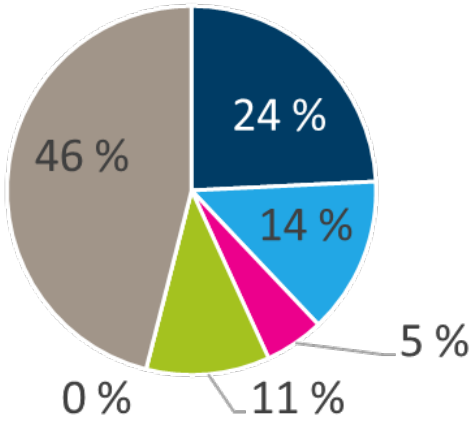
Low Emission Scenario 2030

Nordics: 80 % RES (24 % VRES)
Germany: 69 % RES (54 % VRES)

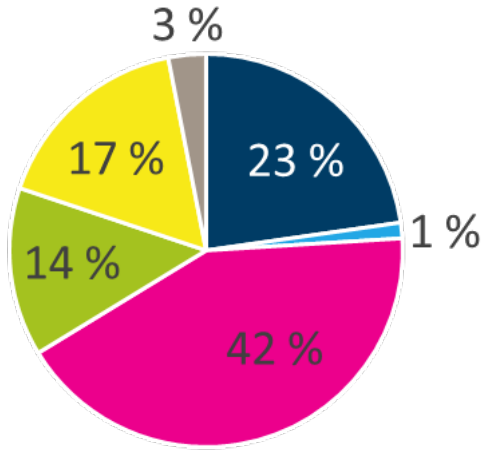
Nordics



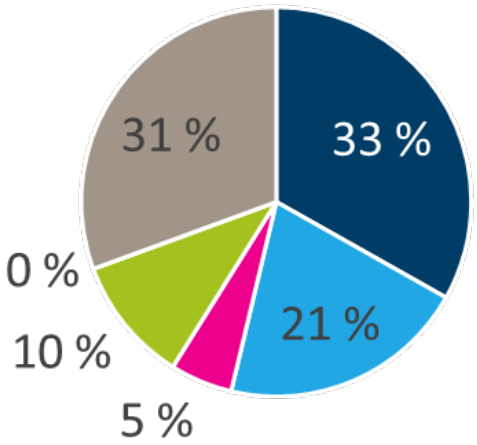
Germany



Nordics



Germany



Wind Solar Hydropower Other RES Nuclear Other

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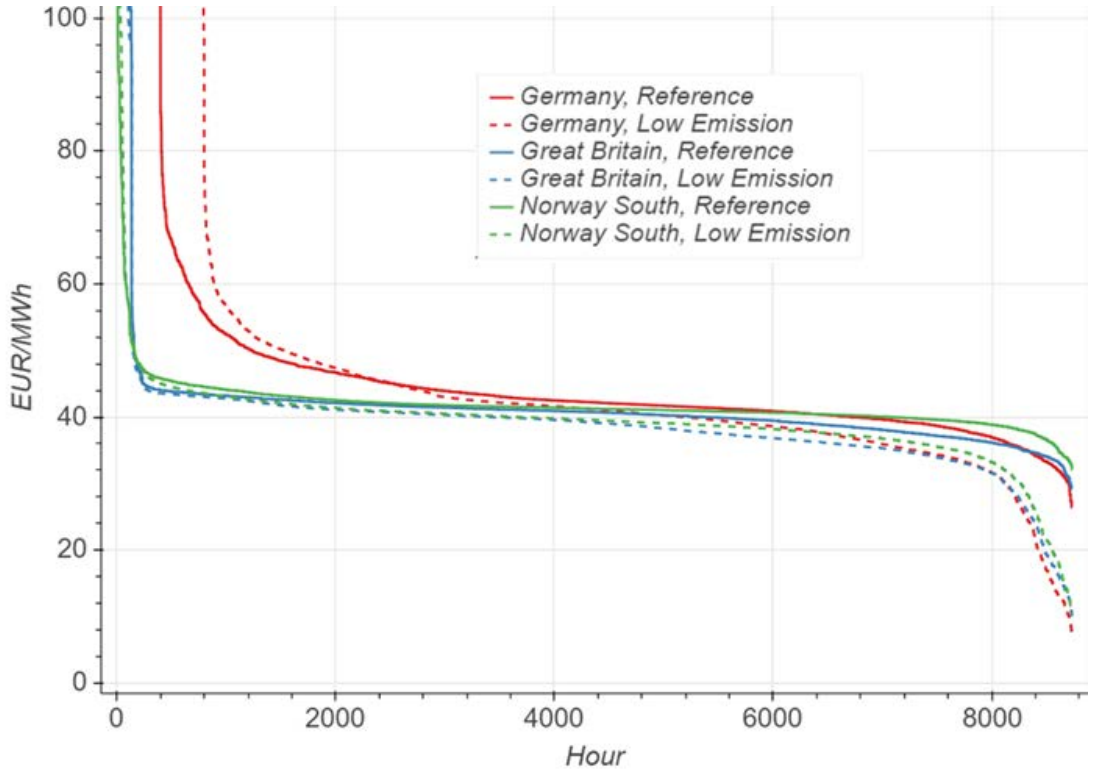
Main impact on price variation not level

- Constant fuel- and CO2 prices
  - Coal: 70 $/t
  - Gas: 20 €/MWh
  - CO2: 30 €/t

- Main difference between scenarios in hours with extreme prices (high and low)



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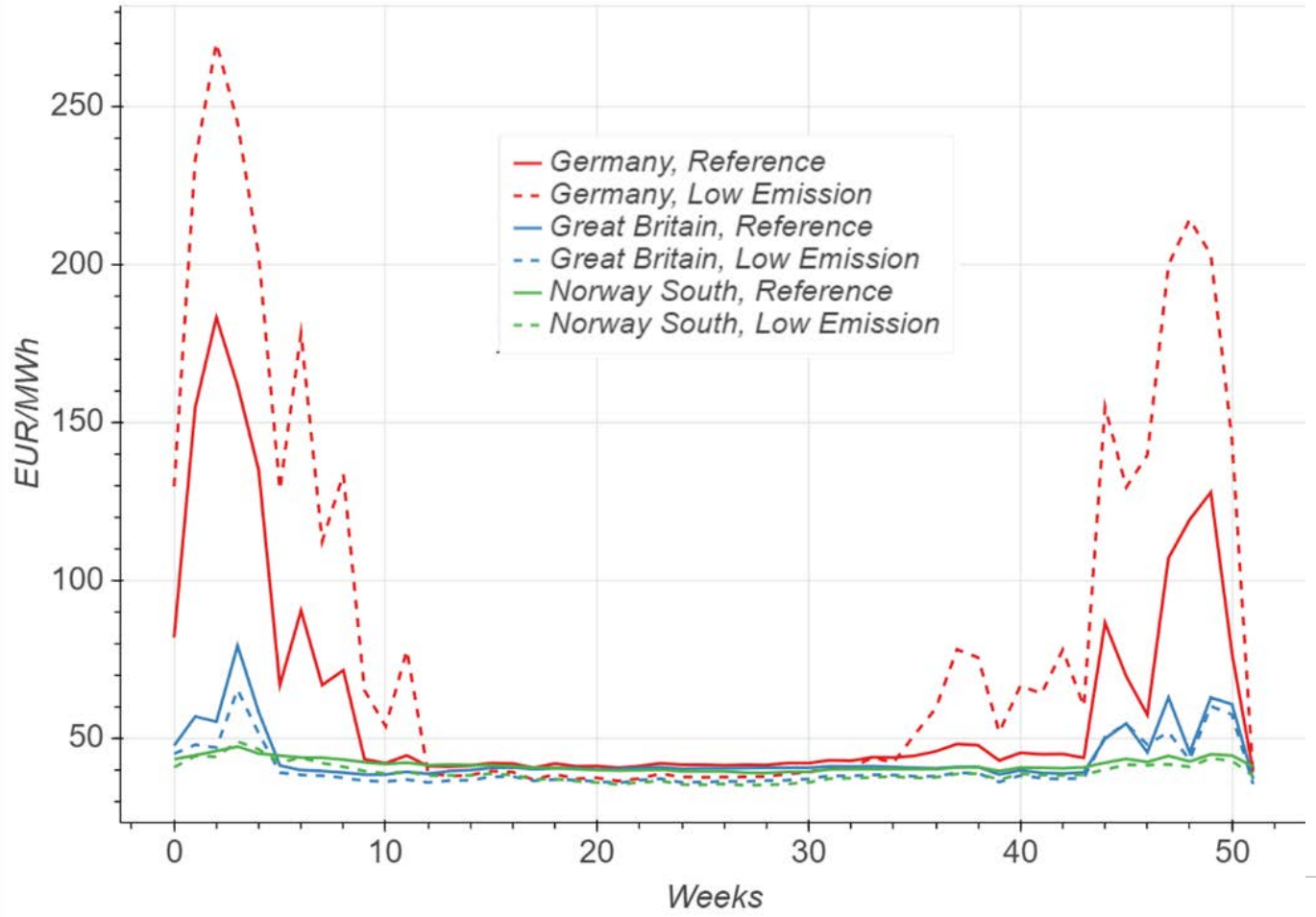
Average power prices



Area	Average Power Price [EUR/MWh]	
	Reference Scenario	Low Emission Scenario
OSTLAND	42.5	39.6
SORLAND	42.0	38.7
TYSK-NORD	46.3	45.4
TYSK-MIDT	46.5	46.2
GB-SOUTH	42.4	40.1
GB-MID	42.0	39.7
GB-NORTH	35.0	32.3

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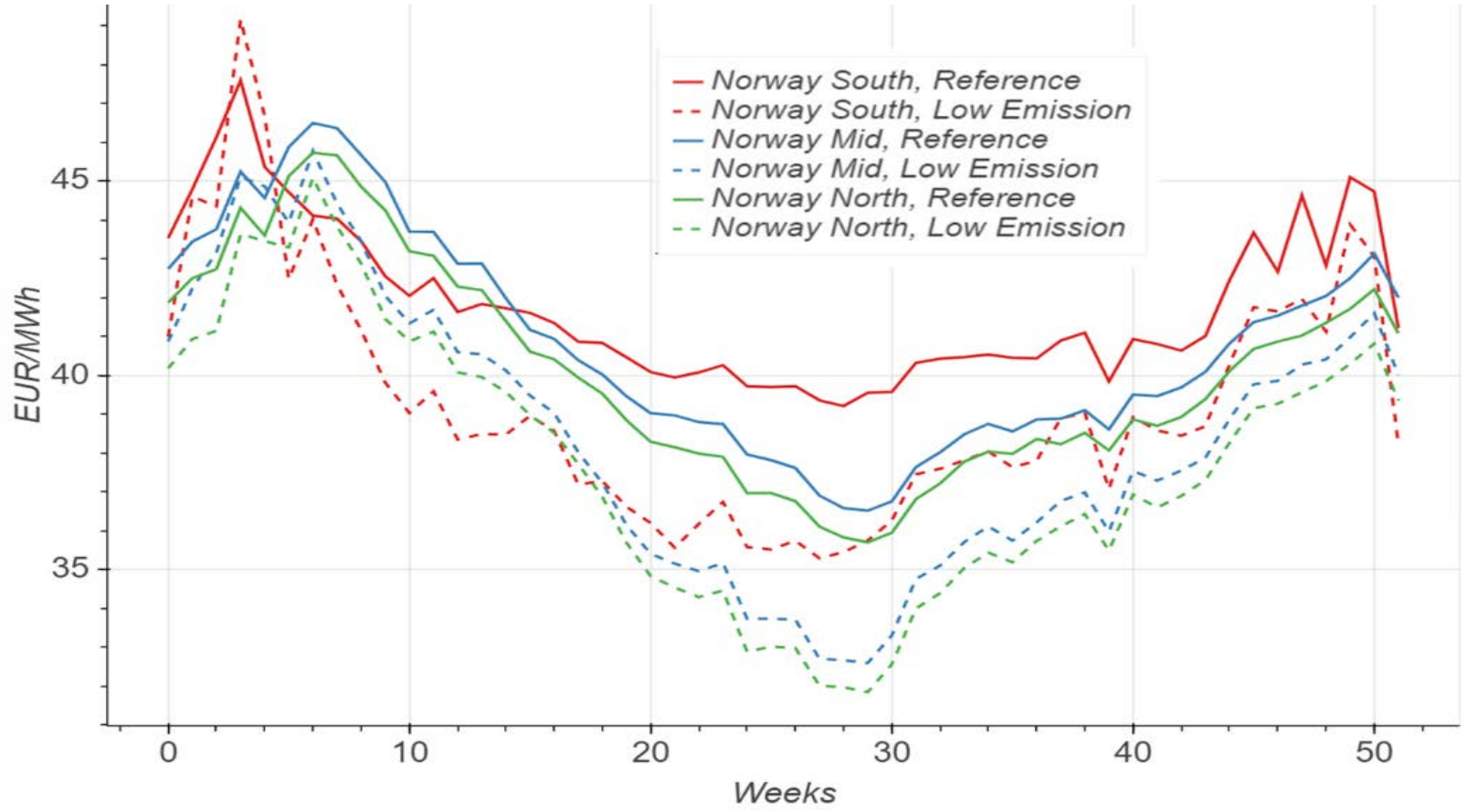
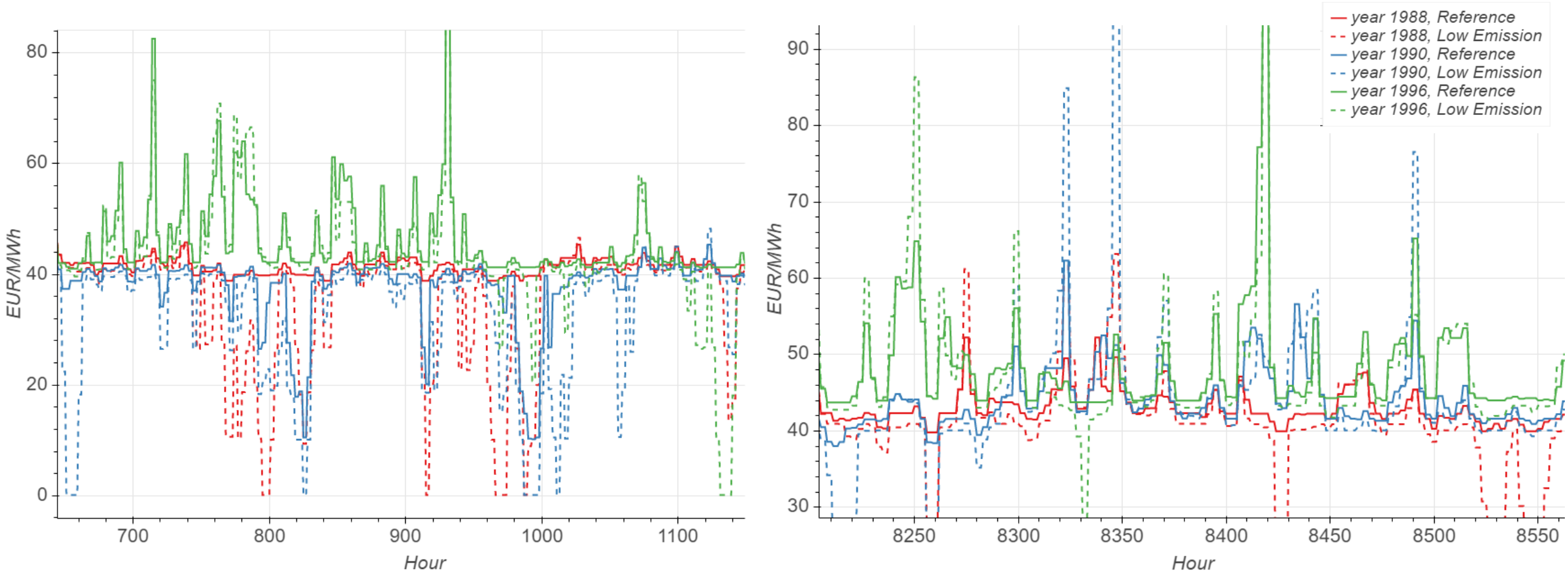
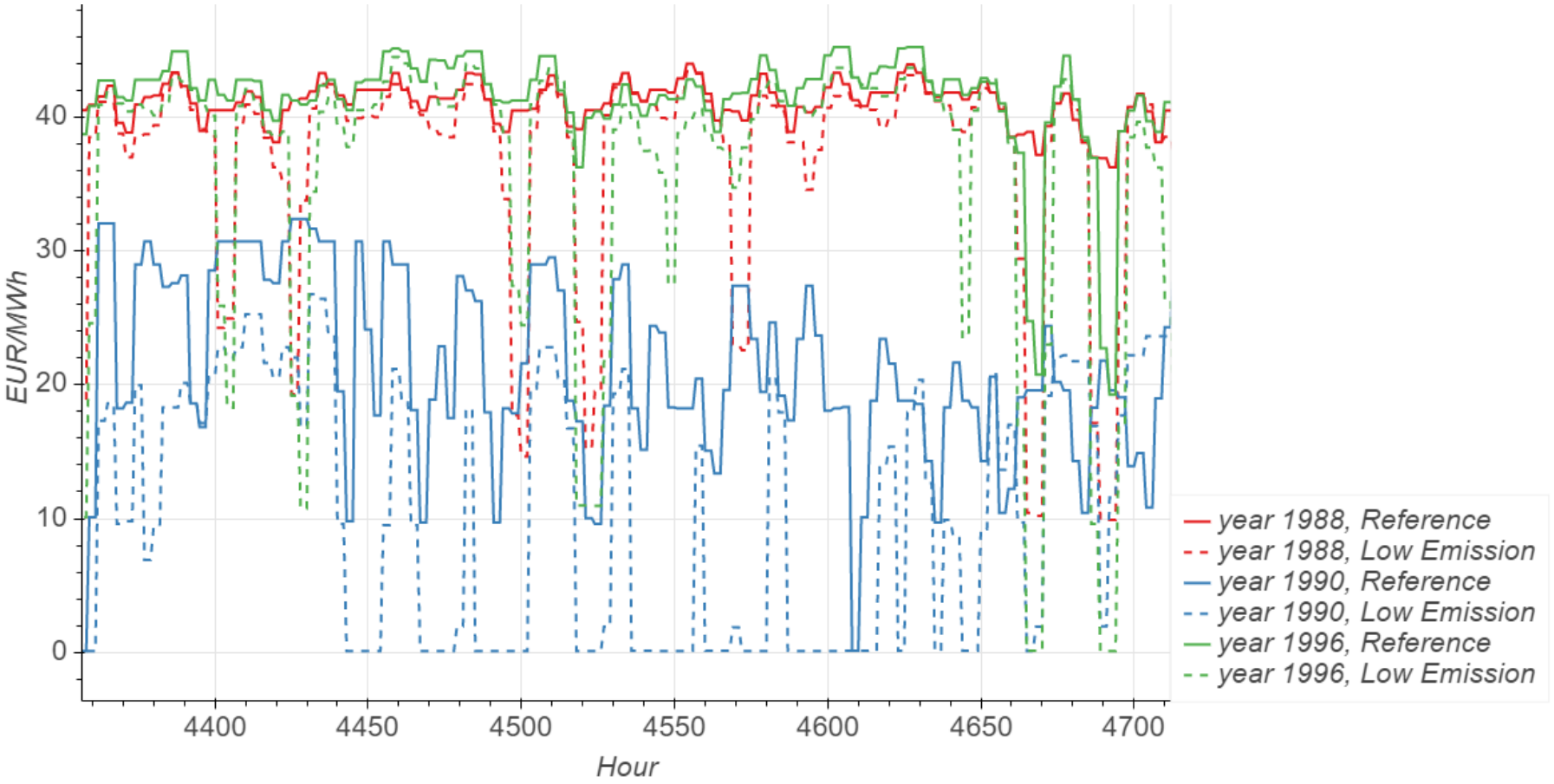
Average prices Norway



Power Prices Winter (3+2 weeks) Sorland



Power Price Summer (2 weeks) Sorland



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Realized Power Price

Plant	Total production [GWh/year]		Total Income [kEUR/yr]	
	Reference	Low Emission	Reference	Low Emission
Blåsjø (Saurdal)	1 531	1 492	67 716	64 887
Aurland 3	326	313	14 351	13 446
Tonstad (Tonstad)	4 144	4 145	179 021	175 002
Svartevann (Duge)	393	372	17 689	16 569
Wind power Sorland	1 108	2 608	45 811	97 831
Solar power Sorland	120	390	4 907	13 395

Plant	Realized power price		Average power price		Performance	
	Reference	Low Emission	Reference	Low Emission	Reference	Low Emission
Blåsjø (Saurdal)	44.23	43.49	41.93	39.45	105 %	110 %
Aurland 3	44.02	42.96	41.42	38.53	106 %	111 %
Tonstad (Tonstad)	43.20	42.22	42.03	38.72	103 %	109 %
Svartevann (Duge)	45.01	44.54	42.03	38.72	107 %	115 %
Wind power Sorland	41.34	37.51	42.03	38.72	98 %	97 %
Solar power Sorland	40.81	34.37	42.03	38.72	97 %	89 %

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Collaboration with the PRIBAS-project

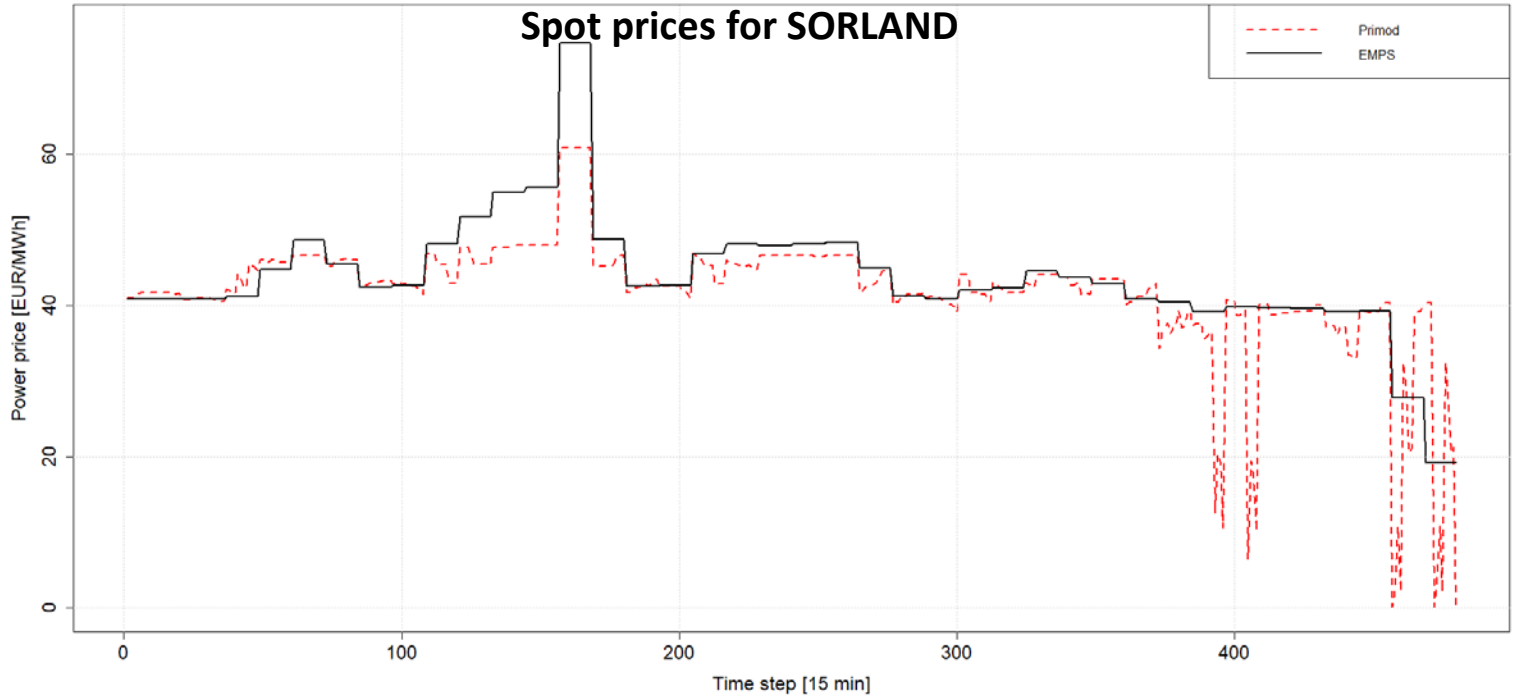
- Capture value of flexibility
- Several markets
- Finer temporal resolution
- Higher level of detail

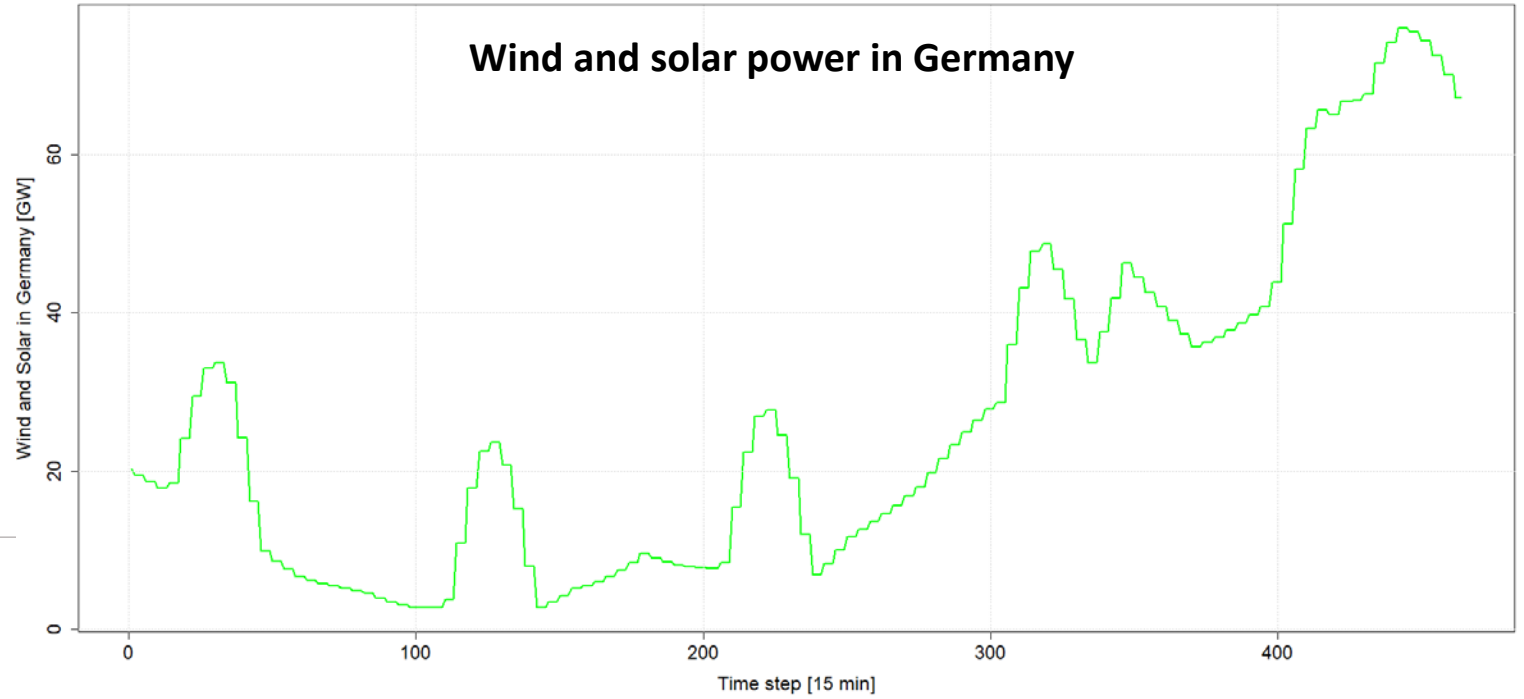
Primod case study: Low emission dataset

- Fundamental multi-market model
- Optimize one day at a time with interpolation in cuts
- 15 min time resolution
- Startup-cost on thermal units, ramping and minimum up-/down-time
- No ramping on cables
- No demand response (yet)

Low Emission Scenario

- Week 1 (Mon-Fri), 1958
- Compare spot prices for SORLAND





Possibilities – mutual benefits

- For HydroCen:
  - Select interesting weeks and model multiple markets
  - More realistic modeling of short term flexibility
- For PRIBAS:
  - Testing Primod om realistic dataset for 2030