Karlsruher Institut für Technologie

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The long-term impact of increased fossil fuel prices and market design on the market values of renewable generation

Thorsten Weiskopf, Florian Zimmermann, Emil Kraft

18th IAEE European Conference, 24.-27. July 2023, Milan, Italy

Agenda

1. Motivation
2. Methodology
3. Scenarios
4. Results
5. Conclusion

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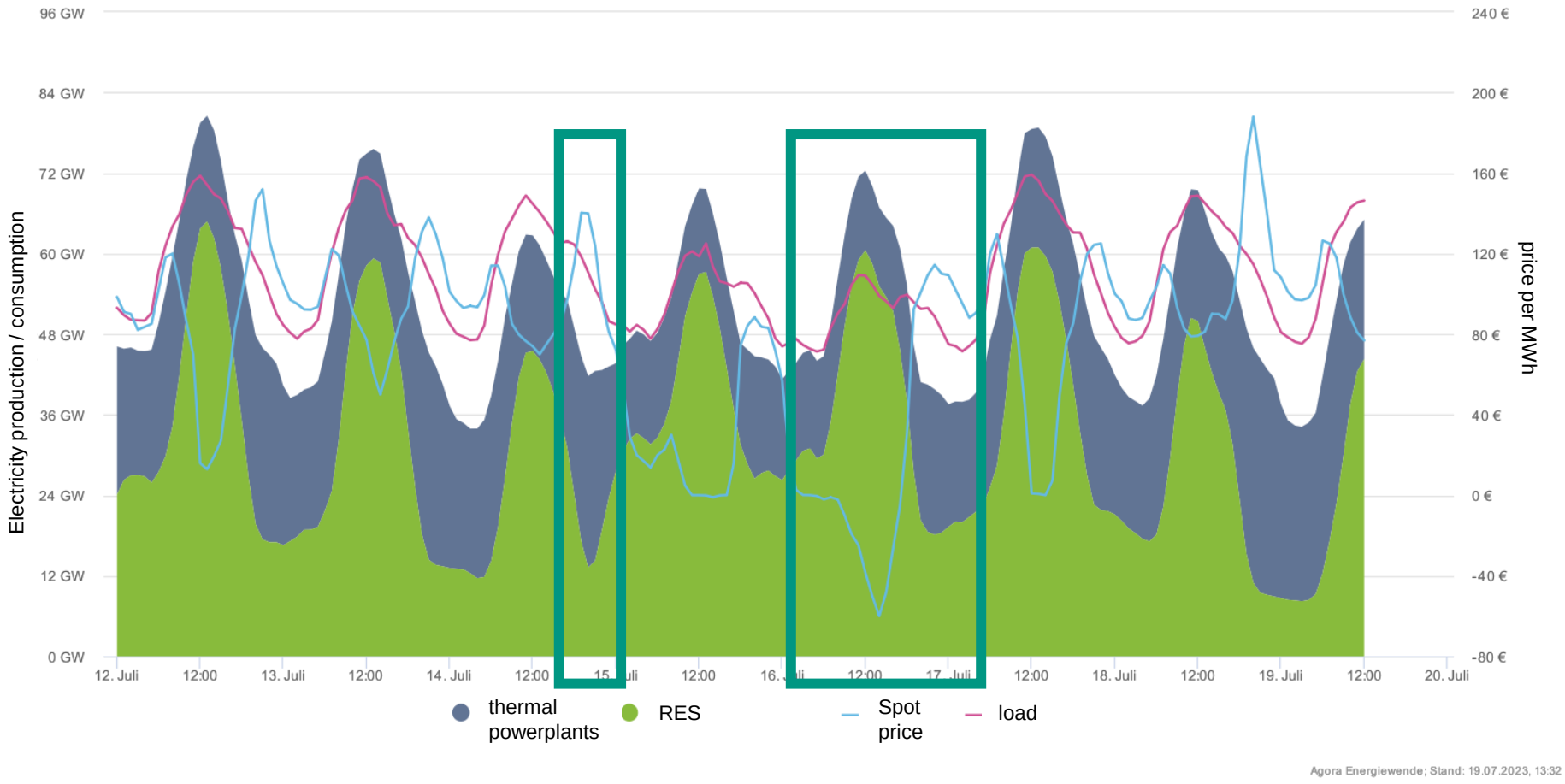
Agenda

Spot prices and RES production



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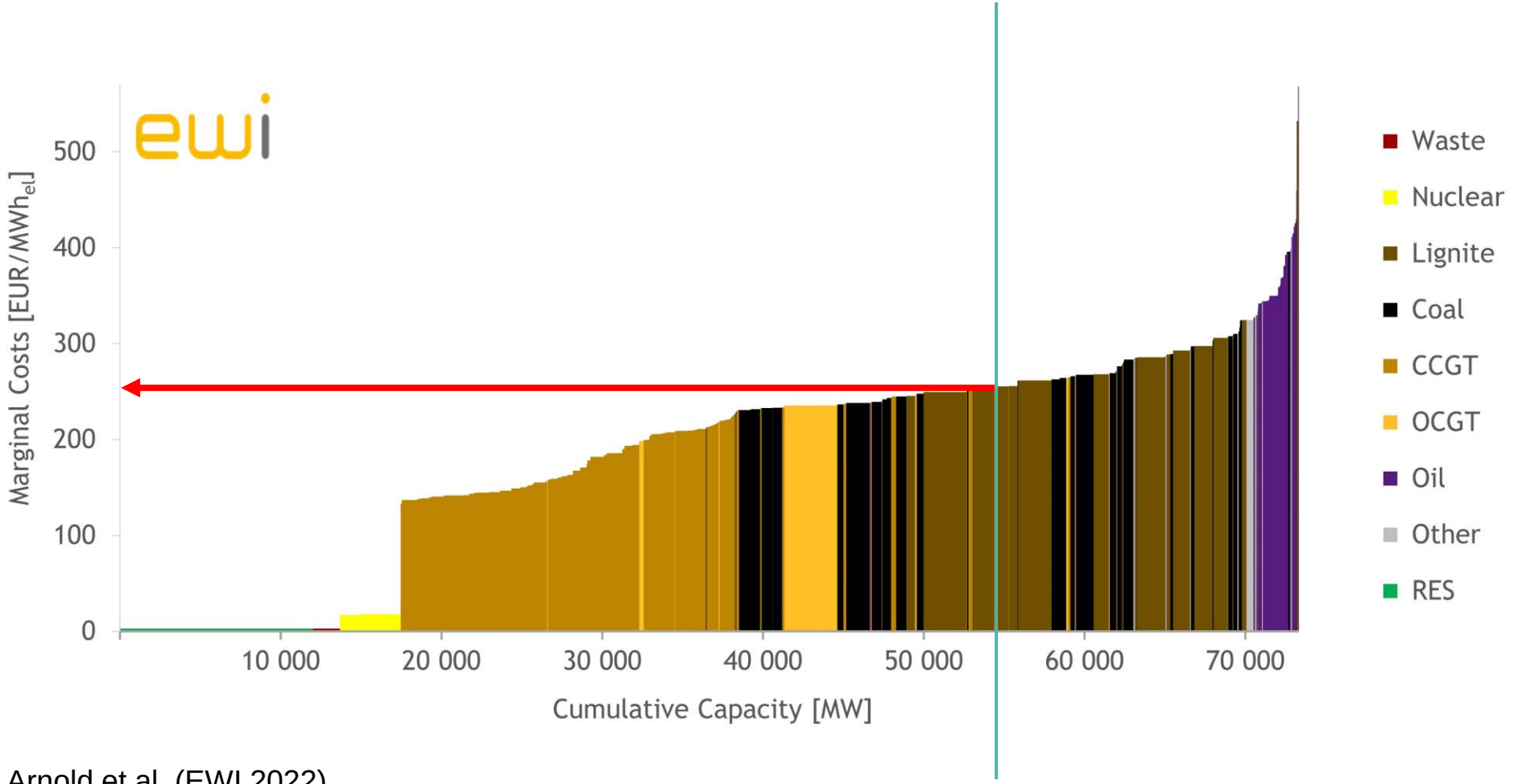
Merit Order effect and market values



Arnold et al. (EWI 2022)

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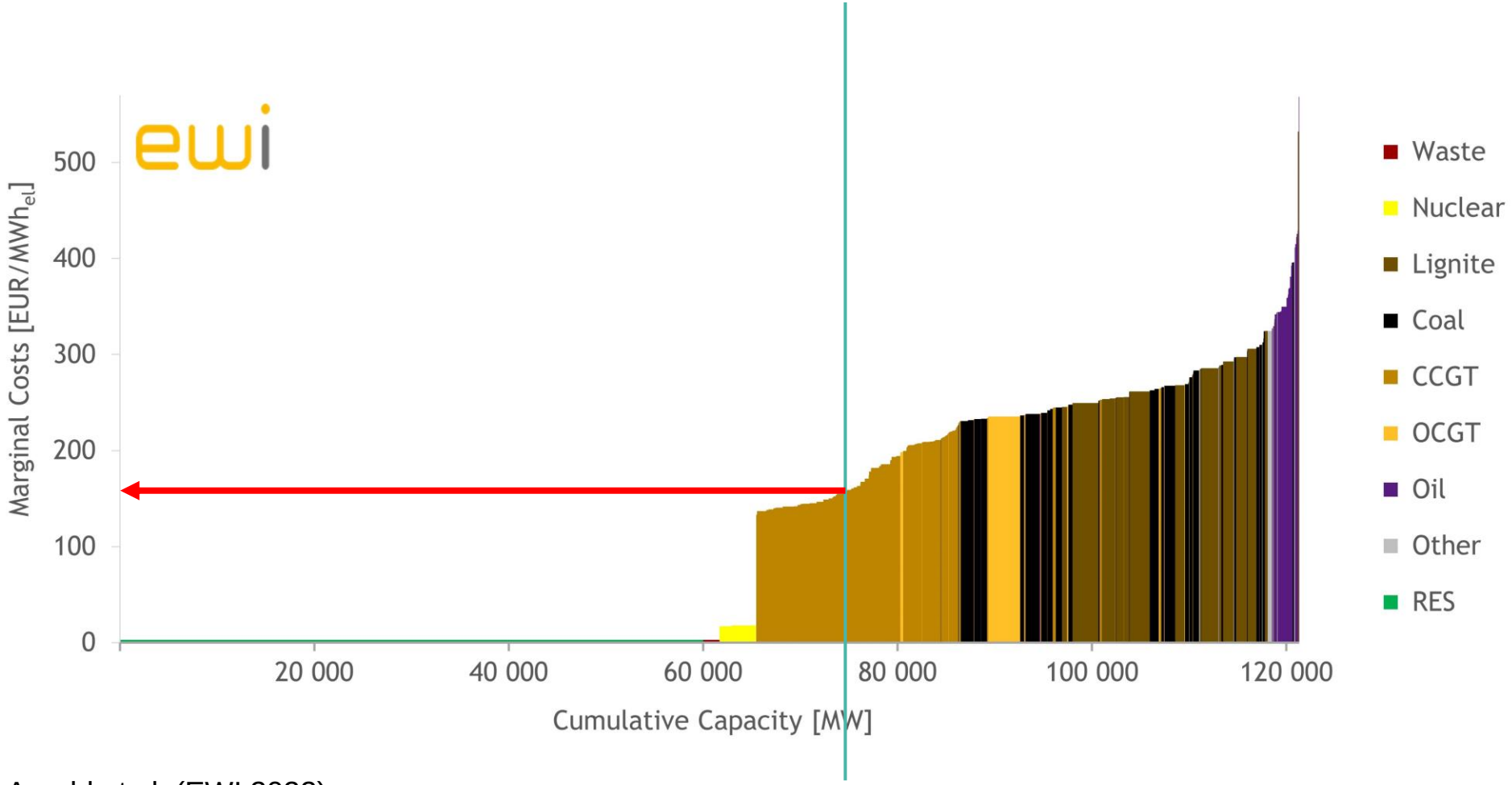

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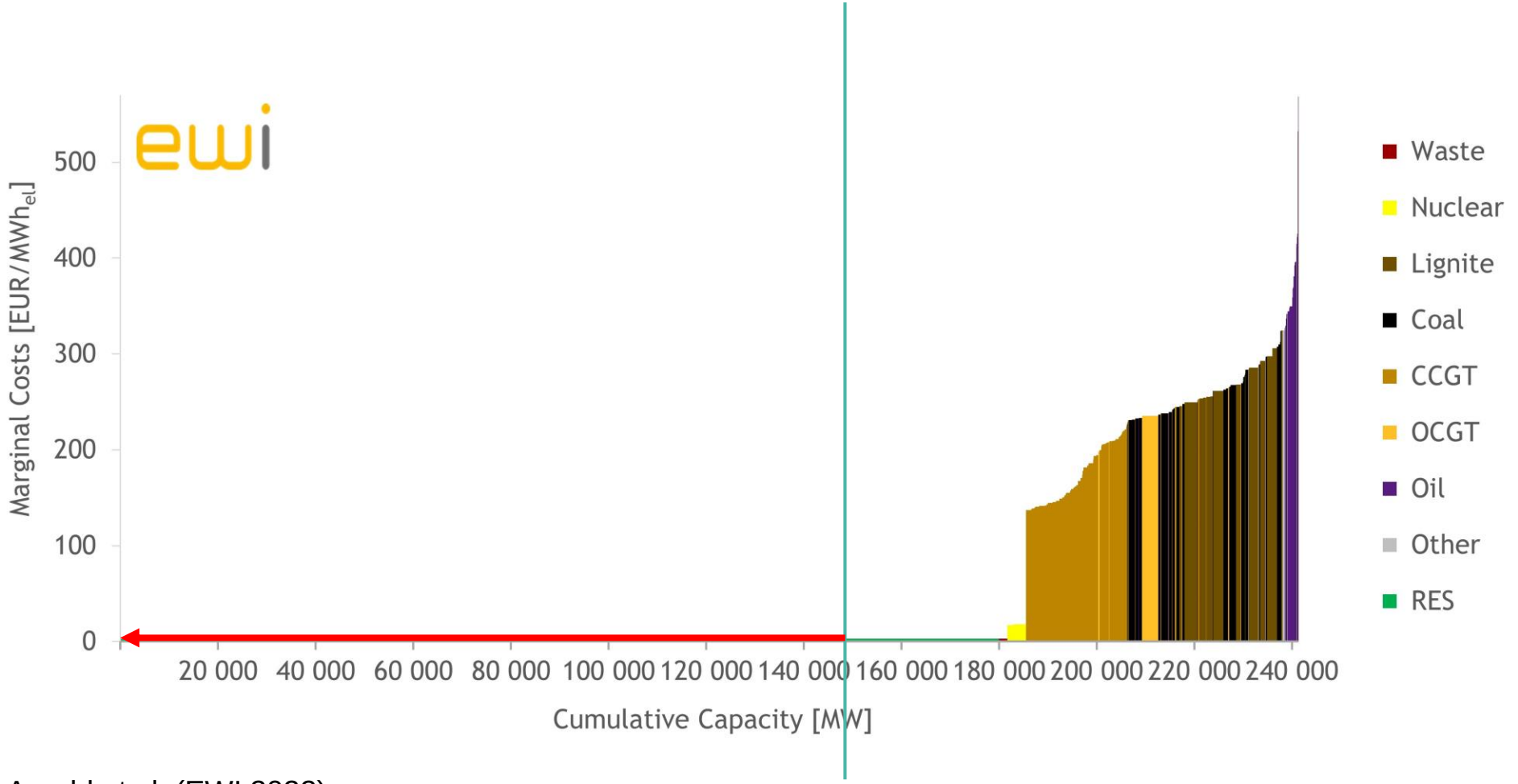

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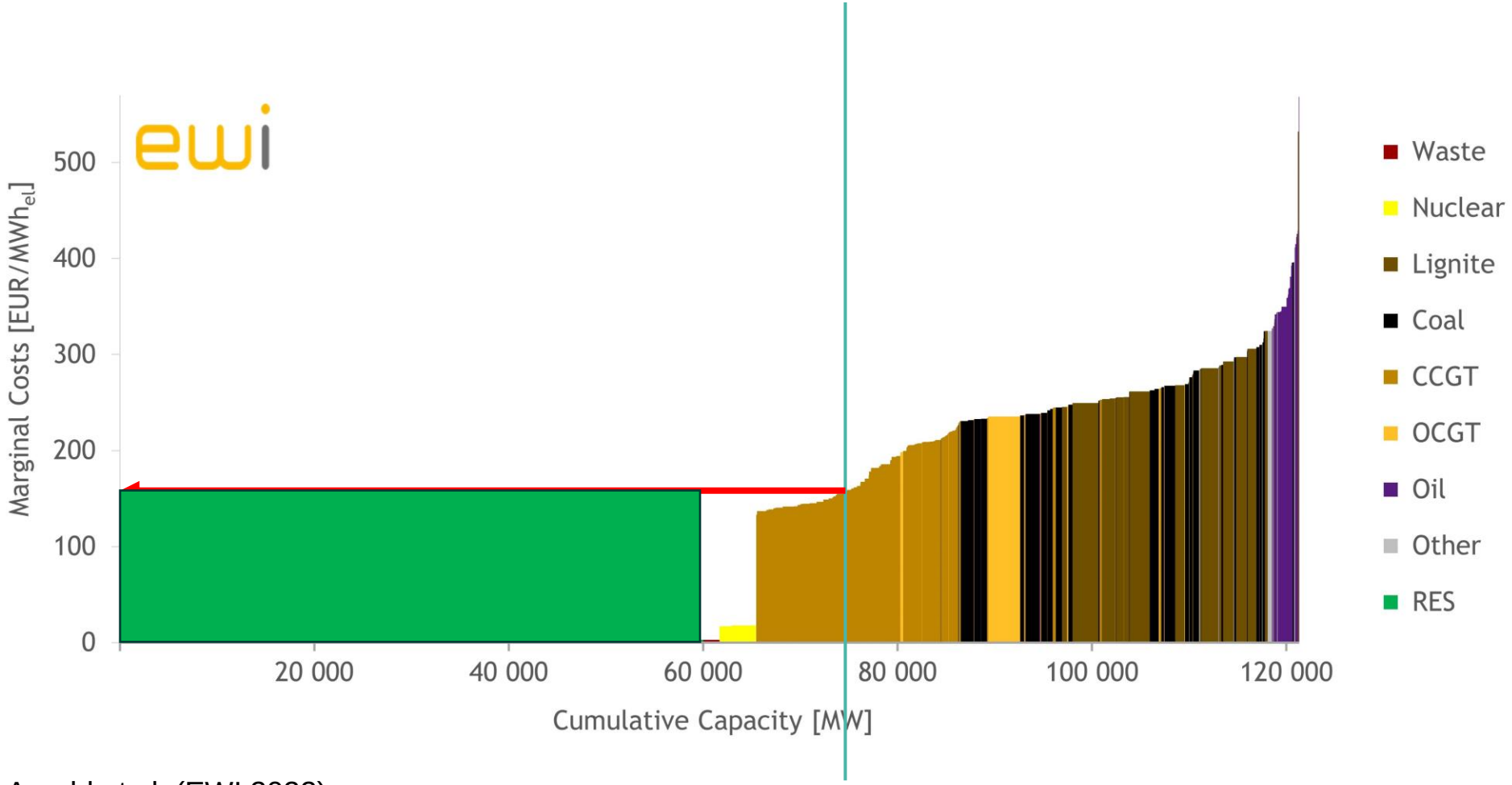

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Market values

$$MV = \frac{\sum_{h=1}^{j} p_h * E_h}{\sum_{h=1}^{j} E_h}$$

- Important for
  - direct marketing
  - calculation of subsidies
  - investment decisions

- MV := market value [€ / MWh]
- p_h := spot market price at hour h
- E_h := produced energy at hour h

Research Question

How do the increased fuel prices affect the long-term market values of RES?

Are the increased fuel prices, along with rising CO2 prices, sufficient to incentivize market-driven expansion of RES?

Does the market design also influence the market values of renewables?

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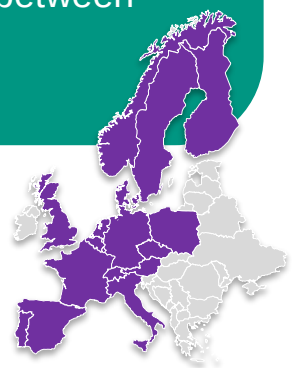
Agent-based electricity market simulation with integrated capacity expansion

PowerACE

Input Data

- Fuel and CO2 prices
- Detailed power plant data with techno-economical parameters (e.g. efficiency, …)
- Hourly RES profil and demand profils
- Trading capacities between market areas
- …



Characteristics

- Hourly simulation of the day-ahead market (8760 h/a)
- Yearly investment decisions
- Time horizon until 2050
- No perfect foresight, i.e., investment decisions

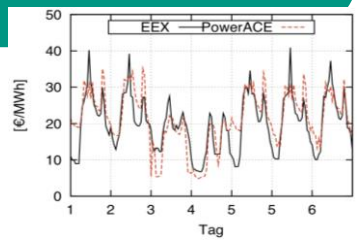
Model results

From market simulation e.g.,

- Electricity production
- Spot market prices and volumes
- …

From investment evaluation

- Capacity development
- Investment decisions
- ….



Source: Genoese (2010), Fraunholz (2021), Zimmermann & Keles (2023)

Simulation scope within this work

- Germany and neighboring countries
- 2015 – 2040
- RES profiles from renewables.ninja
- Load profiles TYNDP 2022 NT

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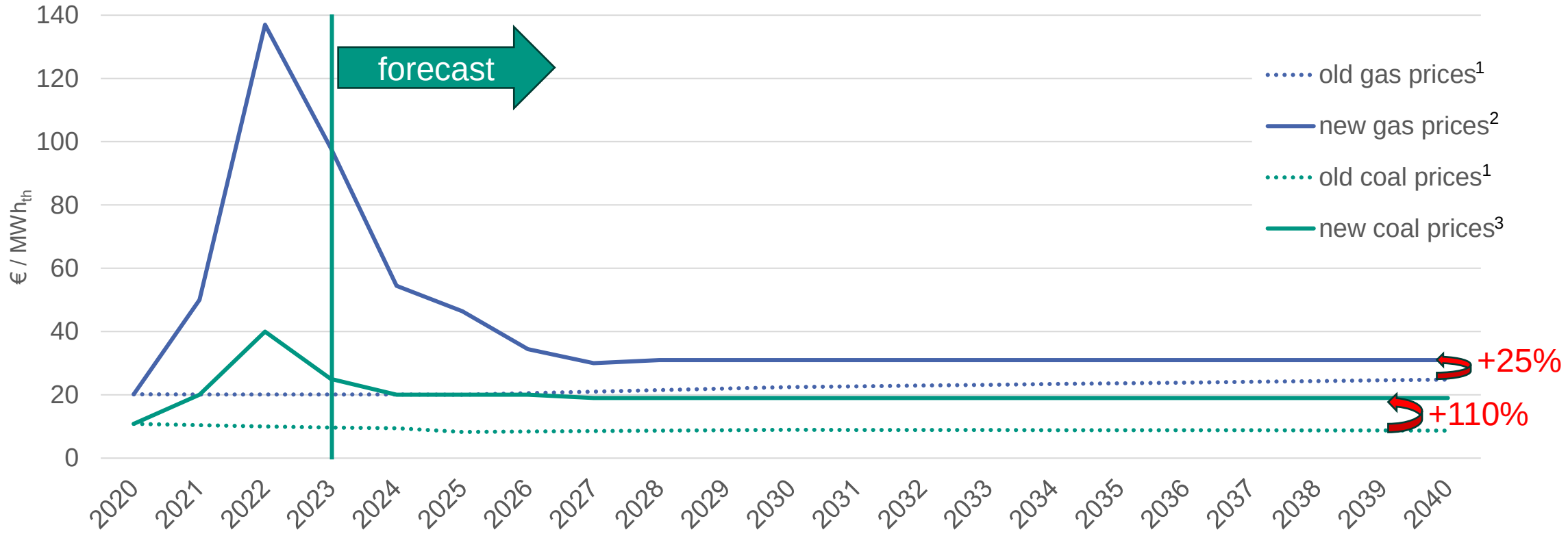
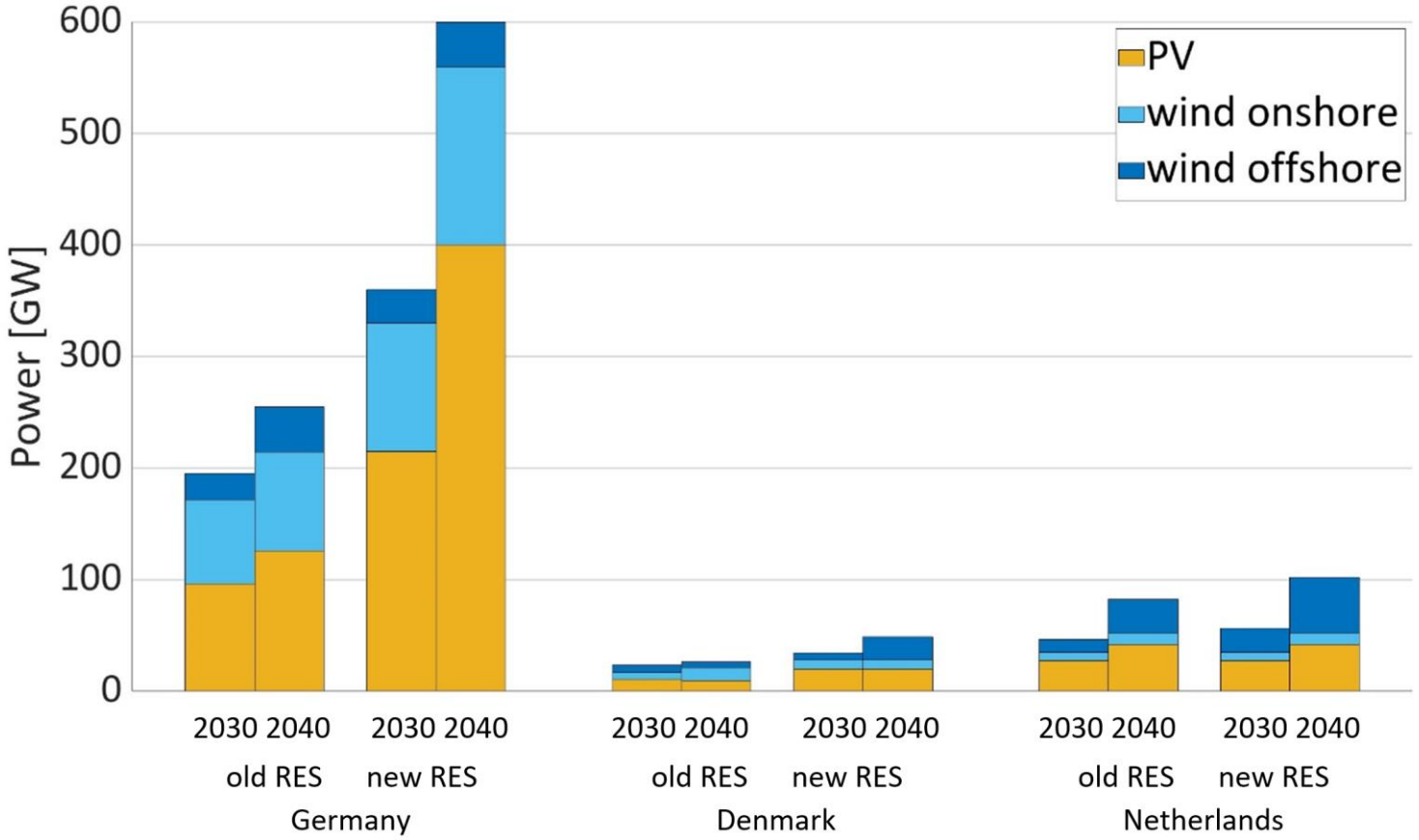
Fossil fuels scenarios



[1] TYNDP 2022 NT Price scenarios
[2] Dutch TTF-Gas-Futures (March 7th, 2023)
[3] Institute of Energy Economics at the University of Cologone

Effects of the energy crisis
RES expansion targets



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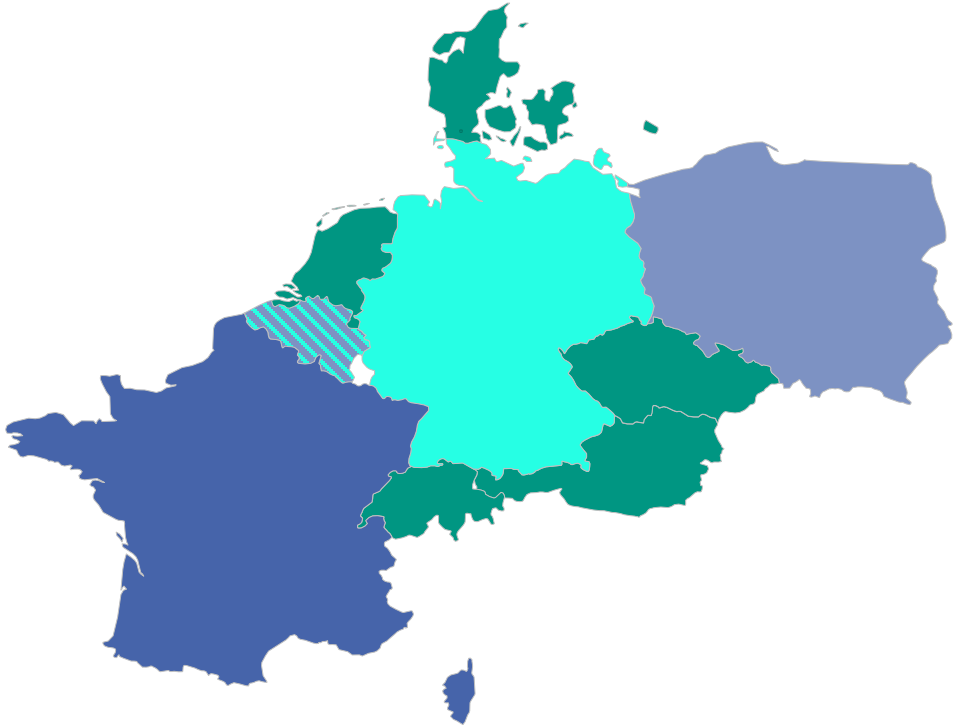
Investigated market areas

Scenario: energy only market (EOM)

Scenario: capacity remuneration mechanism (CRM)



Energy only market
decentral capacity market
strategic reserve
central capacity market

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Scenarios

EOM-OP-OR	Energy-only-market with old prices and old RES scenario
EOM-OP-NW	Energy-only-market with old prices and new RES scenario
EOM-NP-OR	Energy-only-market with new prices and old RES scenario
EOM-NP-NR	Energy-only-market with new prices and new RES scenario
CRM-OP-OR	Capacity remuneration mechanism with old prices and old RES scenario
CRM-OP-NW	Capacity remuneration mechanism with old prices and new RES scenario
CRM-NP-OR	Capacity remuneration mechanism with new prices and old RES scenario
CRM-NP-NR	Capacity remuneration mechanism with new prices and new RES scenario

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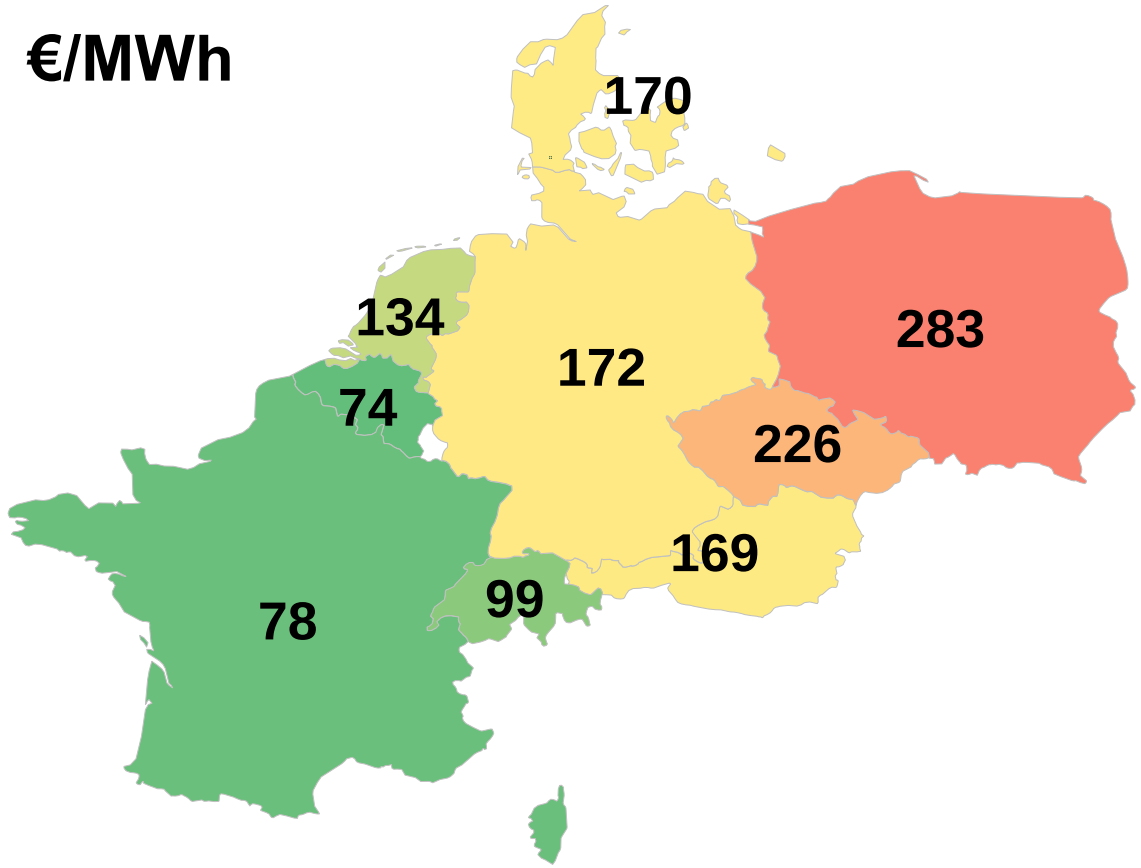
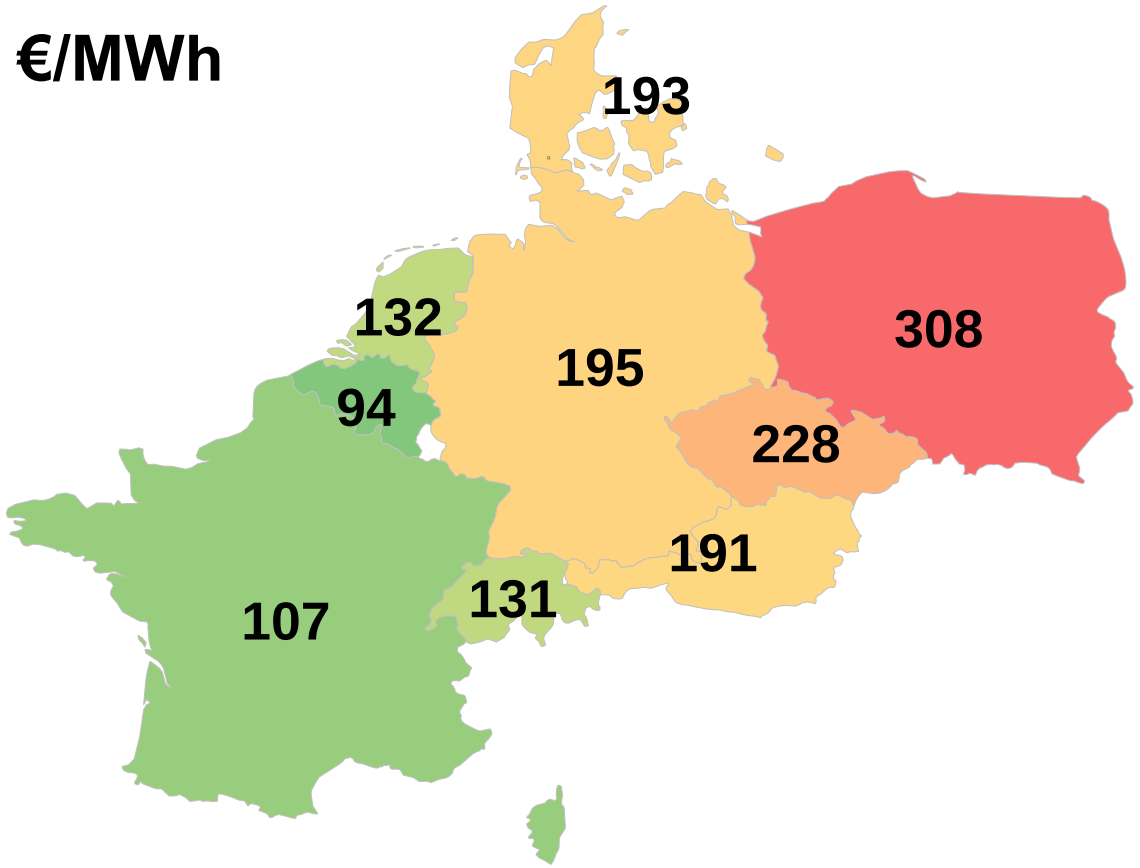
Average spot market price in 2040 CRM-OR

Scenario: old prices



Scenario: new prices



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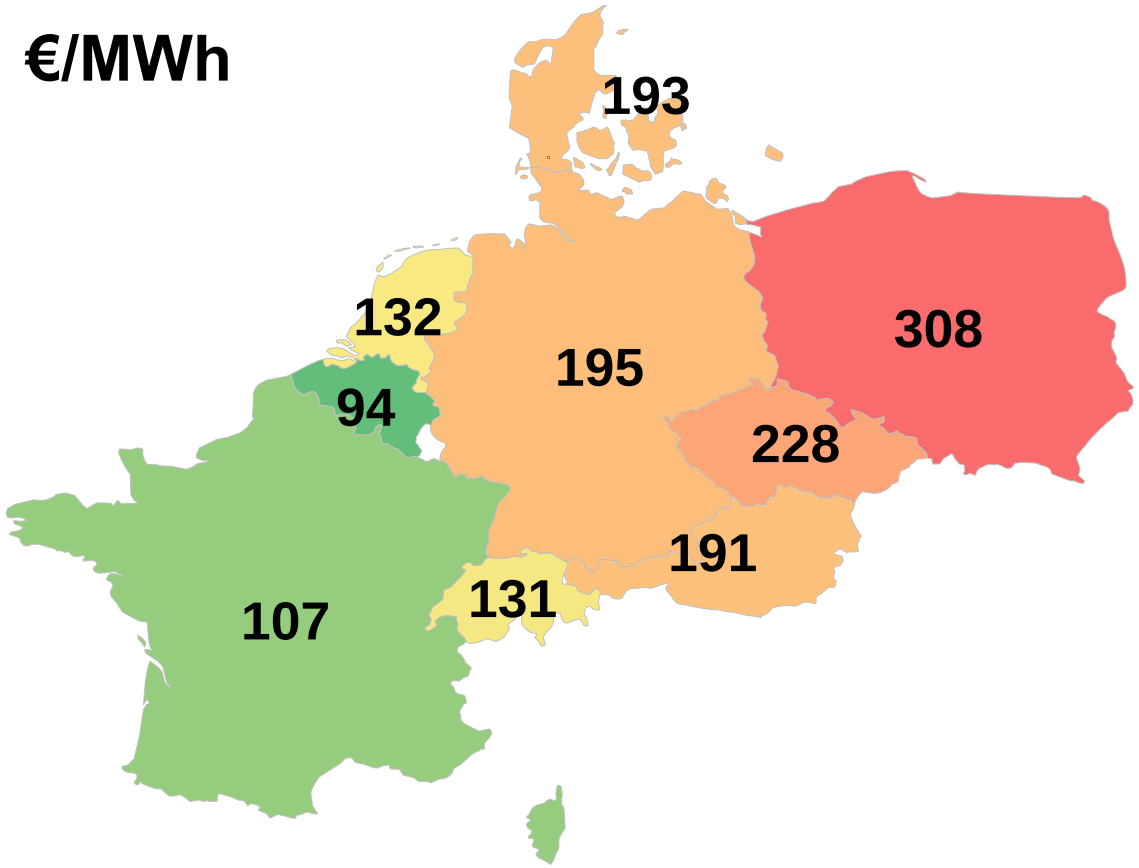
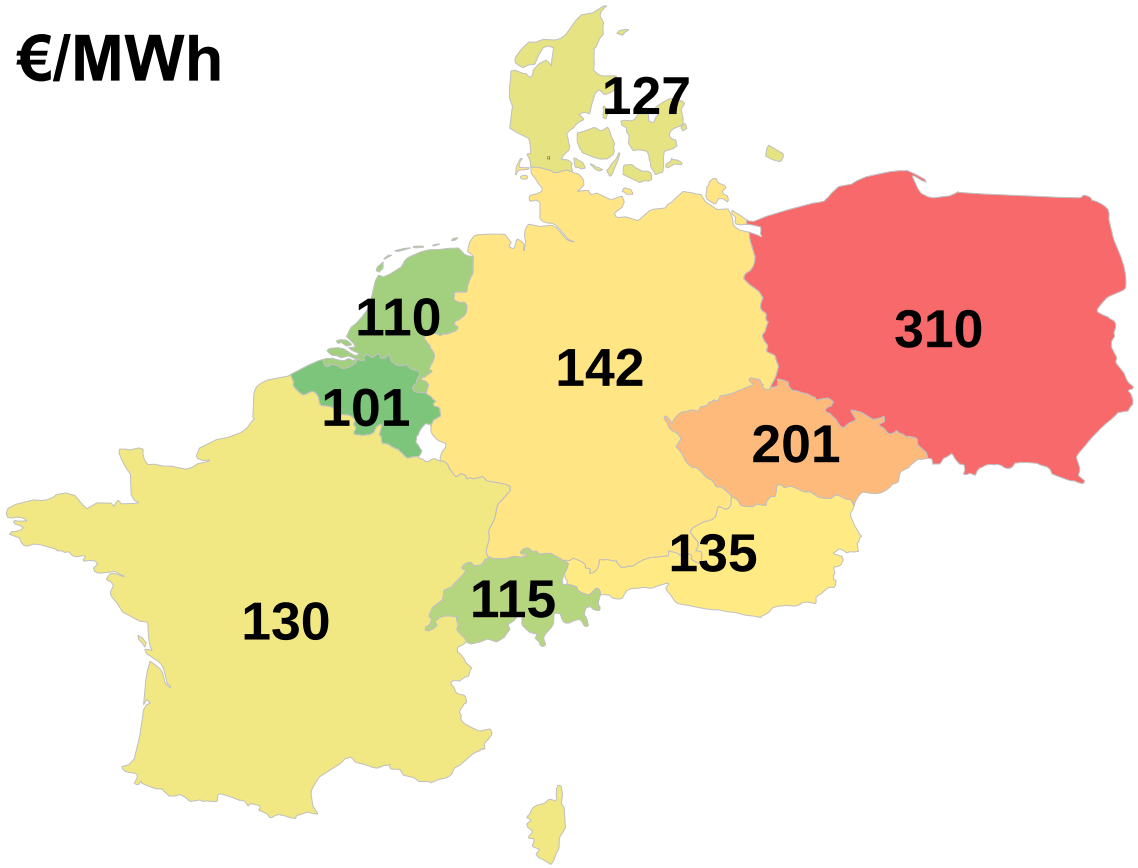
Average spot market price in 2040 CRM-NP

Scenario: old RES



Scenario: new RES



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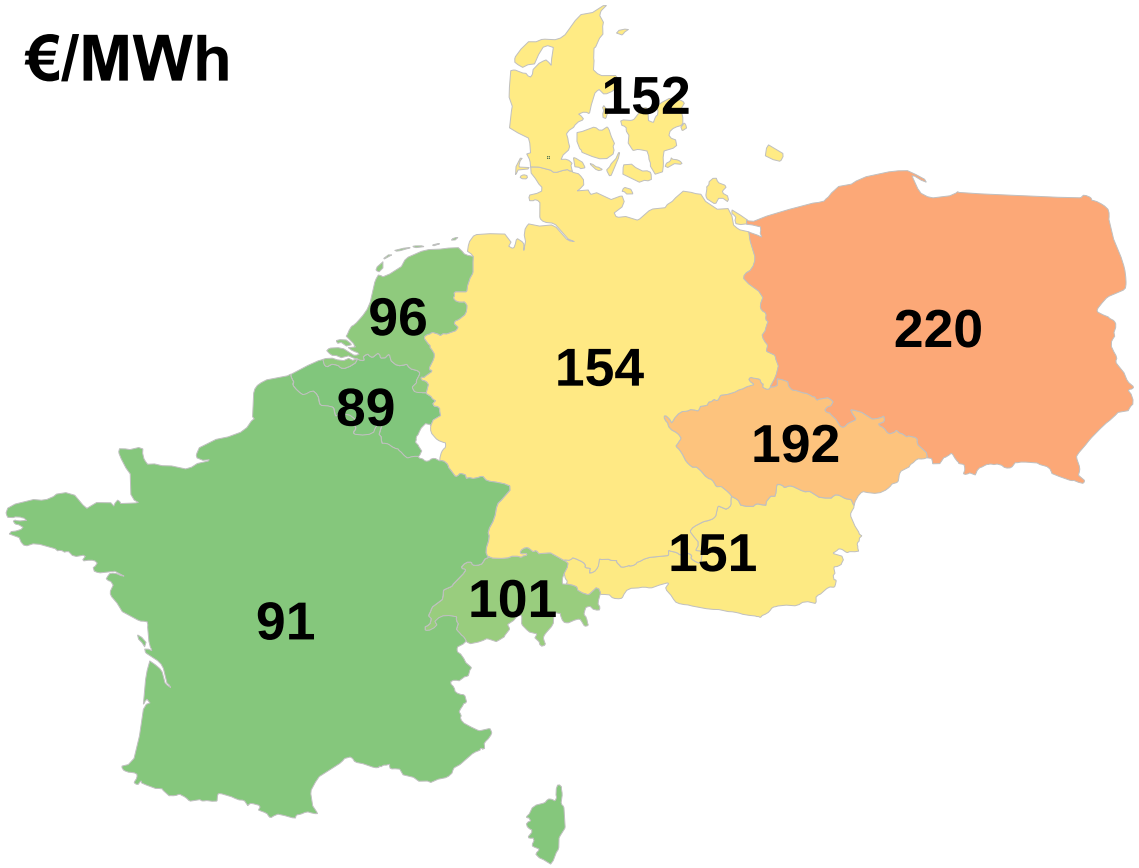
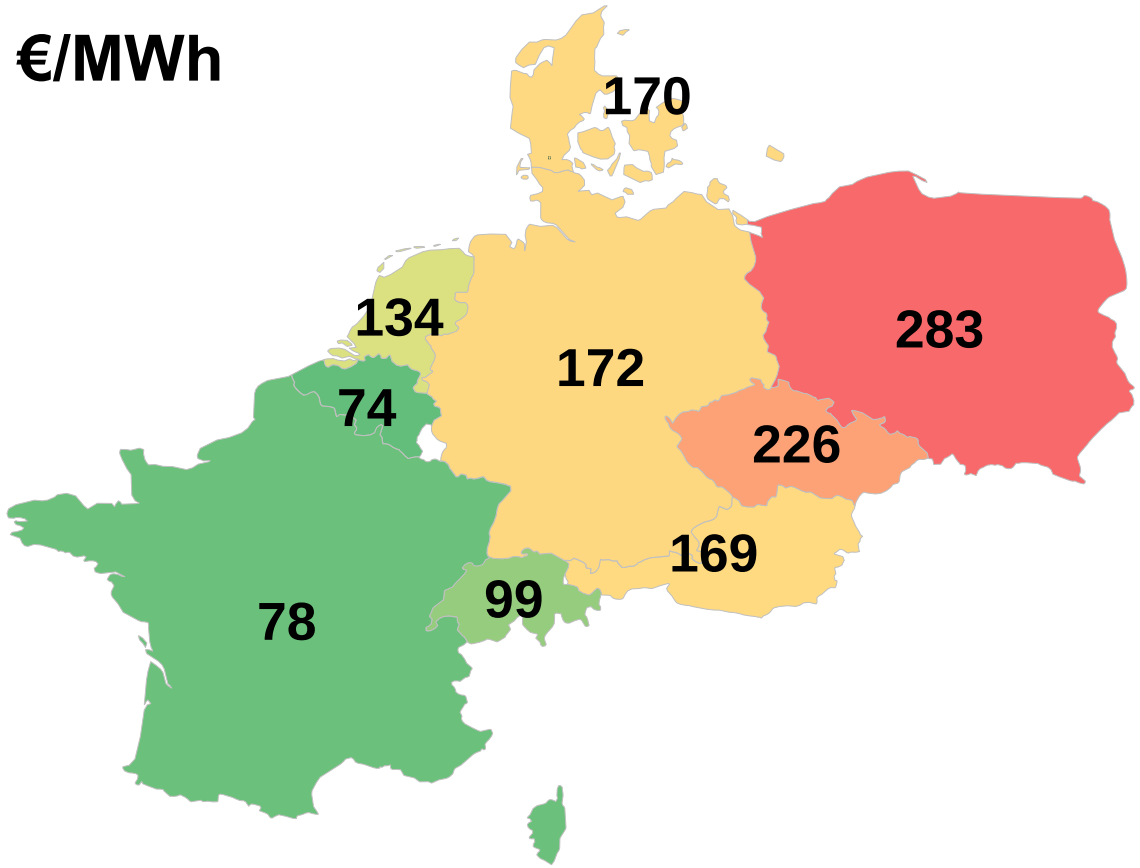
Average spot market price in 2040 OP-OR

Scenario: energy only market (EOM)



Scenario: capacity remuneration mechanism (CRM)



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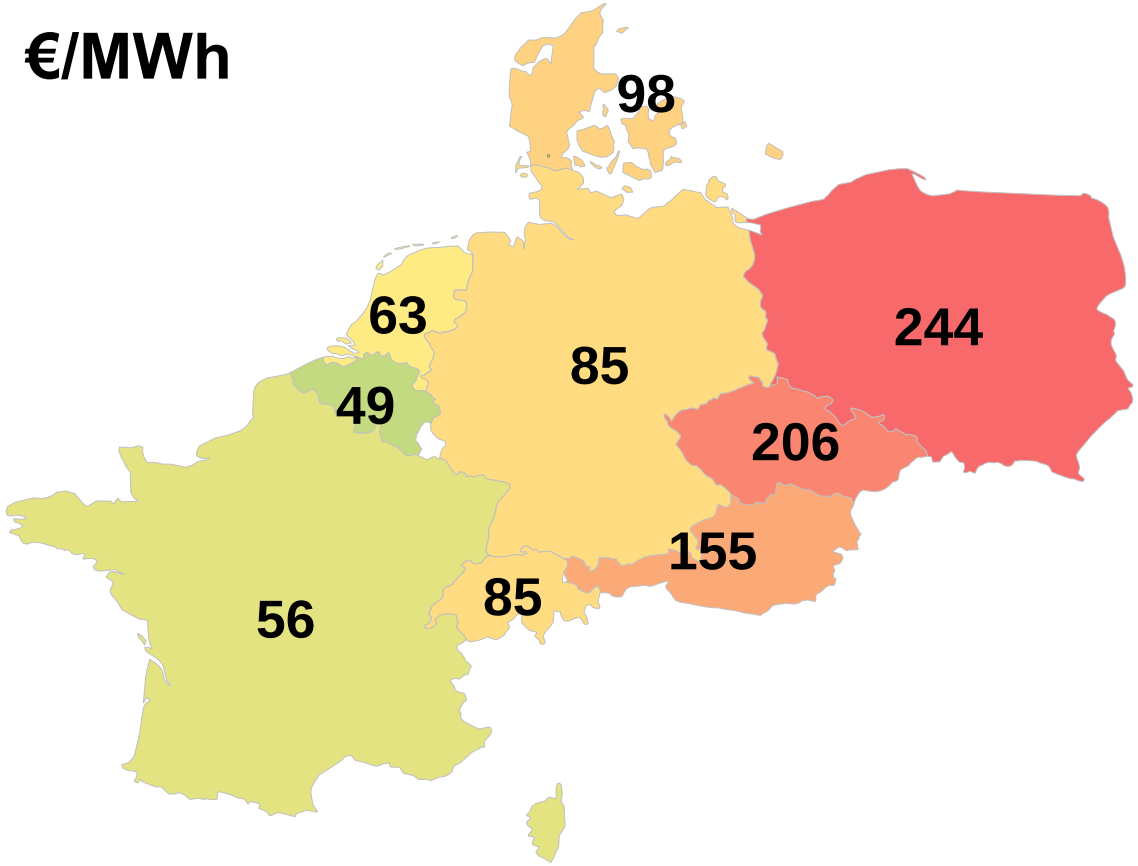
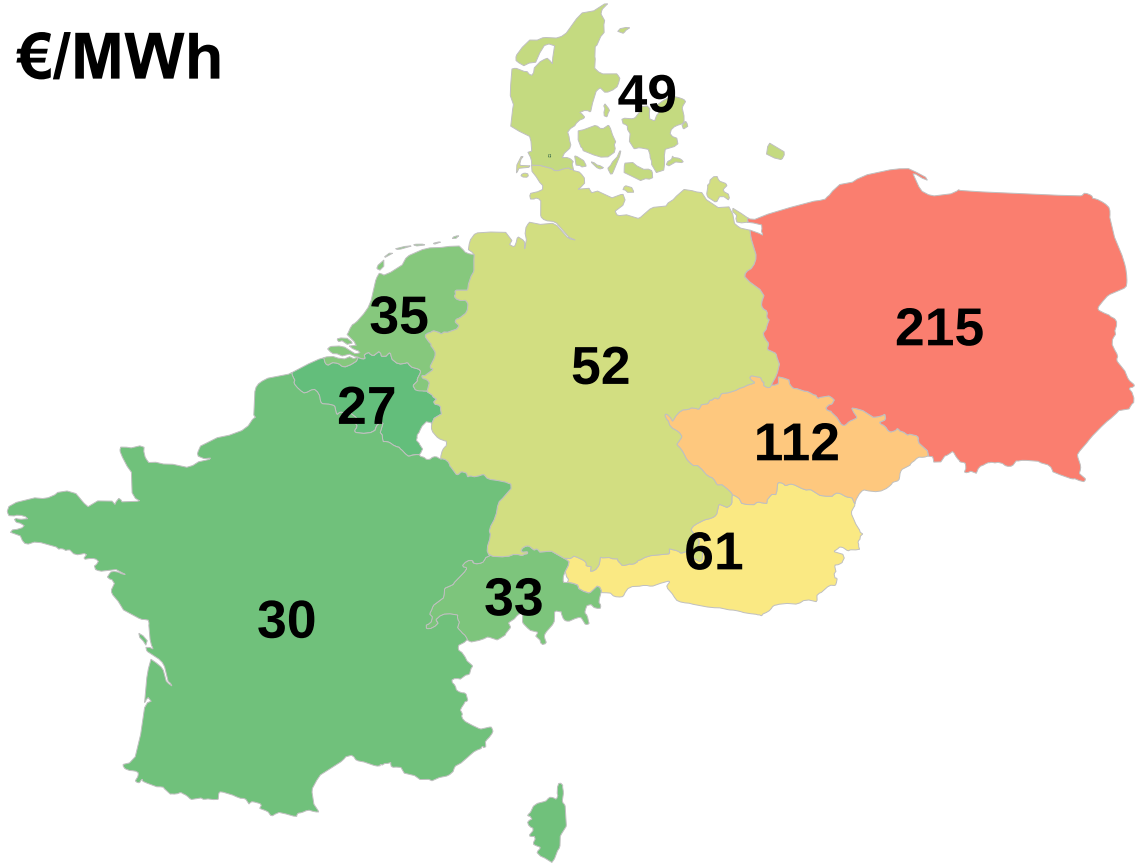
Average market values in 2040 CRM-OP-OR

Wind power (onshore)



Solar power



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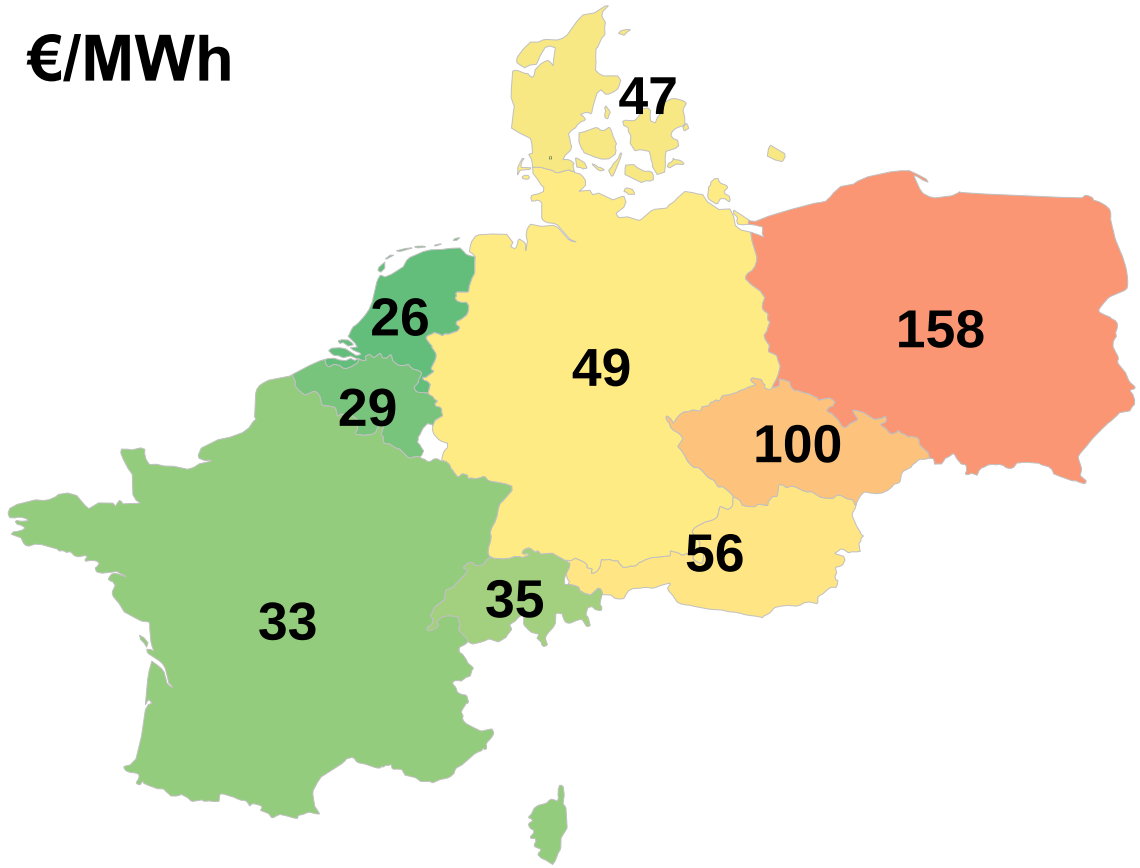
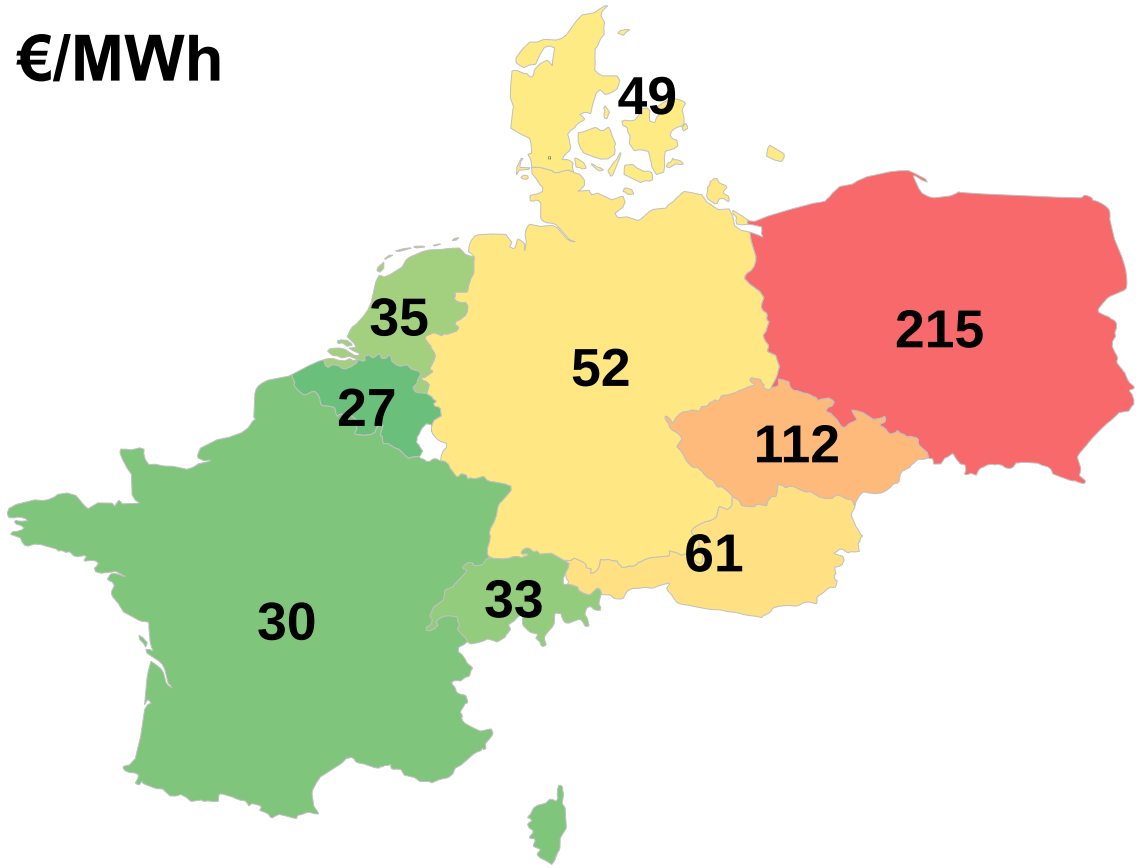
Average market values solar power in 2040 OP-OR

Scenario: energy only market (EOM)



Scenario: capacity remuneration mechanism (CRM)



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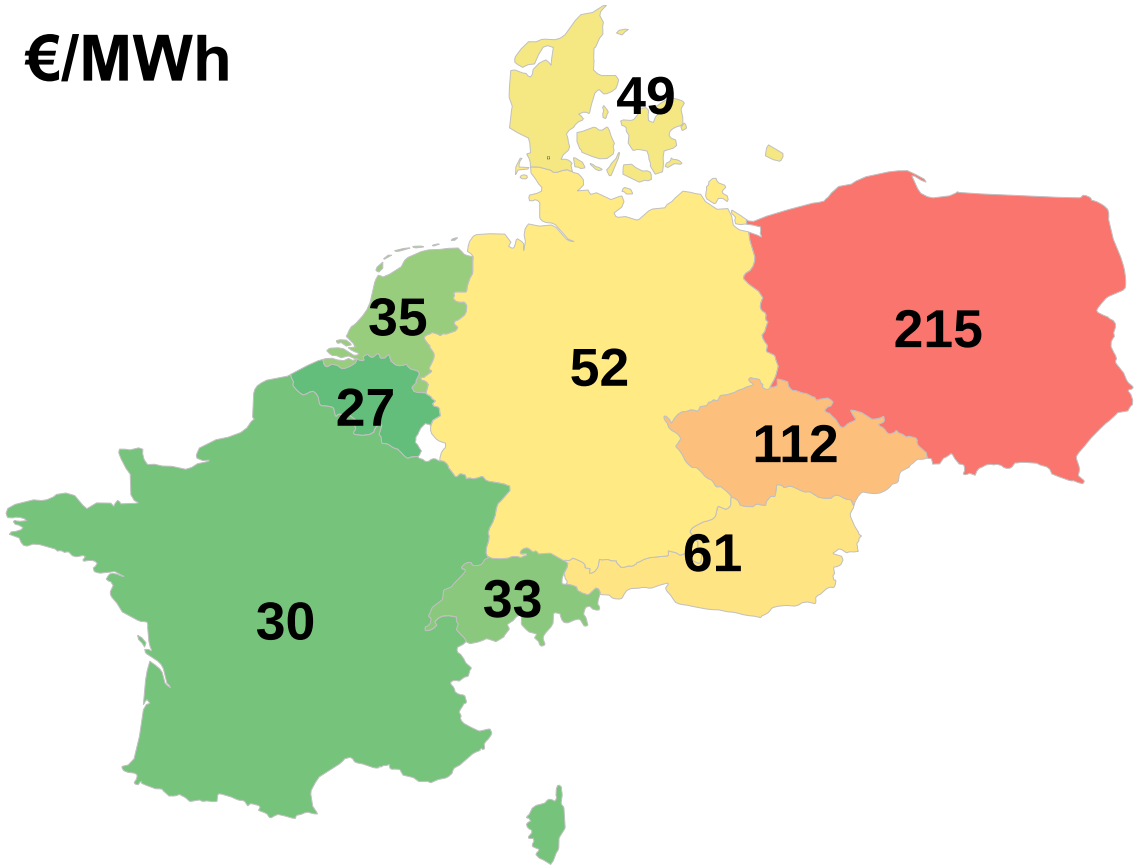
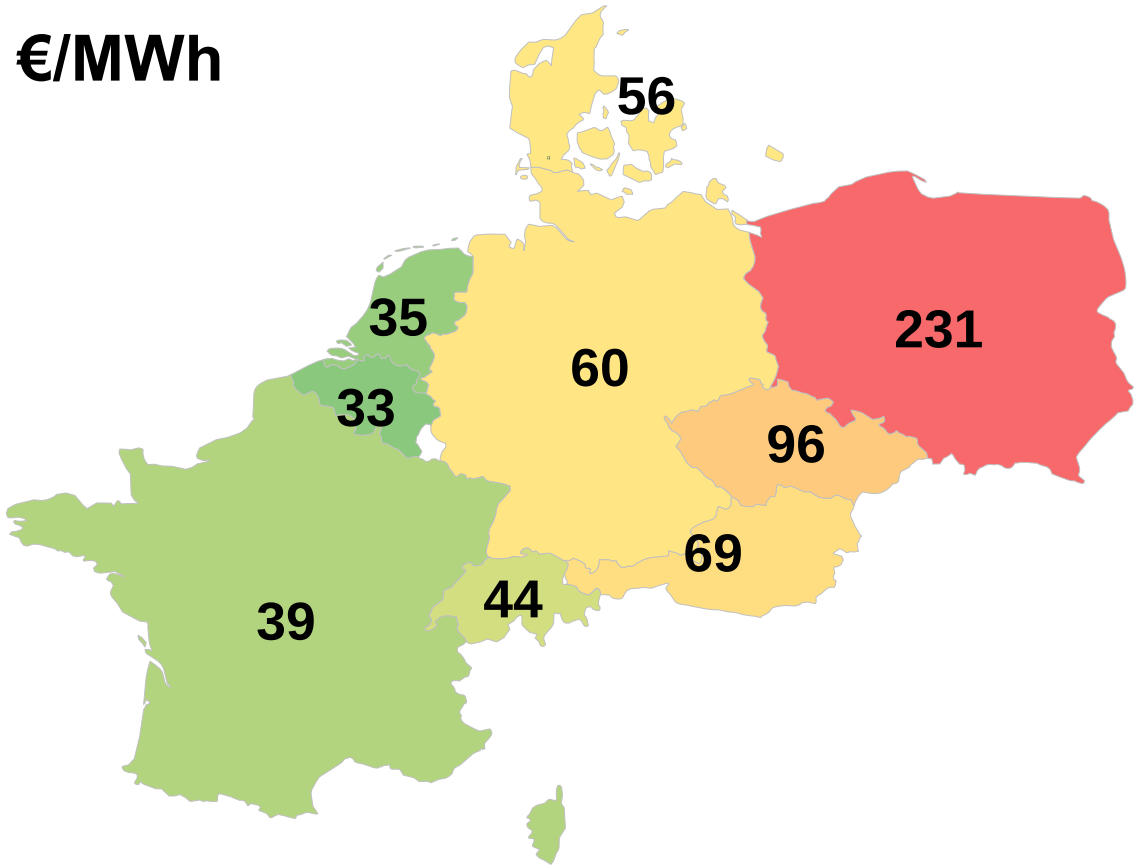
Average market values solar power in 2040 CRM-NR

Scenario: old prices



Scenario: new prices



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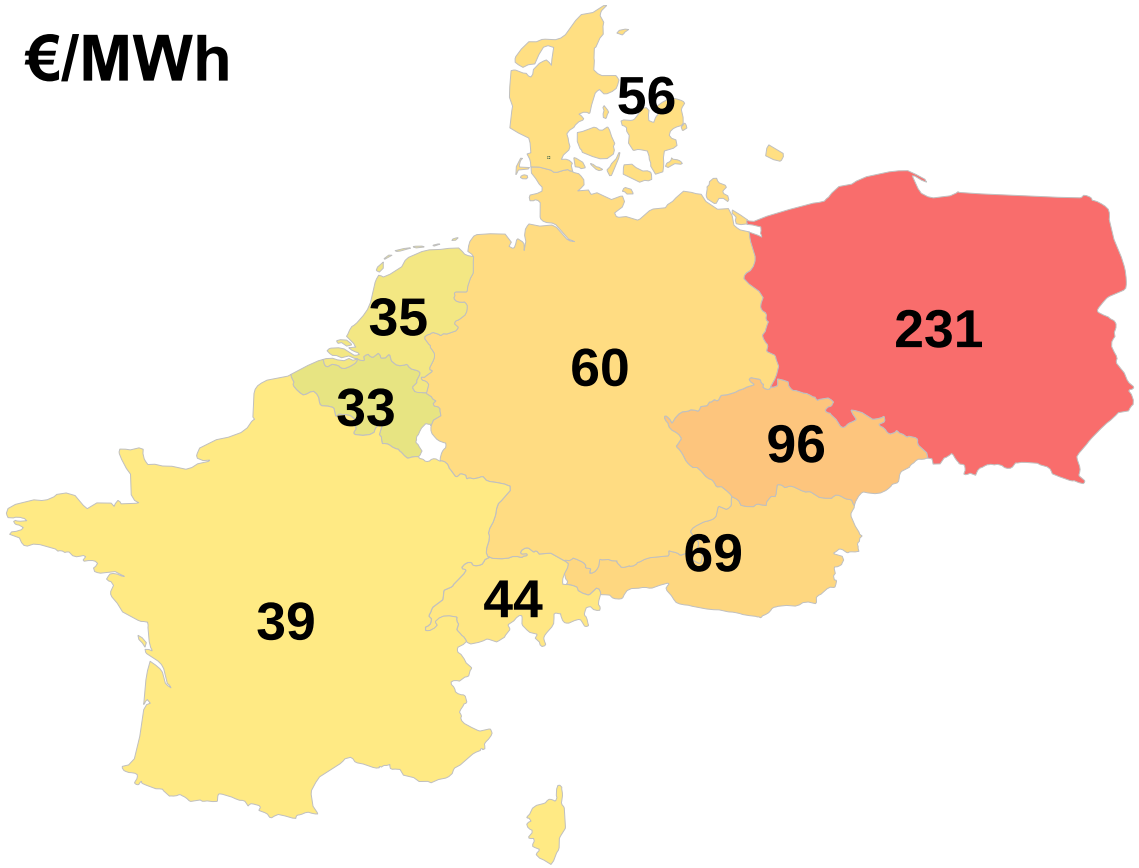
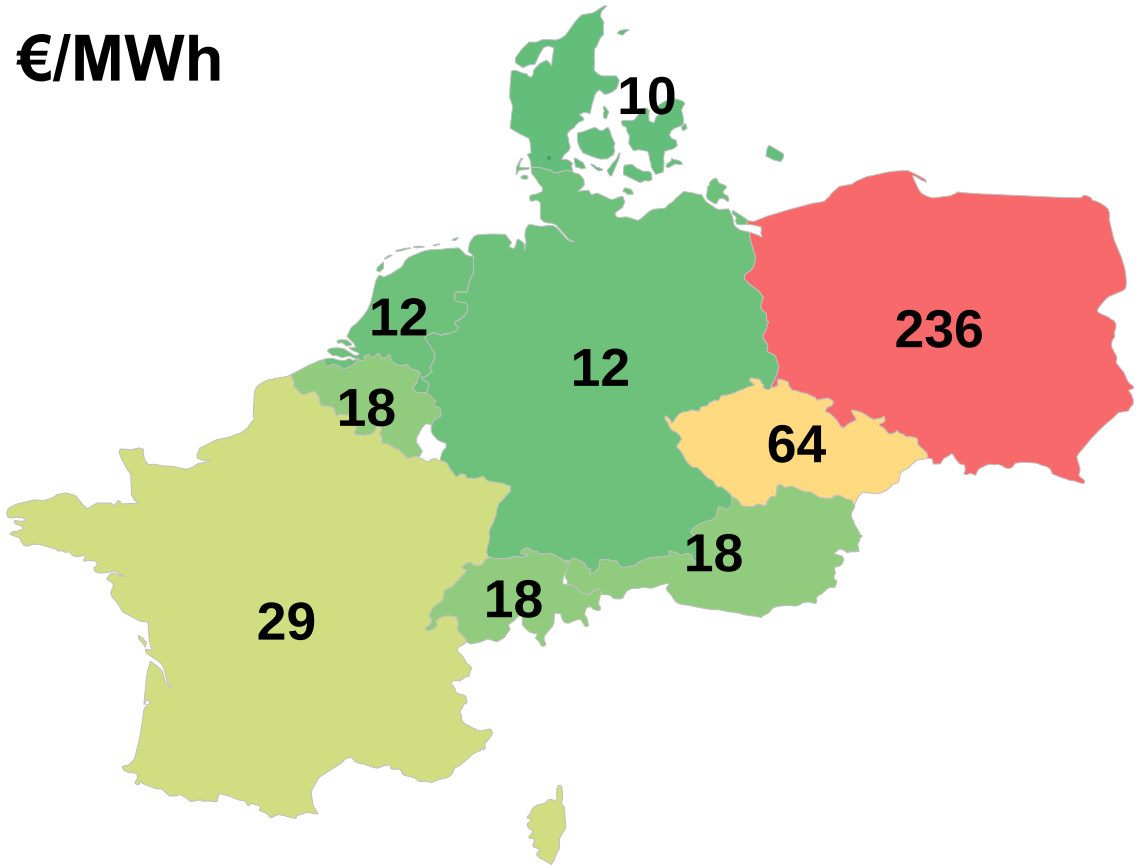
Average market values solar power in 2040 CRM-NP

Scenario: old RES



Scenario: new RES



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Conclusion

The spot market price effect of RES expansion targets is much bigger than the effect of fuel prices or market design

Market values of RES will decrease substantially with higher expansion targets

No scenario shows market values high enough to encourage RES investments without subsidies in Western Europe

Thank you for your attention!

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