The effects of nuclear power plant closures in Germany 2021-2023 on network flows and RE-dispatch

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Enno Wiebrow, *Mario Kendziorski, Lukas Barner, Claudia Kemfert, Christian von Hirschhausen*

Outline

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3. **Scenario Overview**

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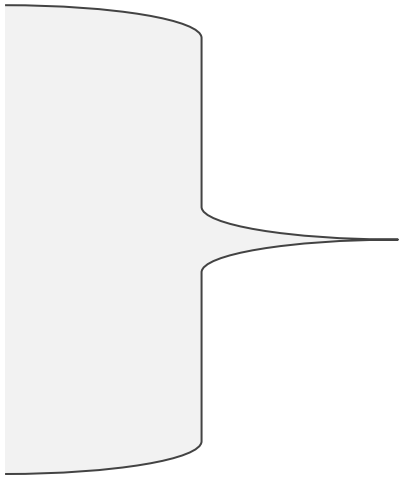
    3. Exploring historical power price data on the Day-Ahead-Market (2021-2023)
    4. Outlook to 2030

5. **Summary and Conclusions**

Motivation

- End of 2021 decomissioning of
  - Grohnde
  - Grundremingen C
  - Brockdorf
- 15.04.2023 decommissioning of
  - Isar 2
  - Emsland
  - Neckarwestheim 2



Net capacity of 8.1 GW

Source: MaStR

- Natural Gas Prices historically high due to Russia's invasion into Ukraine in February 2022
- Understanding the impact of nuclear power plant closures on the electricity grid, in the light of supply security
- Outlook to coal phase out in 2030

Power System model - Overview

- Linear Optimization model, minimizing overall costs of operation

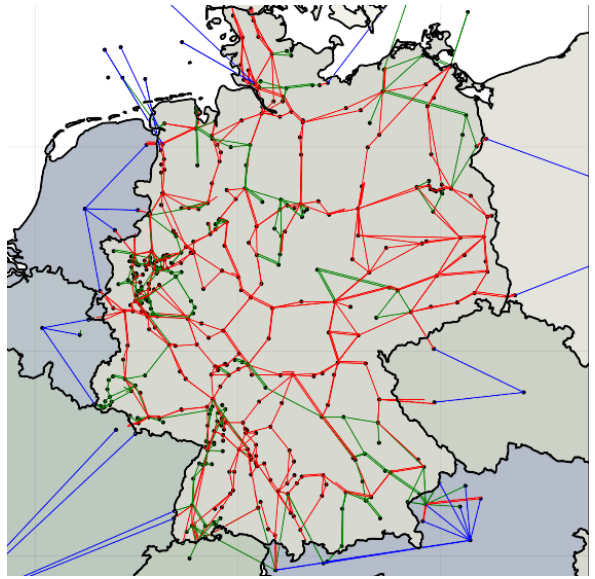
- Market simulation based on 2 Phases
  1. Market clearing following the merit order principles (Similar to Day-Ahead-Market)
  2. Congestion management and Redispatch using the DC load flow approach

- Highly detailed spatial representation of German high voltage grid

- Neighbouring Countries aggregated as 1 Node

- Temporal resolution on hourly level

- Grid Data from the Joint Allocation Office (JAO)



Source: Own illustraition

Scenarios

Base Scenario 2021

- All 6 Nuclear powerplants active
- Target year 2021
- Purpose: Point of reference for model outputs

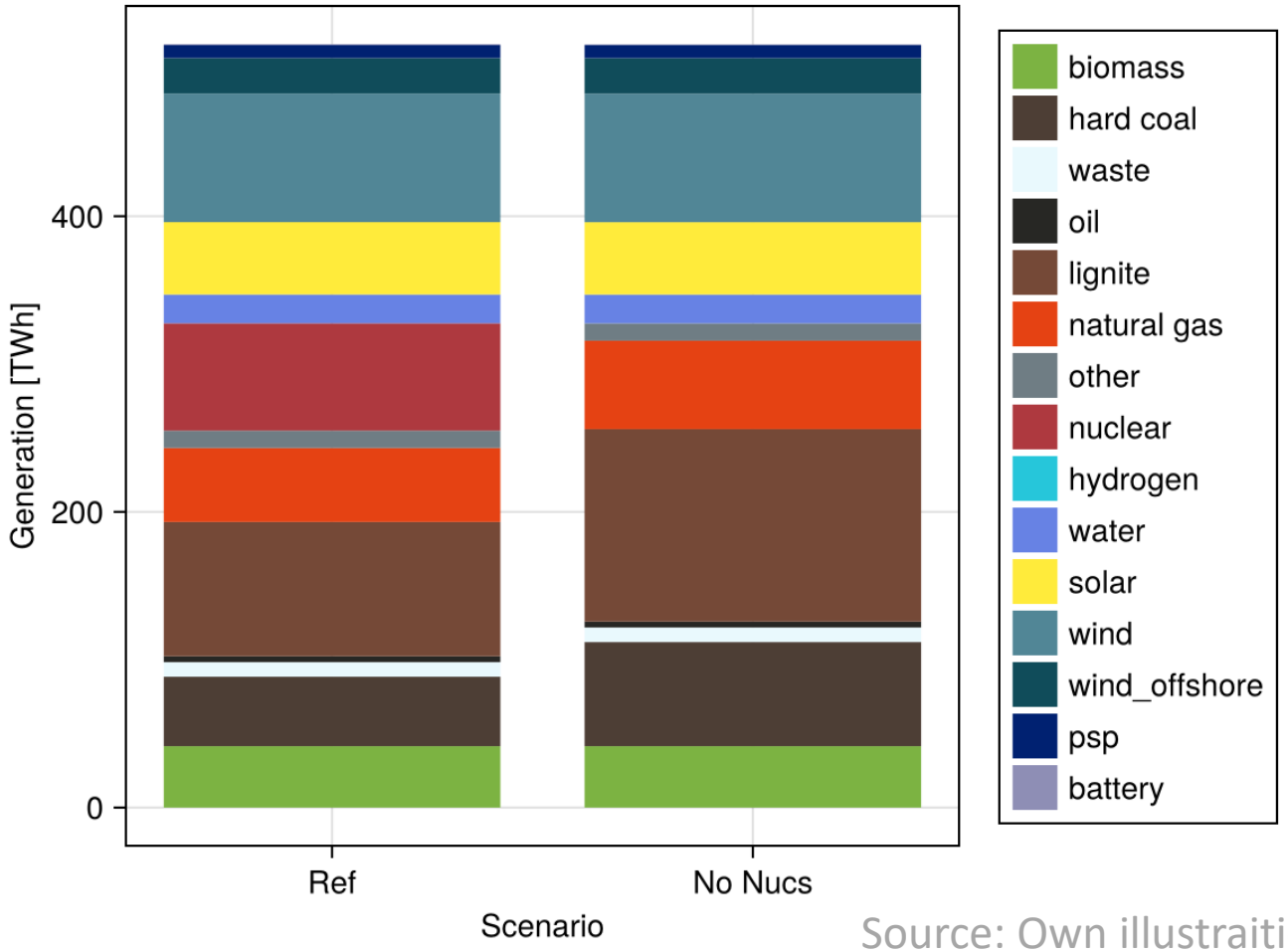
No NPP Scenario

- No nuclear power plants
- Weather year 2021
- Purpose: Illustrate the effects of the nuclear power phase out

2030 Scenario

- No nuclear power plants + No Coal power plants
- Targets for Renewable Energy capacities are met
- Purpose: Provide insight on how the future energy dispatch might look like

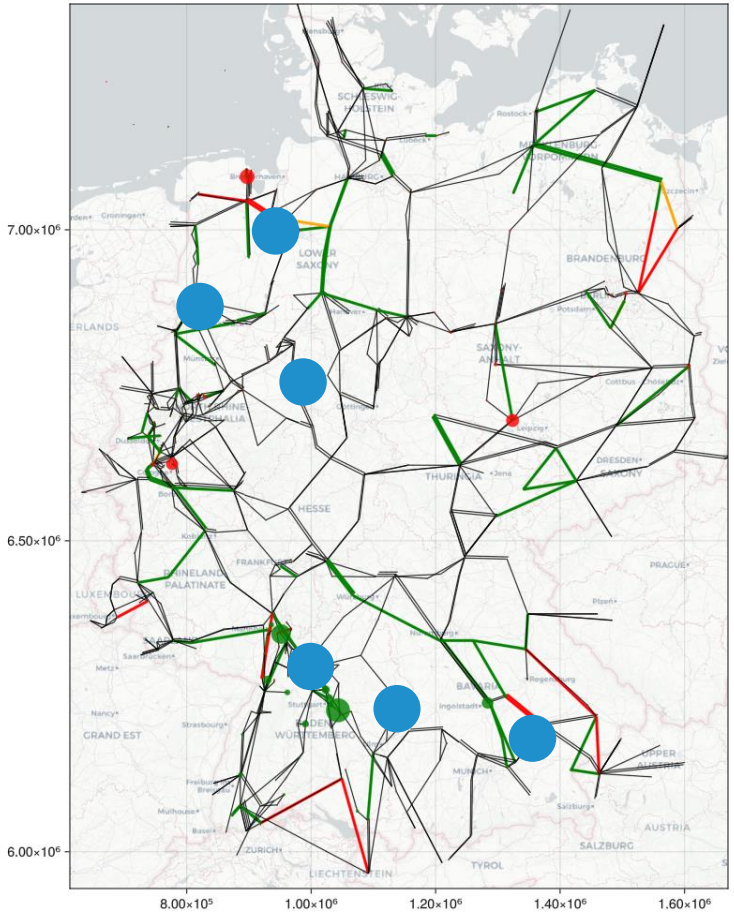
Results 1: Power Production



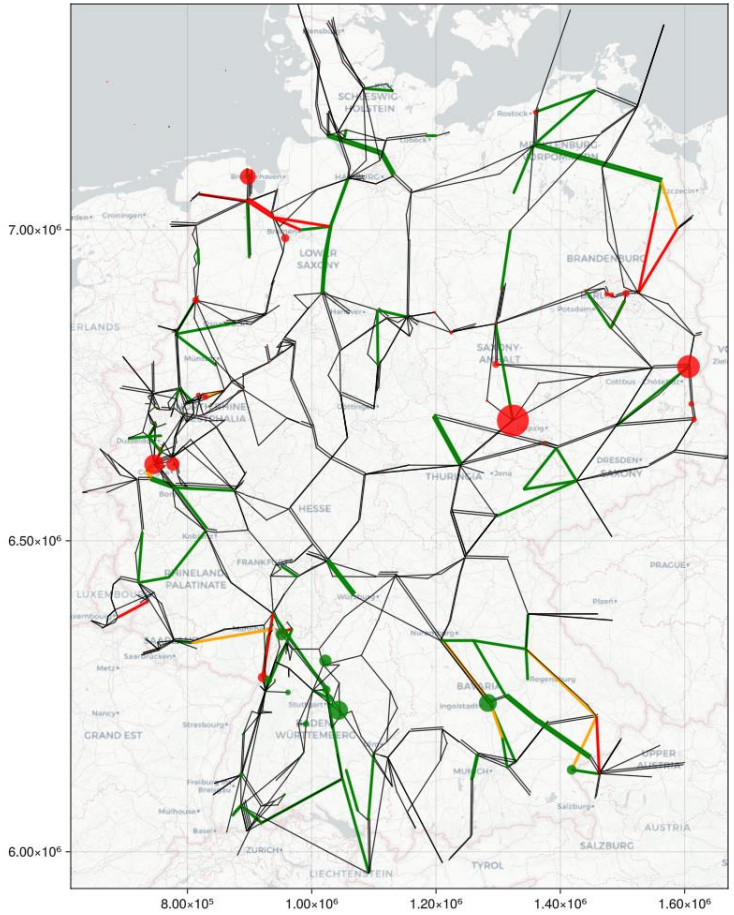
Source: Own illustraition

- Nuclear power is compensated by:
  - Hard Coal (+23 TWh)
  - Lignite (+49 TWh)
  - Natural Gas (+10 TWh)
- Generation capacity is still sufficient

Results 2: Elekticity Network



Redispatch with all 6 NPPs

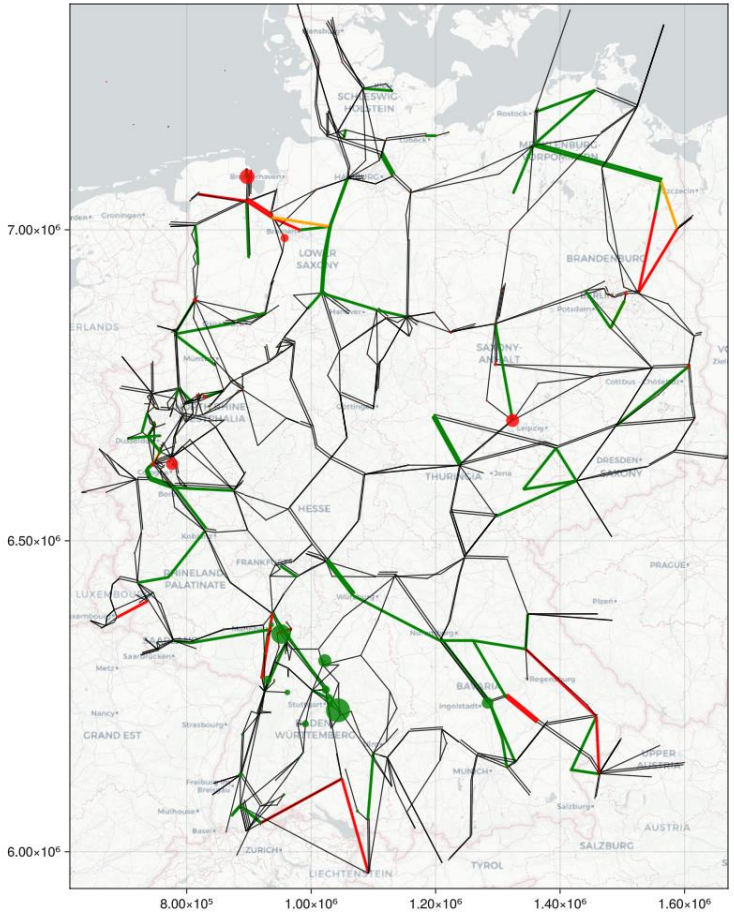


Redispatch without NPPS

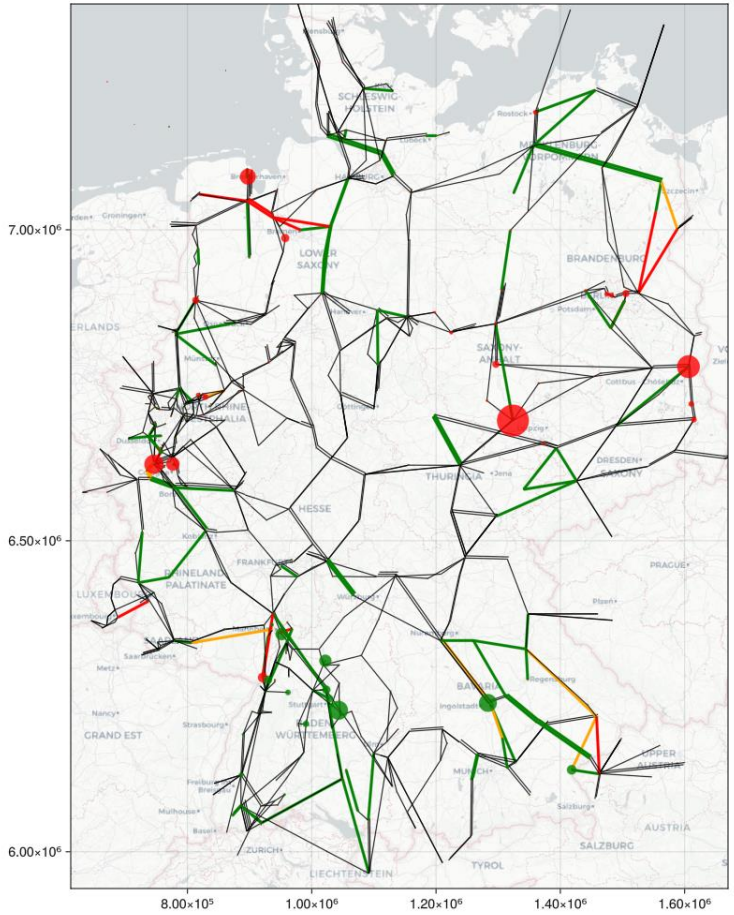
- Slight increase of redispatch (ca. 4 TWh)
- Congestion occurs mostly in the same areas
- Price effect of redispatch small

Source: Own illustraition

Results 2: Elekticity Network



Redispatch with all 6 NPPs



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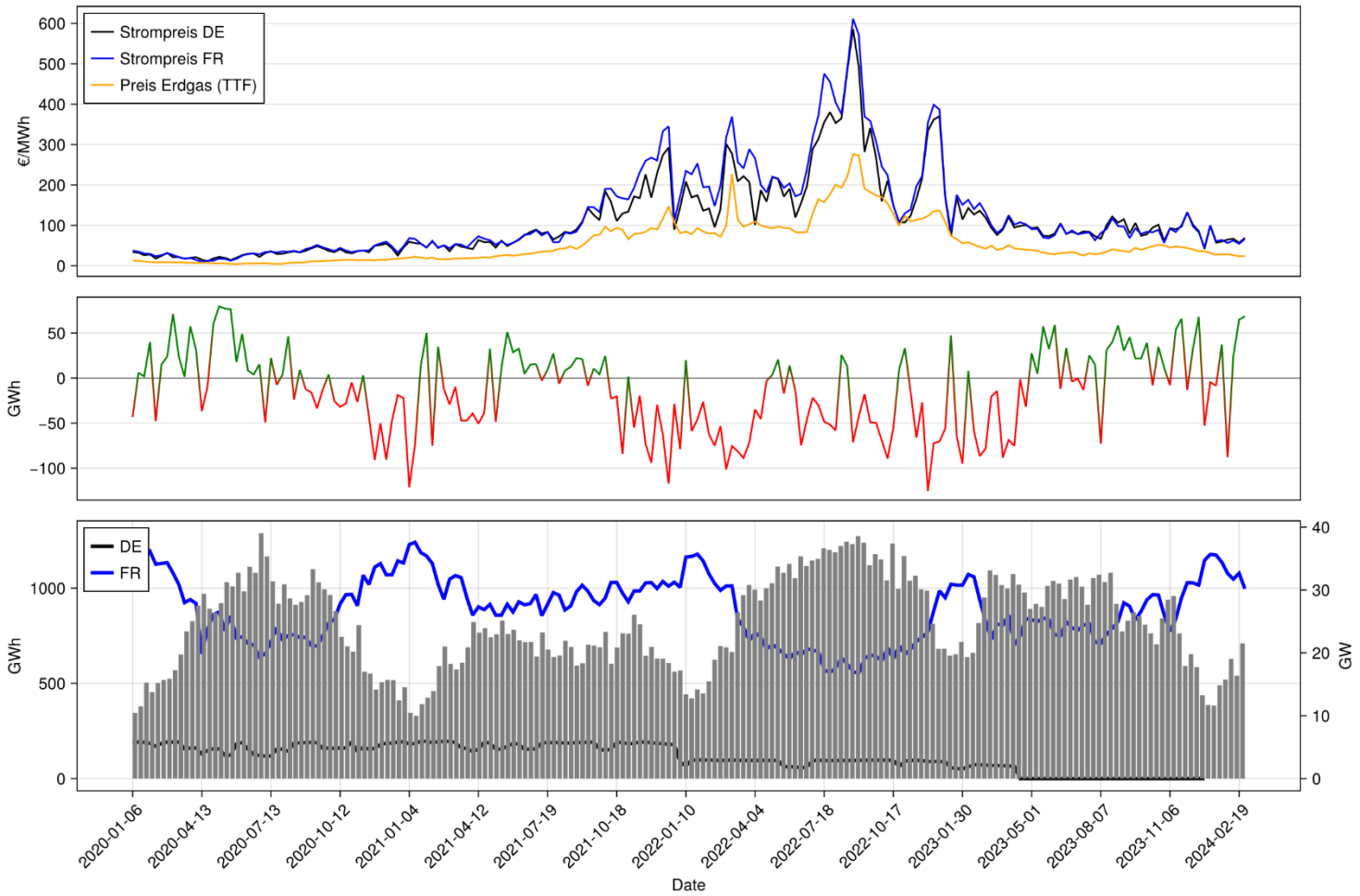
Results 3 – Prices

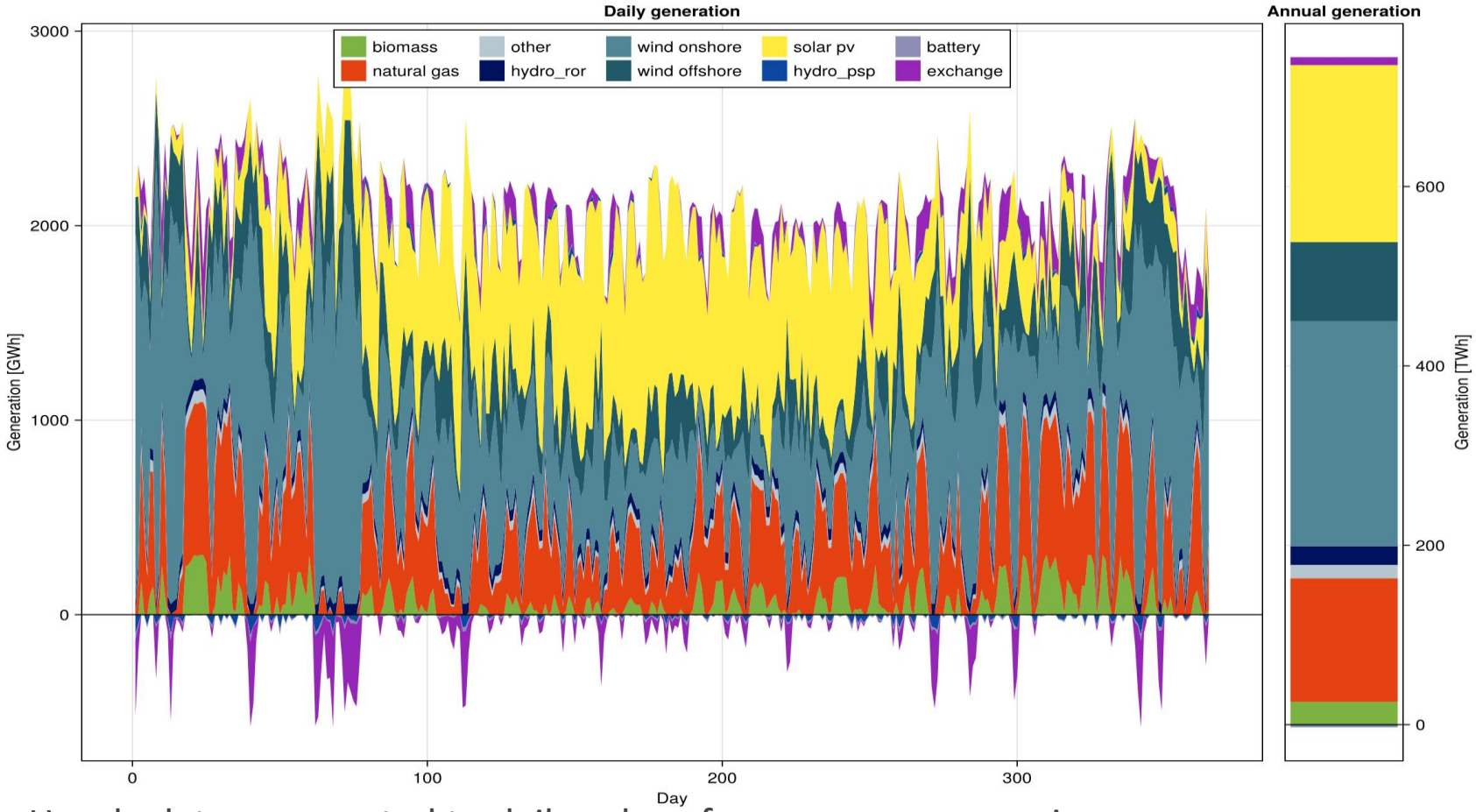


- Natural Gas prices heavily influenced historic Power prices
- Germany increased exports to France in 2022
- Day-Ahead-Prices decreased in the month following the closure of the final 3 NPP on 15th of April 2023
- Model based analysis leads to overall higher power prices of 1,1ct/kWh

Source: Own illustraition based on data from: EEX and ENTSO-E Transparency Platform

Historic market prices (Top), German imports from France (middle) and available nuclear power plant capacities (bottom)

Results 4 – Outlook 2030



Hourly data, aggragated to daily values for german power mix

- Renewable energy generation dominant
- Natural gas and biomass in combination with imports and hydro storages create flexibility
- For the chosen weather year Germany's exports exceeds imports

Source: Own illustraition

Summary and Conclusions

- Suppy security still secured
- Only minor increase in redispatch due to the decomissioning of NPPs
- Electricity Grid can withstand the new dispatch without creating new bottlenecks
- Prices for natural Gas main driver for an incease of electricity Prices in 2022 and 2023
- Short term: NPP capacities are compensated by fossil fuels
- Mediate/long term: The building of new Renewable energy Capacities leads to a possible coal phase out in 2030 while ensuring supply security

Thank you for your attention!

Enno Wiebrow – Research Associate
Technische Universität Berlin – ewi@wip.tu-berlin.de

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