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Policy advice on low-carbon policies for Ukraine

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

Was the dispatch of power plants in May 2020 optimal?

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Implemented by

Berlin Economics

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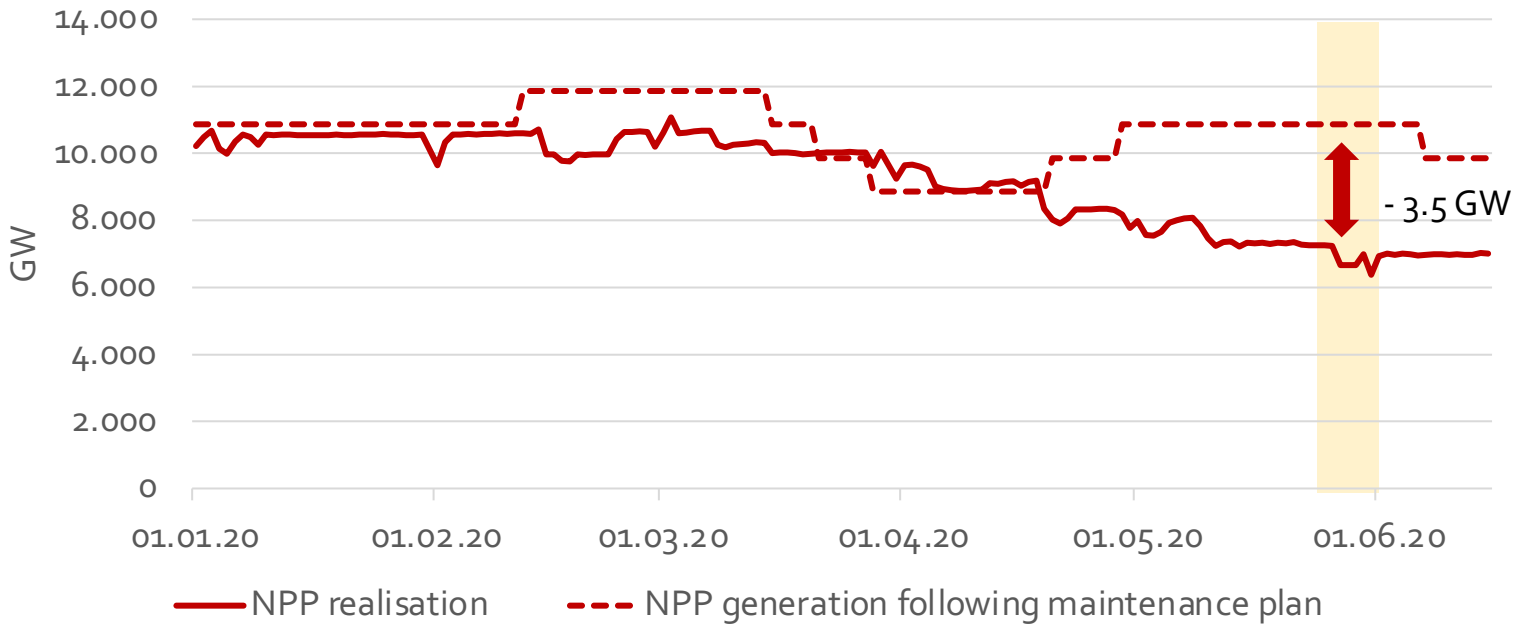
Actual nuclear generation vs. maintenance plan



- NPP maintenance plan foreseen an upper nuclear power generation up to 3.5 GW higher than actual generation in the last week of May
- Balancing restrictions and low demand could partly explain lower NPP generation

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Power plant dispatch was suboptimal

We compare the actual dispatch end of May with an economical optimal dispatch, derived with our Optimal Dispatch Model (ODM)*

- Compared to the optimal dispatch, actual nuclear load end of May was 15% too low
- This resulted in:
  1. Increased CO_2 emissions by **250,000 t** in only one week
  2. Increased operational cost by about UAH 150 m, i.e., 10% of operation cost

* See slide 12, Methodology

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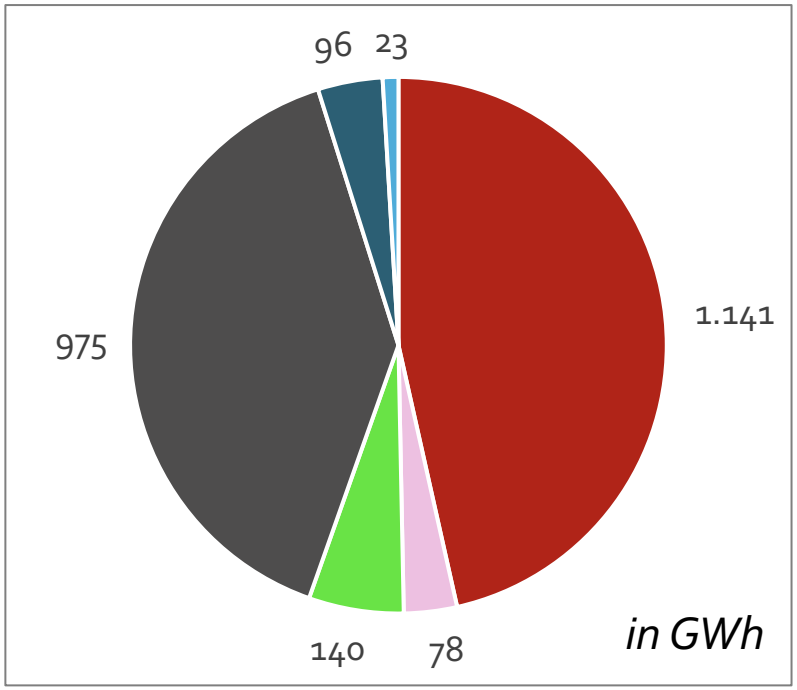
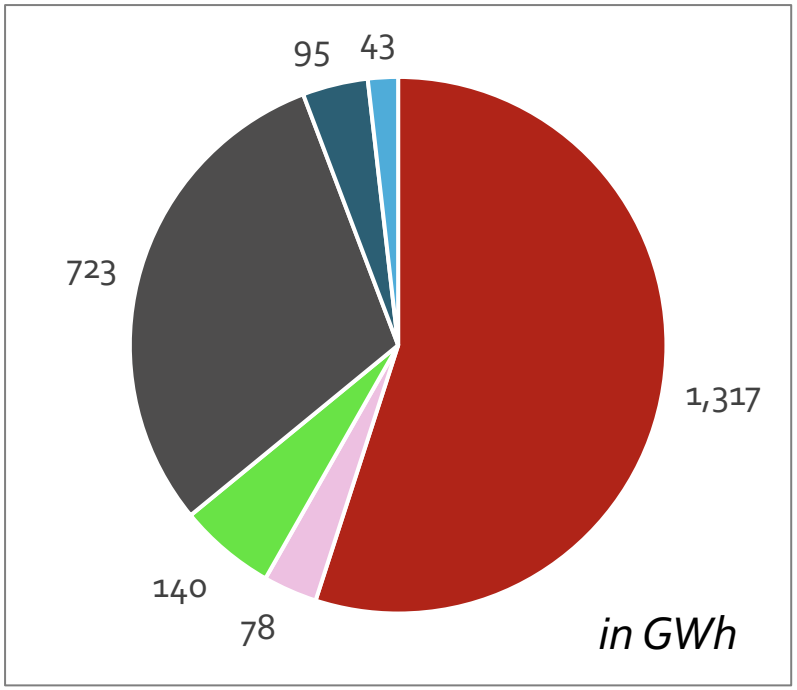
Electricity generation

Realisation vs. optimal schedule 25th-31th May 2020

Actual generation 25th-31th May 2020



Optimal dispatch 25th-31th May 2020



NPP CHP RES (PV + Wind) Thermal PP Big hydro Pumped hydro (generation)

- Actual NPP generation was 15% lower than cost-optimal NPP generation

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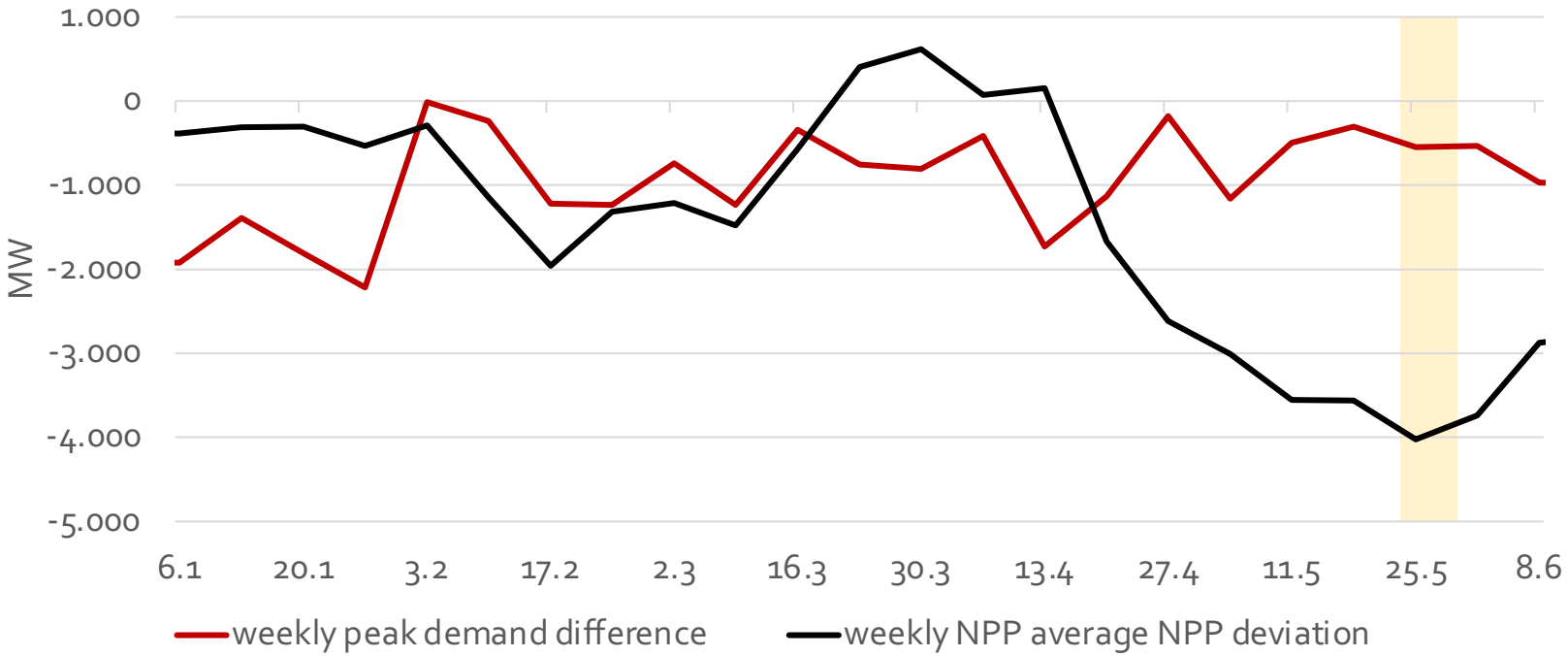
Low nuclear output cannot be explained by "Covid"

Weekly peak demand 2019/20 vs. NPP deviation



- Covid-related demand reduction was steadily between 6-11% since February 2020
- NPP generation decrease only kicked-in in April and **overshot peak demand decrease** by up to 3,000 MW

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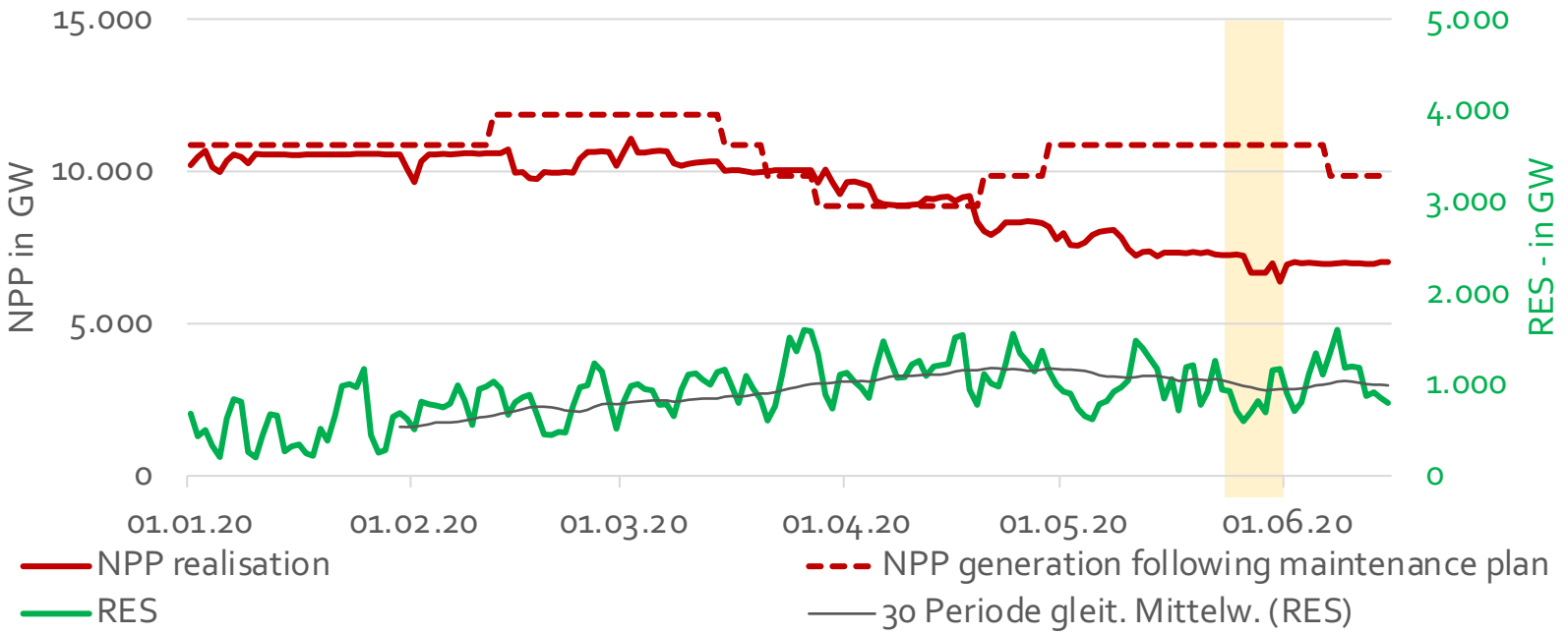
Low nuclear output cannot be explained by "RES surge":
NPP maintenance schedule vs. generation and RES generation



- RES (wind and solar) generation increased form January steadily on
- RES generation range 400 - 900 MW until first week of March and 1,000 - 1,200 MW until first week of June
- ODM modelling results show that thermal generation was higher than necessary to provide spinning reserves for RES fluctuations

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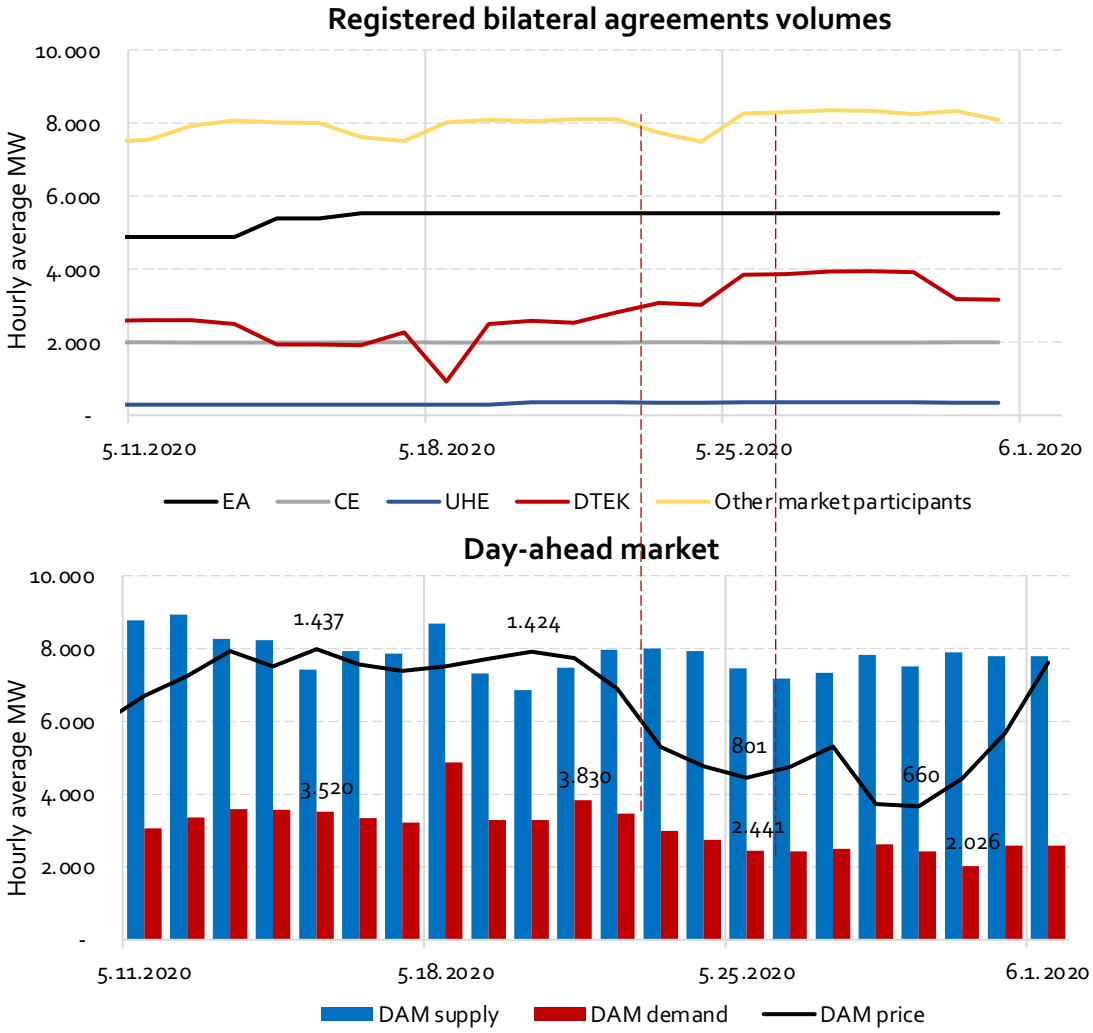
Market developments affected the NPP output decision



- During last two weeks of May DAM experienced <50% drop in price
- This resulted from demand shift from DAM to bilateral agreements
- Meanwhile DAM supply and consumption remained relatively stable
- DTEK generation companies were the sources of additional supply on bilaterals
- No other player has significantly changed their offers
- At the same time, Energoatom cannot offer more on bilaterals, as it is limited by PSO obligations

Sources: Market operator, Ukrnenergo, UEEX data, LCU calculations

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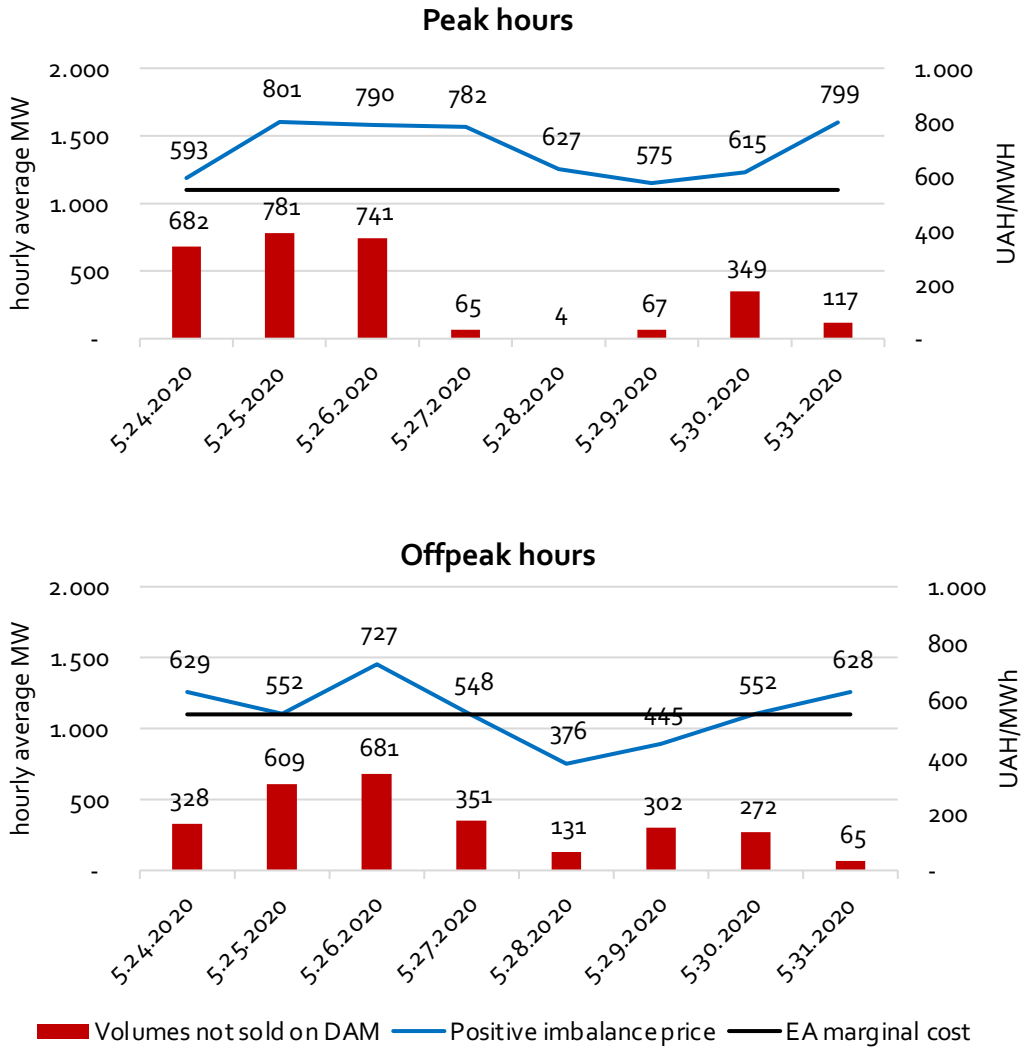
NPP output decrease was a response to market prices



Sources: Market Operator, Ukrenergo data, LCU calculations

- Energoatom, being limited by their administrative obligations, was incurring additional positive imbalances – mostly during off-peak hours
- As soon as the imbalance price reaches the level of marginal costs, EA sells power at a loss
- In order to maximise the profit, EA decided voluntarily to decrease their output for ~600 MW starting from 27/5/20 – thus decreasing their exposure to imbalances

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Conclusion

- Observed decrease in nuclear generation is not justified by economics, demand development or RES deployment
- Ukrenergo's balancing restricition for NPP at 7,220-7,600 MW in May 2020 was lower than extimated optimal 7,840 MW.
- Energoatom's decision to decrease the output to 6,700 MW during May 25-31 was dictated by market design inefficiency
- The result is higher generation from more expensive and polluting coal-fired plants and increased total cost of electricity generation
- The drawbacks of market rules design, namely system of price caps, link between DAM and Balancing market, as well as PSO design, give advantage to privately-owned generators over strictly regulated state-owned Energoatom
- The players with significant market power, both on supply and demand side, must be regulated and their market power addressed

Appendix

Supplemental material

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NPP maintenance schedule 25th-31th of May 2020

- The initial outage and maintenance plan for nuclear capacities had foreseen that following units are in maintenance mode end of May 2020:
  - Zaporizhzhya NPP unit 4 (1,000 GW)
  - Zaporizhzhya NPP unit 5 (1,000 GW)
  - South-Ukrainian NPP (unit 2) (1,000 GW)
- **Following this plan, ca. 11,8GW of nuclear units have had to be in operation end of May 2020**
- The total generation within 7 days would have sum up to ca. 2,000 GWh
- However, realisation of NPP sum up to only 1,480 GWh

Methodology

- We compare an optimal generation schedule with the realisation of generation for the last week of May 2020
- We derive the NPP, TPP, big hydro and pump generation trajectories by utilization of our Optimal Dispatch Model
- We consider CHP and RES generation, demand and trade trajectories as exogeneous
- We derive reserve requirements through a probabilistic consideration of forecast errors
- We consider a high forecast error for RES generation with a standard deviation of relative forecast errors of 50% and a confidence interval of 98%
- This assumption implies a conservative reserve provision that covers close to 100% of deviations of RES generation from forecasts

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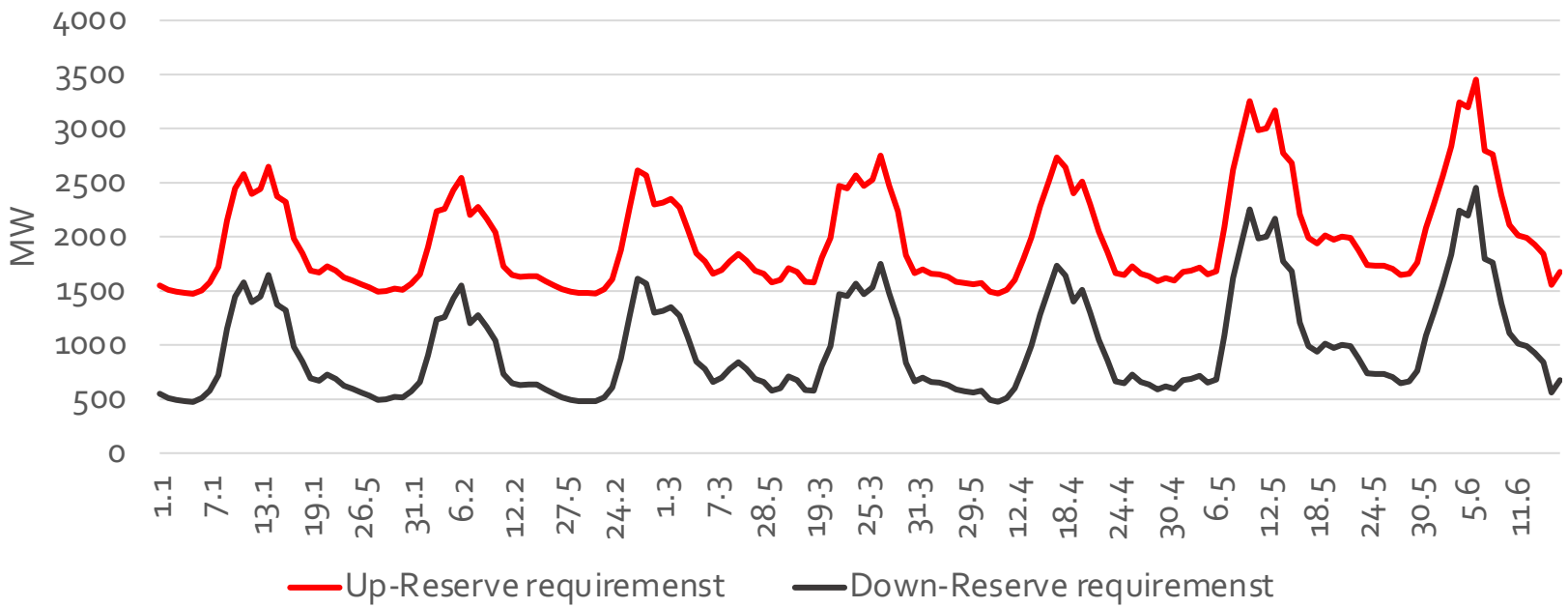
Reserve requirements:
Optimal schedule 25th-31th May 2020



$$\text{Up-Reserve} = 1{,}000\ \text{MW} + 2 \cdot \sigma_{RES} + \sigma_{demand}$$

$$\text{Down-Reserve} = 2 \cdot \sigma_{RES} + \sigma_{demand}$$

Standard deviation RES generation = 50%
Standard deviation demand = 2%
Confidence Interval = 98%

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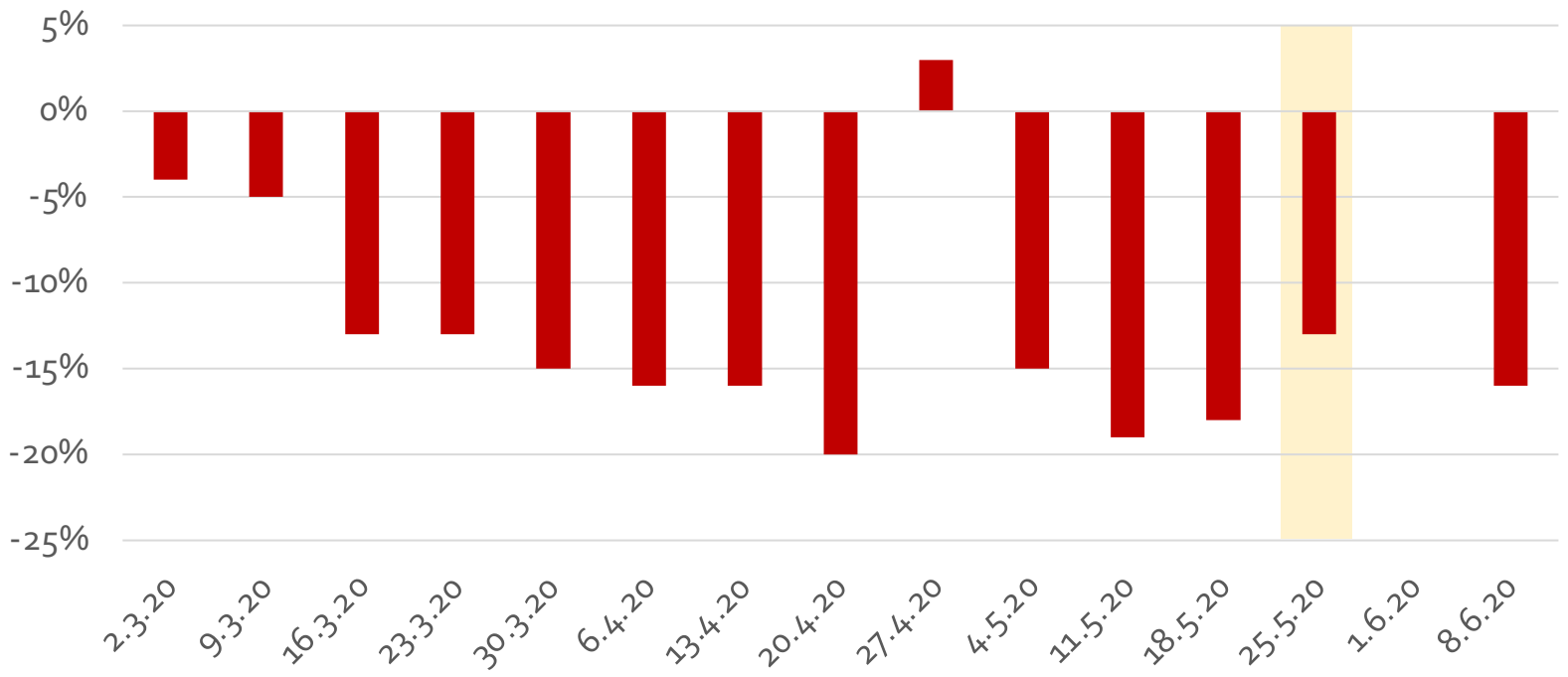
Temperature adjusted demand decrease compared to 2019



Source: Bruegel

- According to Bruegel electricity tracker, temperature adjusted peak demand in 2020 decrease up to 20% compared to same week of 2019 due to Covid-19 crisis
- Demand decrease less pronounced in last week of May

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