

National Technical University of Athens

## Κατανοώντας τις Υψηλές Τιμές Ηλεκτρισμού στην Ευρωπαϊκή Αγορά το Καλοκαίρι του 2024

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#### Prime minister Kyriakos Mitsotakis' letters to the president of the European Commission Ursula von der Leyen regarding the EU energy market

#### 13 September 2024 & 14 January 2025



Day-ahead wholesale electricity prices in the European Union

Based on data from ENTSOE, GME (for IT and MT), EMBER (for cross-validation). Excludes CY.

- Wholesale electricity prices in Greece more than doubled from €60/MWh in April to €130/MWh in August 2024
- This occurred despite a 25% increase in wind and solar generation and a 27% decrease in lignite use compared to the previous summer
- Similar increases in Bulgaria, Romania, Hungary, Croatia, and other Member States, indicating a regional crisis
- Not all Member States were impacted equally: significant rise in price disparities between Member States
- Regional factors: very warm weather, outages of generation and cross-border capacity, and low rainfall during the winter, which left reservoirs with less water for the summer season
- Proposed Solutions:
  - (i) Stronger governance to regulate country-level decisions (e.g., a planned outage) that affect the whole market
  - (ii) More EU regulatory oversight to ensure markets are functioning properly and there is no anticompetitive behaviour
  - (iii) Addressing Ukraine's energy needs

(iv) Increase cross-border capacity

\*Sources: [1] Mitsotakis K. (2024)

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**2024 letter**: What is even more worrisome, the system is so complex and opaque that is virtually impossible to understand precisely what is driving prices at any given point and time. We have created an incomprehensible black box – even to experts. And we cannot explain convincingly to our citizens why the price they pay is rising so suddenly. This is politically unacceptable.

#### *2025 Letter propositions:*

- *a* short-term solution of a task force with the *aim of increasing the flows across borders* where there are significant price disparities
- Calculate the welfare losses from insufficient *interconnections, making clear the benefits of* integration

### EUROPEAN COMMISSION: Action Plan for Affordable Energy

26 February 2025



COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Action Plan for Affordable Energy

- Strengthen the Energy Union: Enhance coordination and governance to prevent cost disparities
- Crisis preparedness: Enhance mechanisms to manage potential energy crises effectively
- **Increased cross-border access to cheap electricity**: Ensuring that cross-border trade of electricity is maximised in crisis situations to mitigate local price spikes in particular markets



## Understanding Eastern Europe's Summer 2024 Electricity Price Crisis

#### 1. Data analysis on critical days:

- Physical flows
- Scarcity conditions/unused capacity
- Hydro reservoirs
- Aggregated buy/sell order curves

## 2. Developing a DA market model to provide causal insights

- Detailed, EU-wide, DA market model with perfect competition assumption and scarcity pricing modeling mechanisms
- Dominant firm with fringe competitors market model

## Data analysis for 03/09/2024

Day: 2024-09-03



Zone	Mean Price (€/MWh)	Peak Price (€/MWh)
GR	186	911
BG	208	950
RO	246	1022
RS	236	900
HU	241	999
IT	151	248

\*Data Sources: EnergyLive through ENEX (GR\_price), Gestore Mercati Energetici (IT\_SUD\_price), IBEX (BG\_price), OPCOM (RO\_price), HUPX (HU\_price). \*Time: UTC+2:00 6

## Greece: physical flows on 03/09/2024





- IT-GR interconnection congested → IT DA price does not follow the extreme peaks
- BG-GR interconnection not congested
- During peak hours GR switches to importing from IT and exporting to BG (the opposite is true for the rest of the day)

\*Data Sources: ENTSO-E Transparency Platform \*Time: UTC

## **Greece: hydro reservoirs**



## **Greece:** aggregated buy/sell order curves



#### Crisis conditions: 03/09/2024

#### Typical day (post-crisis): 30/09/2024



- On 03/09 the last 30% of the quantity is sold at price over 900 €/MWh. Ι.
- ii. On 03/09 approximately 400 MW less quantity offered to be sold

\*Data Sources: HEnEx \*Time: UTC+02:00 9

## **Greece:** aggregated buy/sell orders curves

#### Crisis Conditions: 03/09/2024



	20:00	21:00
Matched Block Orders	3591.0 MW	3602.0 MW
Net Pos	599.0 MW	717.03 MW

\*Data Sources: HEnEx \*Time: UTC+02:00 10





• BG borders not congested, transit country

\*Data Sources: ENTSO-E Transparency Platform

### Romania: physical flows on 03/09/2024





- Romania is a net importer
- During the critical hours (17:00-20:00 UTC) RO imports from all its neighbors (including RS)

\*Data Sources: ENTSO-E Transparency Platform

### Hungary: physical flows on 03/09/2024



\*Data Sources: ENTSO-E Transparency Platform

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## AT-HU Link

ΜM



- The AT-HU link is without flows for about a month starting from 12/8
  - The DA prices of AT do not follow the price spikes even when the link is open

\*Data Sources: ENTSO-E Transparency Platform

## Data analysis for 03/09/2024

- Uncongested corridor connecting GR, BG, RO
- GR, BG, RO coupled during the price spike
- RO acts as a local sink during the critical hours
- Currently under investigation: (i) Bottlenecks of the FB sub-network (ii) Congestions of the links for Balkan zones outside of SDAC (SEE CAO)



## **Greece: unutilized capacity**





Note: Unutilized capacity is negative during the critical hours because the reserve supplied by hydro is not taken into account.

## HU and RO: unutilized capacity



 Strong indications that there are scarcity conditions for the thermal power plants in zones GR, HU, RO

\*Data Sources: ENTSO-E Transparency Platform

## **BG: unutilized capacity**



\*Data Sources: ENTSO-E Transparency Platform

- When using the ENTSO-E dataset, there seems to be a substantial amount of unutilized capacity during critical hours, pointing to potential anti-competitive behavior
- Inconsistency in installed capacity data sets for BG

Counterfactuals parametrizing the model with data from 2023 and 2024



Model features:

1. Zonal model

**Core zones:** ALBE, ALDE, AT, BE, HR, CZ, FR, DE\_LU, HU, NL, PL, RO, SK, SI **Non-Core zones:** BG, GR

- 1. Zonal model
- 2. Optimizing for the production of thermal power plants, considering each power plant individually



- 1. Zonal model
- 2. Optimizing for the production of each power plant individually (PyPSA dataset)
- 3. Network constraints: Flow-Based for Core Region and NTC for Balkan region

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- 6. Fixed renewables and hydro and cross-border flows from countries/zones that are not modeled using historical data

#### Model features:

7. Unavailability of production

Kozloduy NPP Unit 6 to shut down due to non-nuclear malfunction



On 15 June, Unit 6 of the Kozloduy Nuclear Power Plant will be shut down for planned preventive maintenance due to a detected malfunction in the oil system of the unit transformer in the non-nuclear part and indications of a heat transfer medium leak in the steam generator. This was announced by the nuclear power plant.



\*Data Sources: ENTSO-E Transparency Platform

#### Model features:

8. Dynamic reserve requirements

Contracted Reserves GR for 48h



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- 2. Optimizing for the production of each power plant individually (PyPSA dataset)
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- 4. Marginal cost adjustment to reflect the gas prices and EU Carbon Permits of both years
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- 6. Fixed renewables and hydro and cross-border flows from countries/zones that are not modeled using historical data
- 7. Unavailability of production
- 8. Dynamic reserve requirements

#### Results



#### Challenges

- Choosing the available capacity in the model to reflect the amount supplied to the market
- Producing results that recreate the sustained phenomenon



## **Modeling market power** [4], [5], [6]



## Modeling market power: first results



#### References

**[1]** Kyriakos Mitsotakis. 'Prime Minister Kyriakos Mitsotakis' Letter to the President of the European Commission Ursula von Der Leyen Regarding the EU Energy Market', 13 September 2024. <u>https://www.primeminister.gr/en/2024/09/13/34887</u>.

[2] Kyriakos Mitsotakis. 'Prime Minister Kyriakos Mitsotakis' Letter to the President of the European Commission Ursula von Der Leyen Regarding the EU Energy Market', 14 January 2025..

[3] EUROPEAN COMMISSION. 'Action Plan for Affordable Energy'. Accessed 17 March 2025. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0079.

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**[5]** Hobbs, B.F., C.B. Metzler, and J.-S. Pang. 'Strategic Gaming Analysis for Electric Power Systems: An MPEC Approach'. *IEEE Transactions on Power Systems* 15, no. 2 (May 2000): 638–45. <u>https://doi.org/10.1109/59.867153</u>.

**[6]** Jing-Yuan, Wei, and Yves Smeers. 'Spatial oligopolistic electricity models with Cournot generators and regulated transmission prices'. *Operations Research* 47.1 (1999): 102-112.

## Thank you for your attention

## For more information:

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# Appendix