FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Energy Economics

Fachbereich 2 Informatik und Ingenieurwissenschaften

Assessment of a gas price cap

- What is the problem Neuhoff (2022) wants to work on?
- What are his assumptions?

Gas supply gap

EU historic gas demand	4000 TWh
Historic Russian Gas supply (interrupted)	1600 TWh (40%)
Assumption on gas saving within EU	800 TWh (20%)
Assumption on additional gas supply at 50 Euro/MWh	560 TWh (14%)
Supply-demand gap to be filled	240 TWh (6%)

Figure: Assumptions about demand-supply balance according to Neuhoff (2022).

Gas price cap – assumptions

- demand shift of 240 TWh from Asia to the EU for a gas price of 300 €/MWh
- gap of 240 TWh for a gas price of 50 €/MWh
- constant elasticity of supply (demand)

$\Rightarrow$ constant elasticity: -0.16

- value of lost load (VOLL) equals 600 €/MWh

Gas price cap – calculations

- insert the known prices of 50 and 300 €/MWh into the demand function

$$950 = A50^{\epsilon}$$

$$710 = A300^{\epsilon}$$

- division of first equation by the second yields

$$\frac{950}{710} = \frac{50^{\epsilon}}{300^{\epsilon}}$$

$\Leftrightarrow$

$$\ln\left(\frac{950}{710}\right) = \epsilon \ln\left(\frac{50}{300}\right) \Leftrightarrow \epsilon \approx 0.1625$$

Main result of the paper

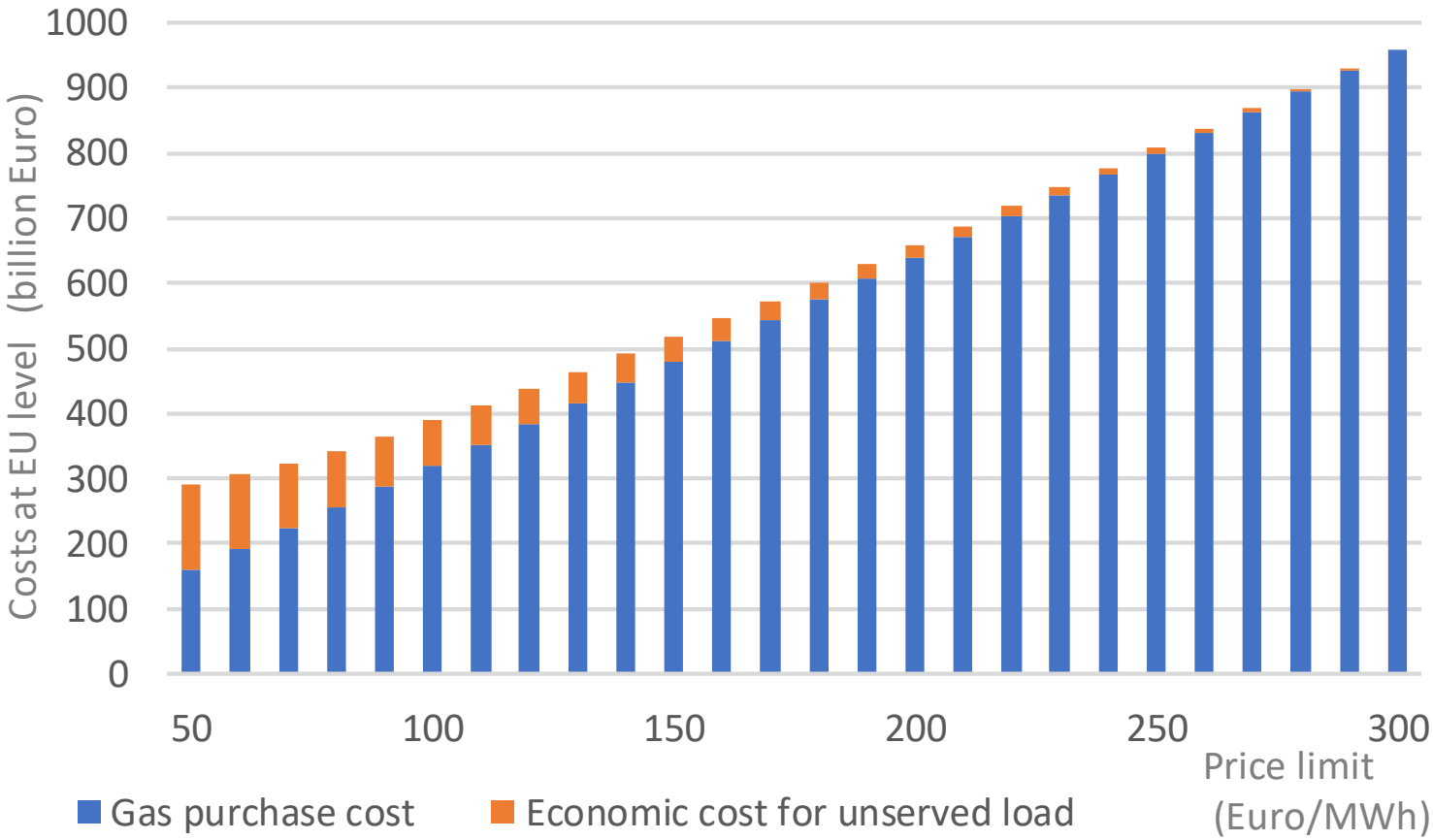

Figure: Cost to EU consumers after a supply interruption of Russian gas; source: Neuhoff (2022).

Robustness check

- sensitive assumptions: elasticity, VOLL
- EU savings are not responsive to the market price
- *weather influence is not considered by scenarios*
- is demand response between 50 and 100 € really that low?

Wholesale gas prices in the EU

Figure: Price evolution for TTF gas from January 1, 2021 until February 20, 2022; source: tradingeconomics.com (2023).

Wholesale gas prices in the EU

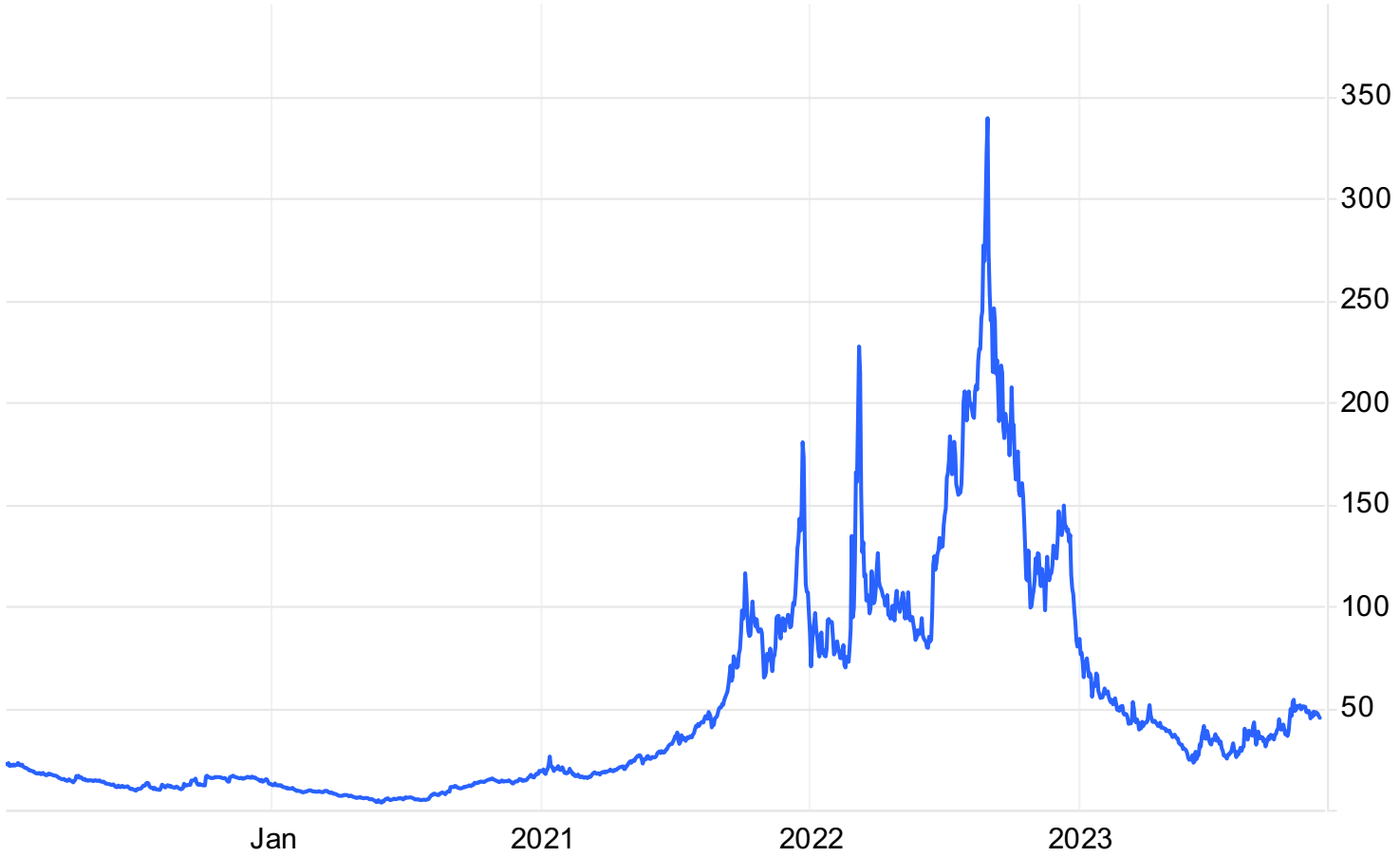

Figure: Price evolution for TTF gas from January 1, 2019 until November 17, 2023; source: tradingeconomics.com (2023).

Wholesale gas prices in the EU

Figure: Price evolution for TTF gas from November 1, 2022 until January 31, 2023; source: tradingeconomics.com (2023).

Gas storage in Germany

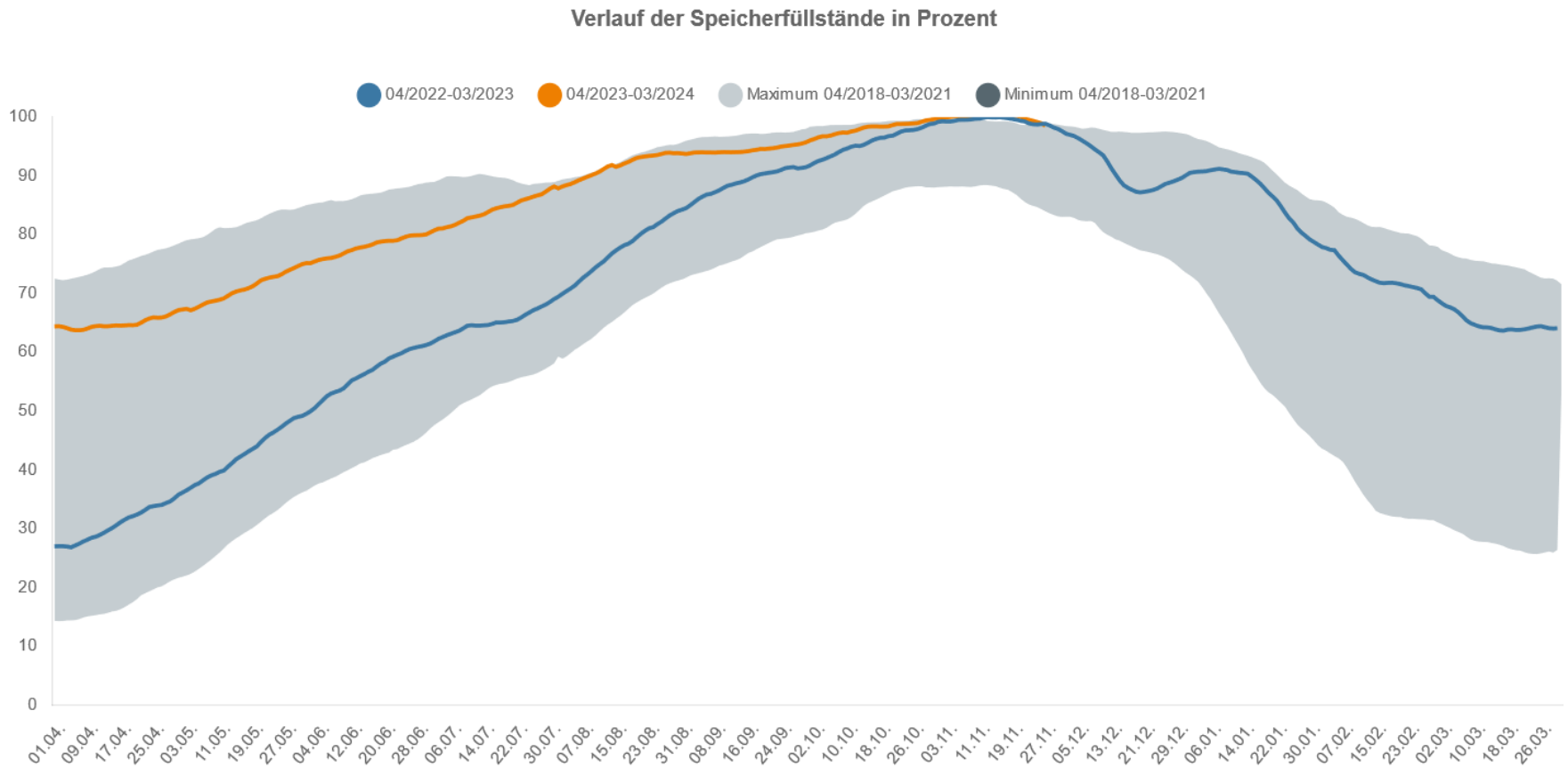

Figure: Development of gas storage levels in Germany from January 1, 2022 until November 17, 2023; source: `https://www.bundesnetzagentur.de/DE/Gasversorgung/aktuelle_gasversorgung/_svg/Gasspeicher_Fuellstand/Speicherfuellstand.html`.

Electricity generation in Germany

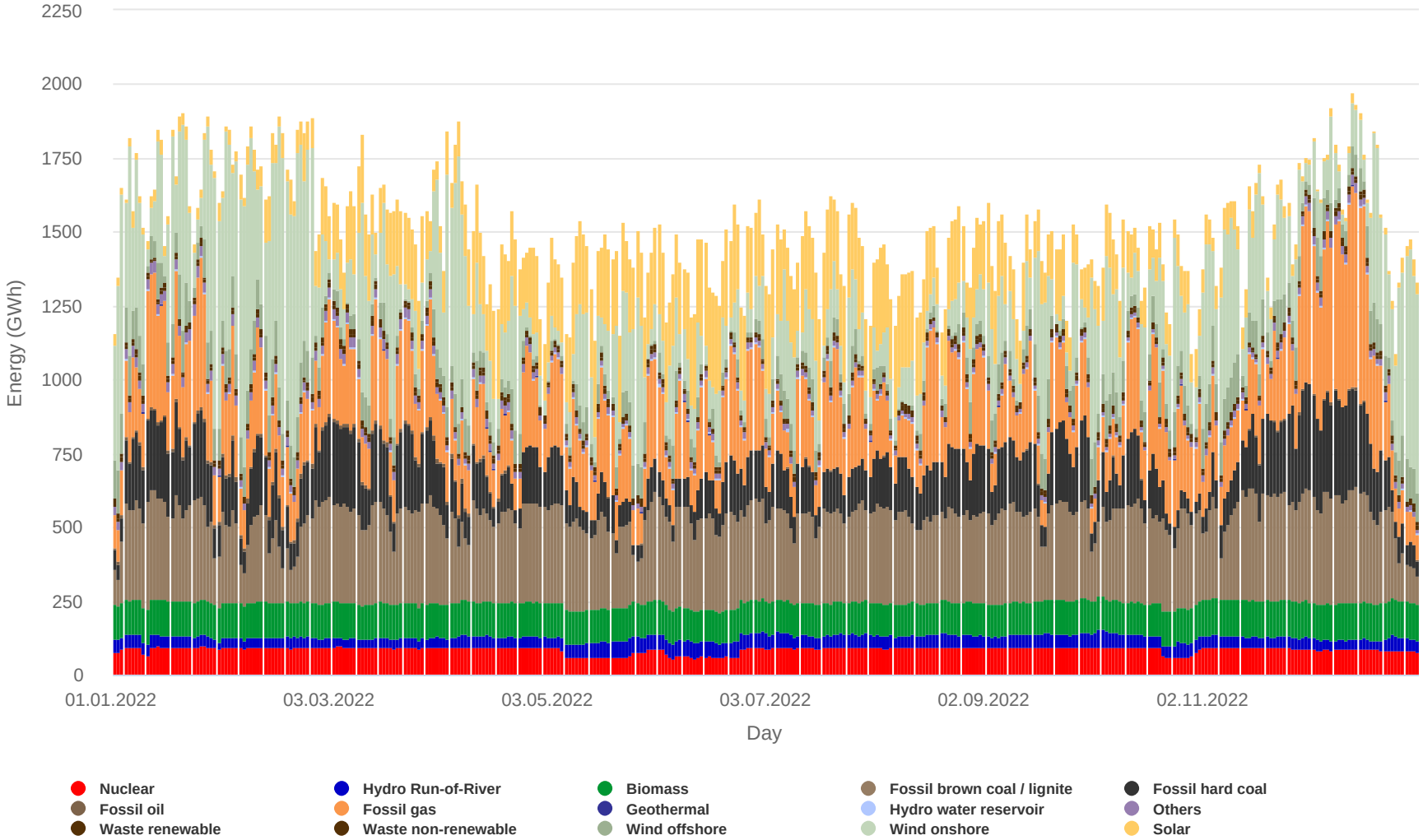

Figure: Total net electricity generation in Germany in 2022 (energetically corrected values); source: Energy-Charts (2023).

Electricity generation in Germany

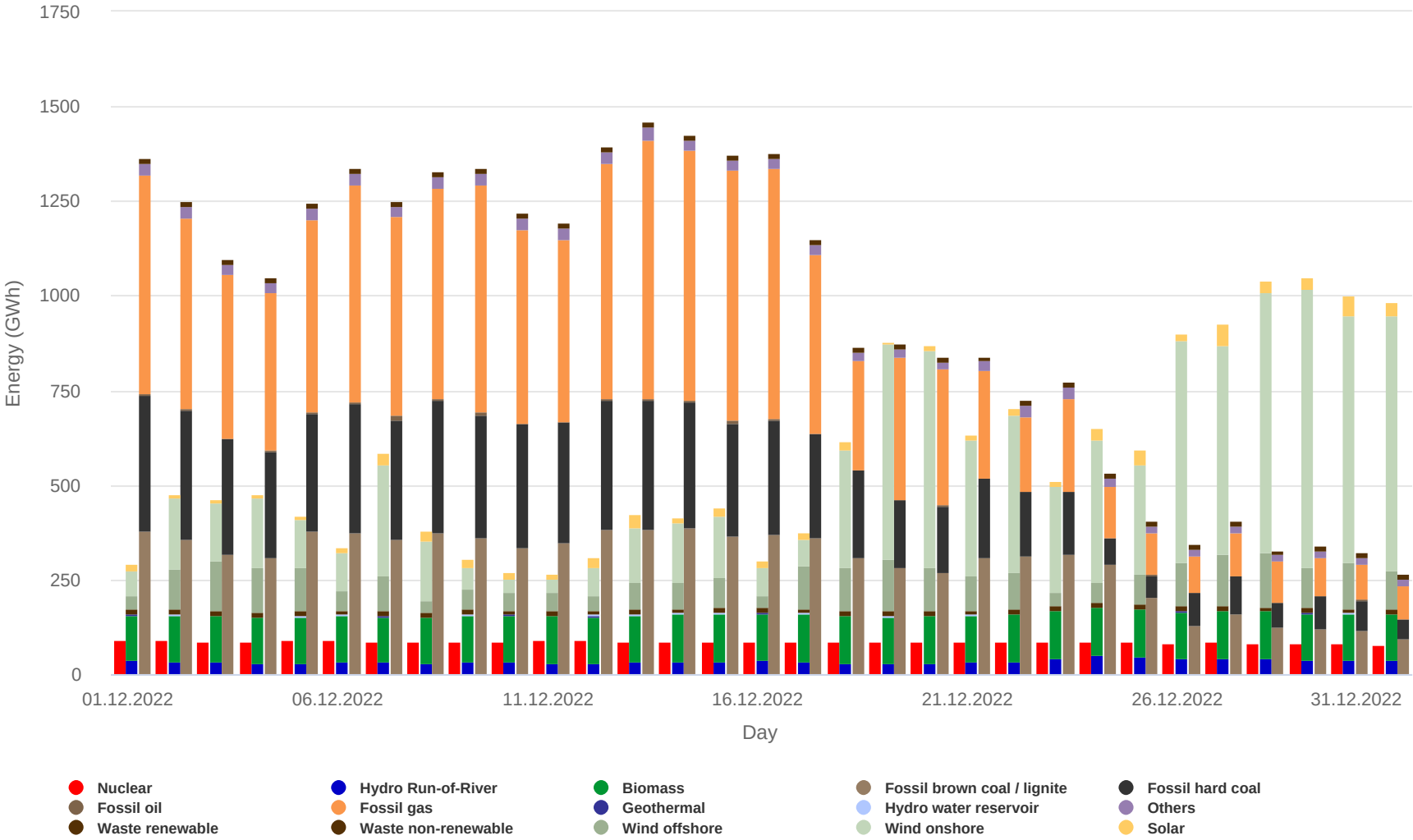

Figure: Total net electricity generation in Germany in December 2022 (energetically corrected values); source: Energy-Charts (2023).

Strategic behavior

Assume you are a lawyer and you defend a client who robbed a bank together with an accomplice. So far, the police "only" found your client and his accomplice each with a pistol which means 3 years in prison for each of them. The states lawyer suggests the following deal:

a) no prison if your client confesses the robbery for him and his accomplice while his accomplice denies it (leniency notice)

b) 10 years in prison if your client denies but the robbery is proved by his accomplice

c) 5 years in prison if your client and his accomplice both confess (attenuating circumstances).

d) 1 hour time!

The prisoners' dilemma

Matrix form of the game described above

		accomplice	
		deny	confess
client	deny	(-3; -3)	(-10; 0)
	confess	(0; -10)	(**-5**; **-5**)

payoffs Π in years: $(\Pi_{client};\Pi_{accomplice})$

$\Rightarrow$ rational decision eventually harms the decider

Nash equilibrium

Figure: John F. Nash (1928 – 2015) at a conference for game theory in Cologne in 2006. Winner of the "Nobel Memorial Price" in 1994; source: Wikipedia

A Nash equilibrium is a combination of strategies without incentive for any player to deviate from his/her strategy.

$\Rightarrow$ The players' strategies are best answers to the other player's strategy

Price cap on Russian oil

game theoretic approach

		Russia	
		not accept	accept
EU+G7+Australia	draw back	(<-2?; 0)	(–; –)
	hold out	(-2; -10)	(1; -1)

payoffs Π in years: $(\Pi_{EU+G7+Australia};\Pi_{Russia})$

$\Rightarrow$ What happened?

Price cap on Russian oil

Impact on payouts in a more general form

		Russia	
		not accept	accept
EU+G7+Australia	draw back	(<-d?; 0)	(–; –)
	hold out	(-d>-c; -c<-b)	(a; -b)

with $c > b$ and $c > d$

payoffs Π: $(\Pi_{EU+G7+Australia};\Pi_{Russia})$

Responses to the oil price cap

Statement of Dimitri Peskov on December 7, 2022:

- no oil export to countries supporting the cap
- no oil export for contracts accepting the cap
- definition of a maximum discount with respect to other crude oils

Responses to the oil price cap

Statement of Vladimir Putin according to Reuters on December 9, 2022:

"*As for our reaction, I've already said that we simply will not sell to those countries that make such decisions. We will think, maybe even, I'm not saying that this is a (made) decision - but we will think, if necessary, about a possible reduction in production. [...] I repeat, we are thinking about this, there are no decisions yet. And specific steps will be outlined in the decree by the President of Russia, which will be issued in the next few days.*"

Urals Crude and Brent Oil price

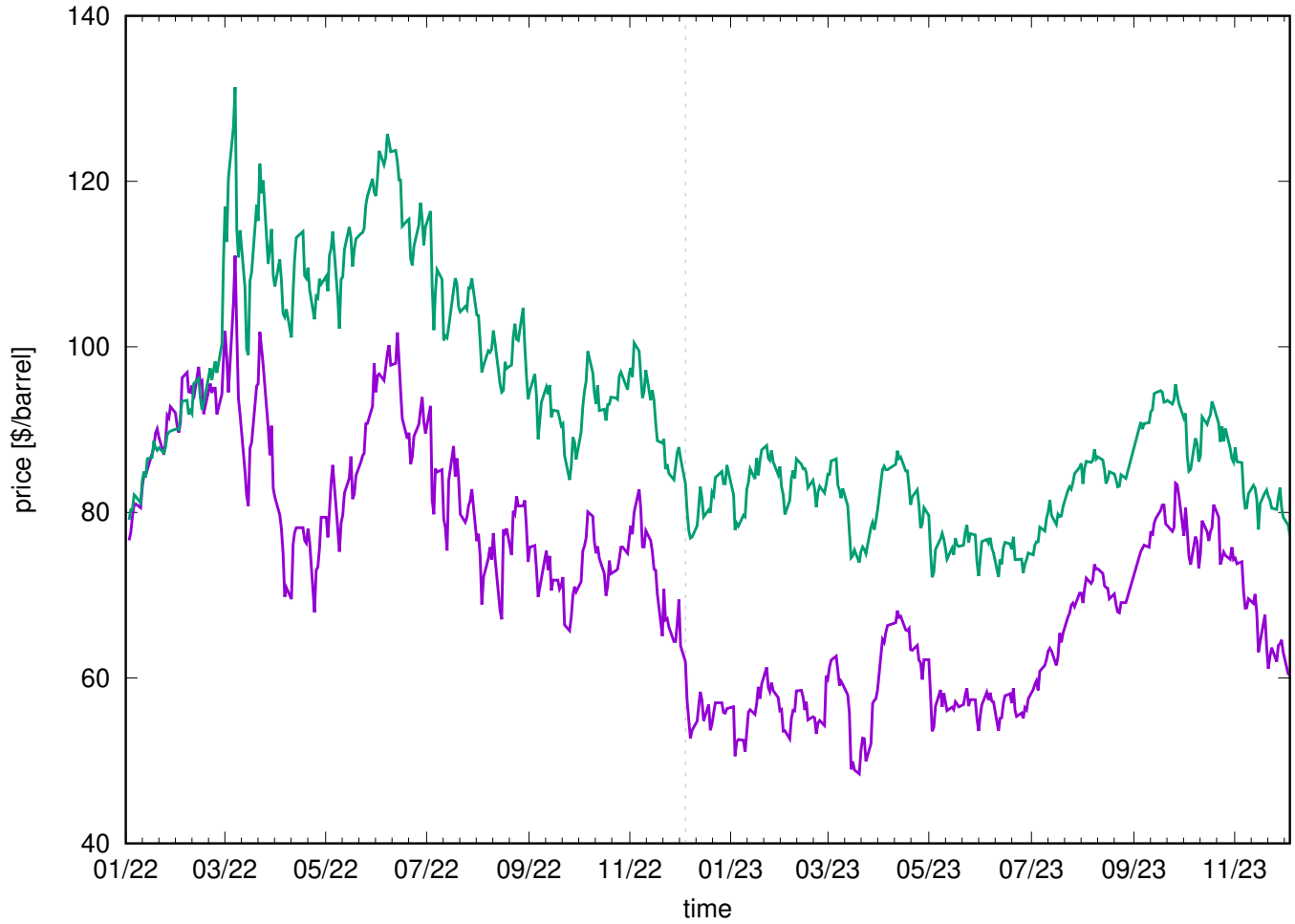

Figure: Price evolution for Brent Oil and Urals Crude Oil from January 1, 2022 until December 6, 2023; source: own illustration based on tradingeconomics.com (2023).

Ratio of Urals Crude and Brent Oil price

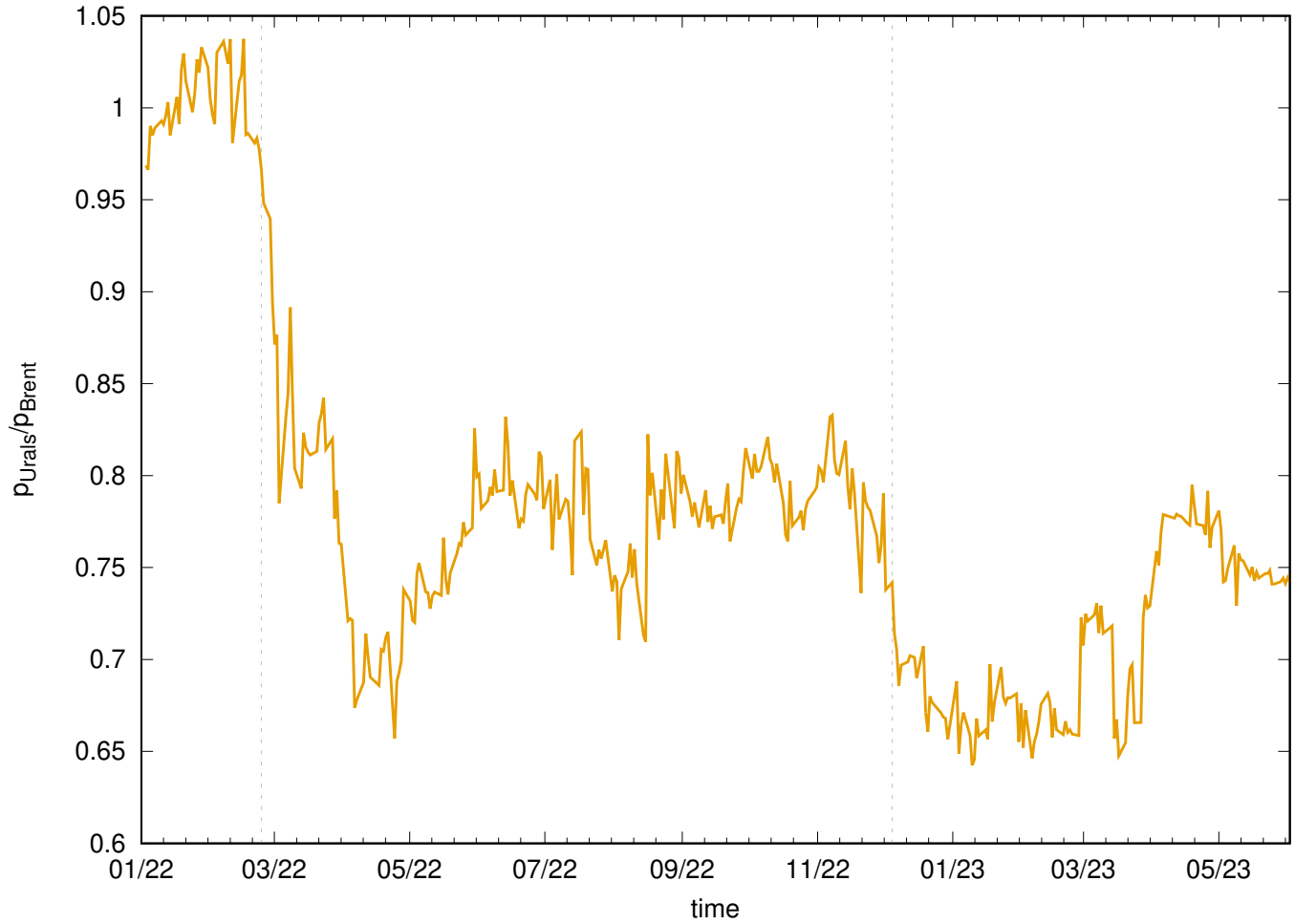

Figure: Development of the price ratio between Urals and Brent Oil from January 1, 2022 until December 6, 2023; source: own illustration based on tradingeconomics.com (2023).

Development of USD/RUB

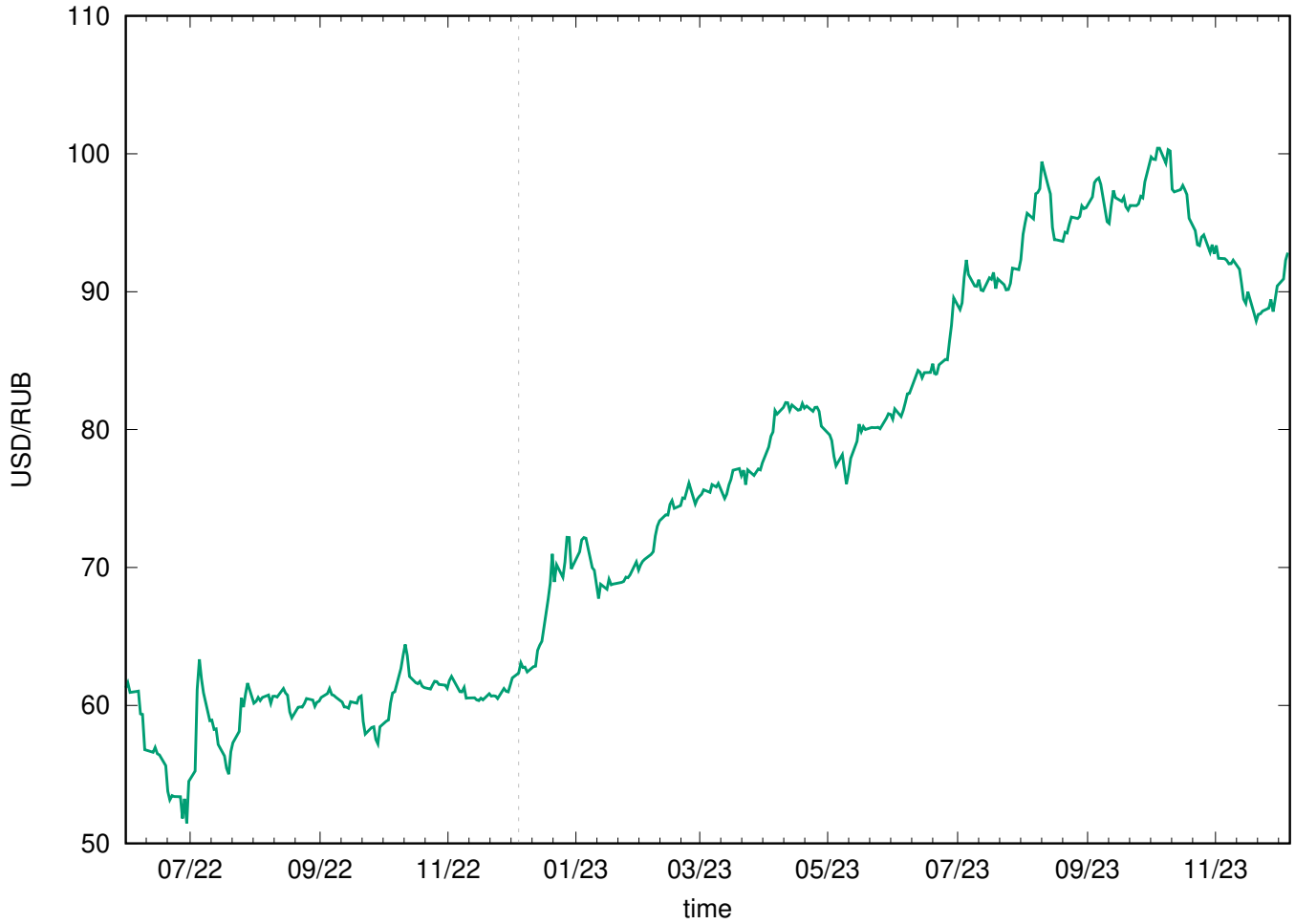

Figure: Development of the USD/RUB currency pair from June 1, 2022 until December 6, 2023; source: own illustration based on tradingeconomics.com (2023).

Development of USD/RUB

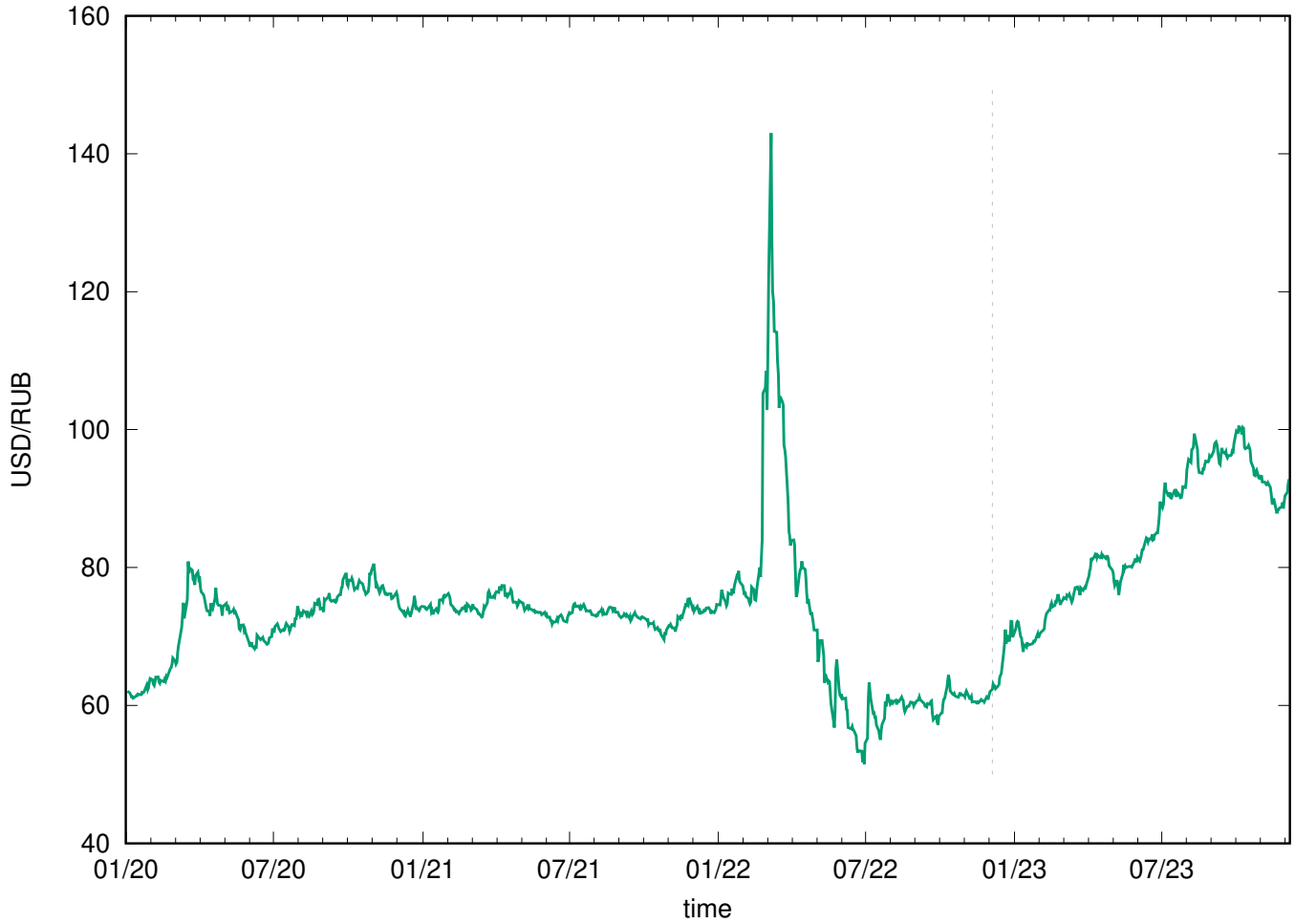

Figure: Development of the USD/RUB currency pair from January 1, 2020 until December 6, 2023; source: own illustration based on tradingeconomics.com (2023).

Cost structure of electricity generation

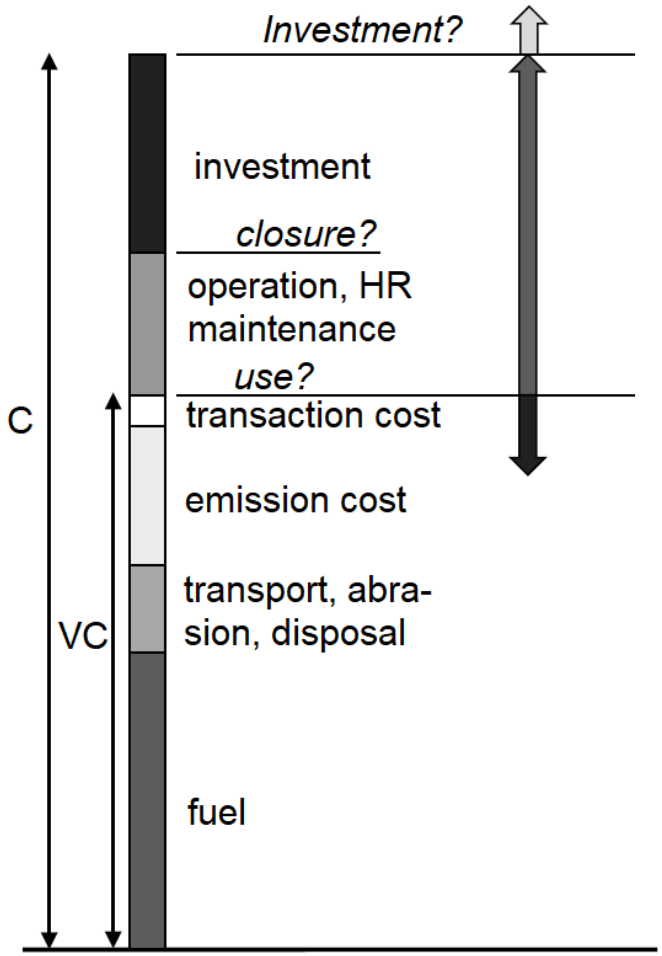

Figure: General cost structure of electricity generation; taken with adjustments from Schwintkowski *et al.* (2021).

Cost structure of electricity generation

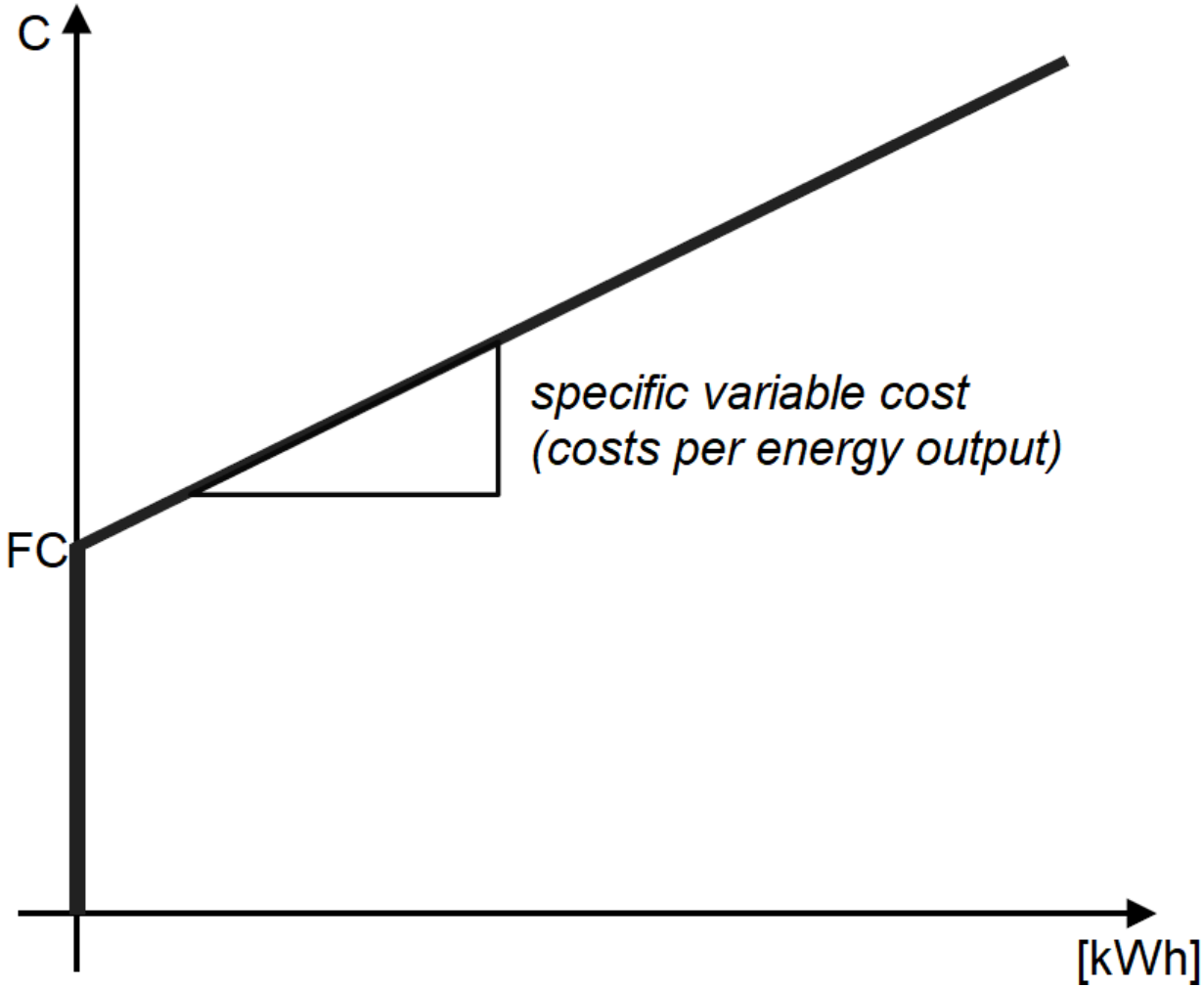

Figure: General cost structure of electricity generation; taken with adjustments from Schwintkowski *et al.* (2021).

Model system with different power plants

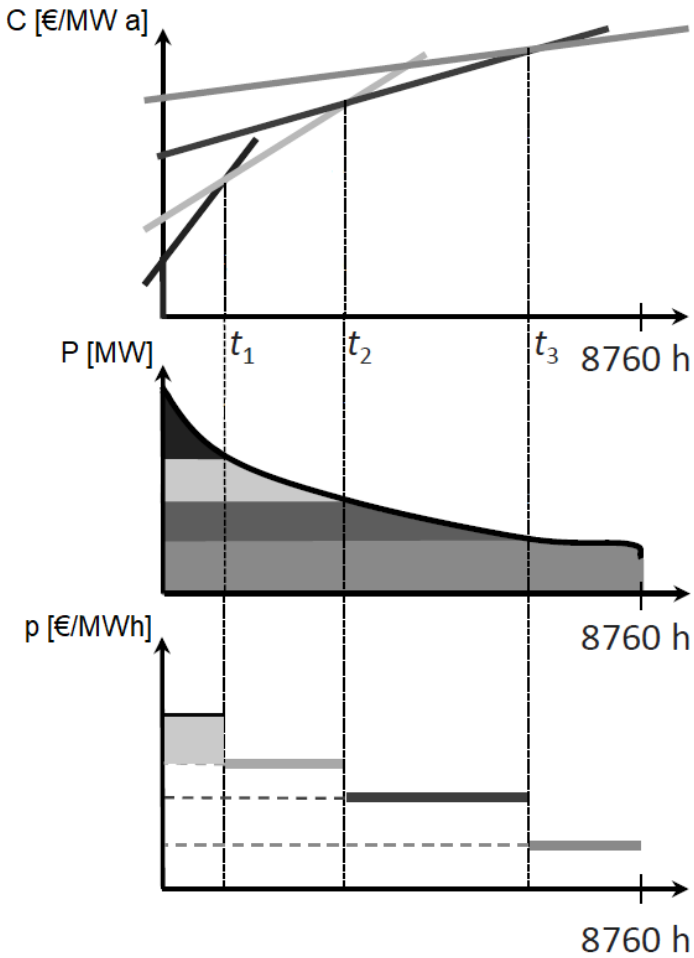

Figure: Model system with an optimal power plant mix resulting from total costs; taken with adjustments from Schwintkowski *et al.* (2021).

Electricity pricing under scarcity

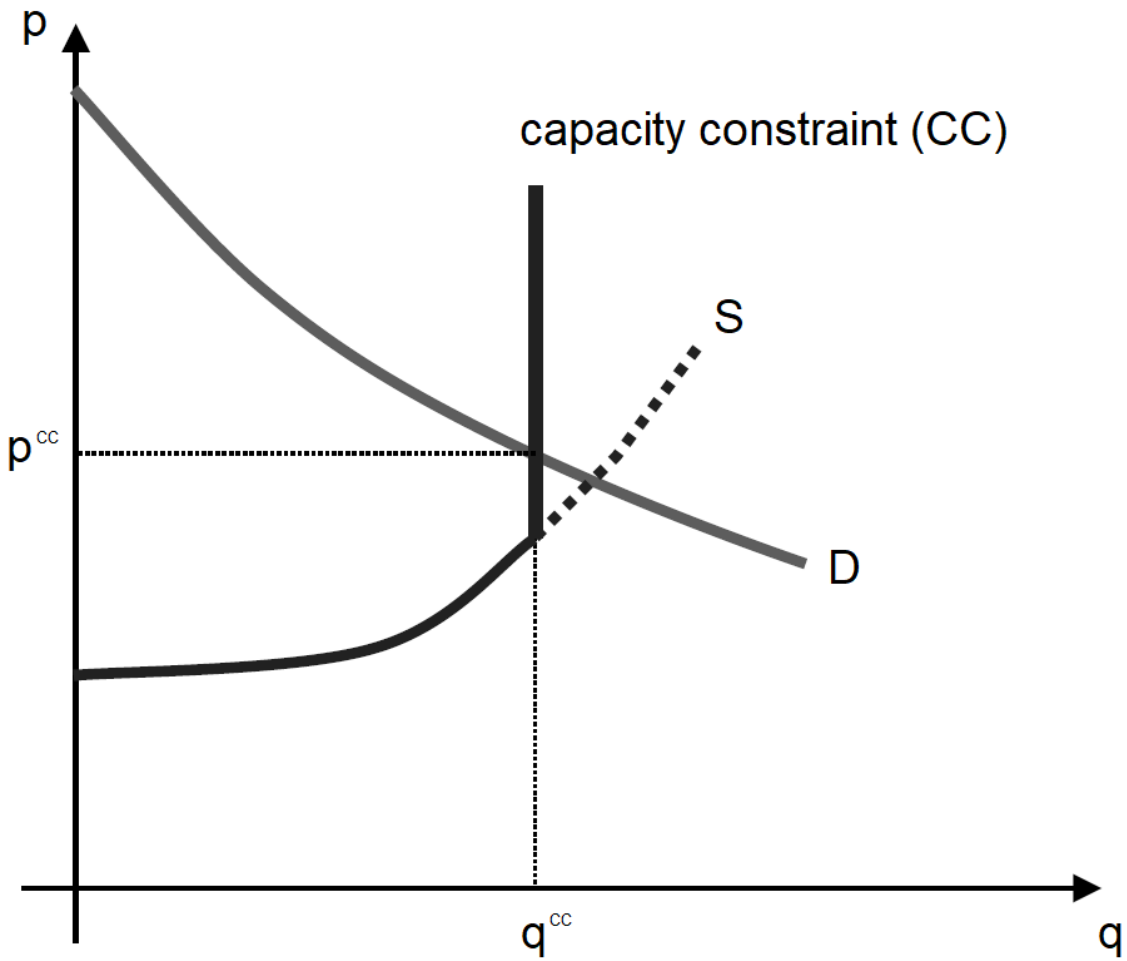

Figure: Schematic illustration of electricity pricing considering the capacity constraint; taken with adjustments from Schwintkowski *et al.* (2021).

Electricity market equilibrium

Assume a perfect electricity market

- optimal power plant mix
- scarcity pricing exactly covers fixed cost of all power plant operators

$\Rightarrow$ equilibrium

Now demand increases by 10 % (shifting the load curve)

- scarcity rent (also called peak energy rent – PER) increases
- revenue for **all** power plant operators increases to the same extent since all power plants are running in an event of scarcity

$\Rightarrow$ a profit occurs

$\Rightarrow$ incentive for investments into all types of power plants

Electricity market equilibrium

Now demand increases by another 1 GW every hour

- scarcity rent increases more
- revenue for **all** power plant operators increases since all power plants are running in an event of scarcity

$\Rightarrow$ a higher profit occurs for base-load power plants

$\Rightarrow$ investments are incentivized particularly for base-load power plants

Products at the electricity market

- standard products (e.g. for Germany)
  - one hour
  - base for next day, month, year etc.
  - peak (Monday – Friday, 8 am – 8 pm)
- structured products
  - usually consist of a structure of standard products
  - e.g. contract for electricity delivery of a certain amount within one year with the option to increase the contracted amount
- full supply (shielded consumers)
- derivatives (e.g. futures, options)

Formation of a power exchange in Germany

- power exchanges in Düsseldorf, Hannover, Frankfurt, Leipzig

$\rightarrow$ June 10, 1999: recommendation for Frankfurt

$\rightarrow$ October 10, 2001: fusion of power exchanges in Frankfurt and Leipzig

$\Rightarrow$ European Energy Exchange (EEX) Leipzig

- common spot market with Powernext $\rightarrow$ EPEX Spot SE, Paris

Spot market

- day ahead (auction), intraday (continuously)
- price range -1000 € till +3000 €

hour\price	0	6,9	7	16,9	17	17,1	17,2	149,9	150	3000
1	200,0	200,0	100,0	100,0	0,0	-75,0	-75,0	-75,0	-275,0	-275,0
2	154,9	154,9	42,6	42,6	6,3	6,3	0,0	0,0	-20,0	-20,0
3	-57,0	-57,0	-100,0	-100,0	-100,0	-175,0	-175,0	-175,0	-325,0	-325,0
4	200,0									200,0

Figure: Exemplary bid at the day ahead market skipping negative prices; taken with adjustments from Schwintkowski *et al.* (2021).

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EEX (2022). EEX German Power Futures Base. Available at: https://www.eex.com/de/marktdaten/strom/futures#%7B%22snippetpicker%22%3A%2228%22%7D, accessed December 18, 2022.

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