FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Energy Economics

Fachbereich 2 Informatik und Ingenieurwissenschaften

Electricity market derivatives

- **futures**

→ "buying" a standard electricity product defined by price and quantity **now** for delivery at a certain point in the **future**

- **options**

→ buying the **option** to buy (call) or sell (put) a standard electricity product defined by price and quantity **now** for delivery at a certain point in the **future**

Example for a future contract

- In summer 2017 a can manufacturer was awarded the contract for delivery of an additional volume of cans at December 1, 2017. The manufacturer will need complete November (24/7) to produce the cans. It requires 1 MW electricity for production which costs 30 €/MWh for November when the contract is fixed.

$\rightarrow$ risk of an increasing electricity price

$\Rightarrow$ base load

$\rightarrow$ buying the Phelix Base Future at the EEX can eliminate the risk

Example for a futures contract

Future	price	31 €	33 €	31 €	30 €	32 €	31 €	34 €	....	36 €	37 €	38 €
	change [€]	1	2	-2	-1	2	-1	3	....	2	1	1
	volume [MWh]	720	720	720	720	720	720	720	....	720	720	720
	contracts	1	1	1	1	1	1	1	1	1	1	1
	payment [€]	720	1.440	-1.440	-720	1.440	-720	2.160	....	1.440	720	720

Figure: payments of the exemplary future depending on the future price development; taken with adjustments from Schwintowski *et al.* (2021).

Example for a futures contract

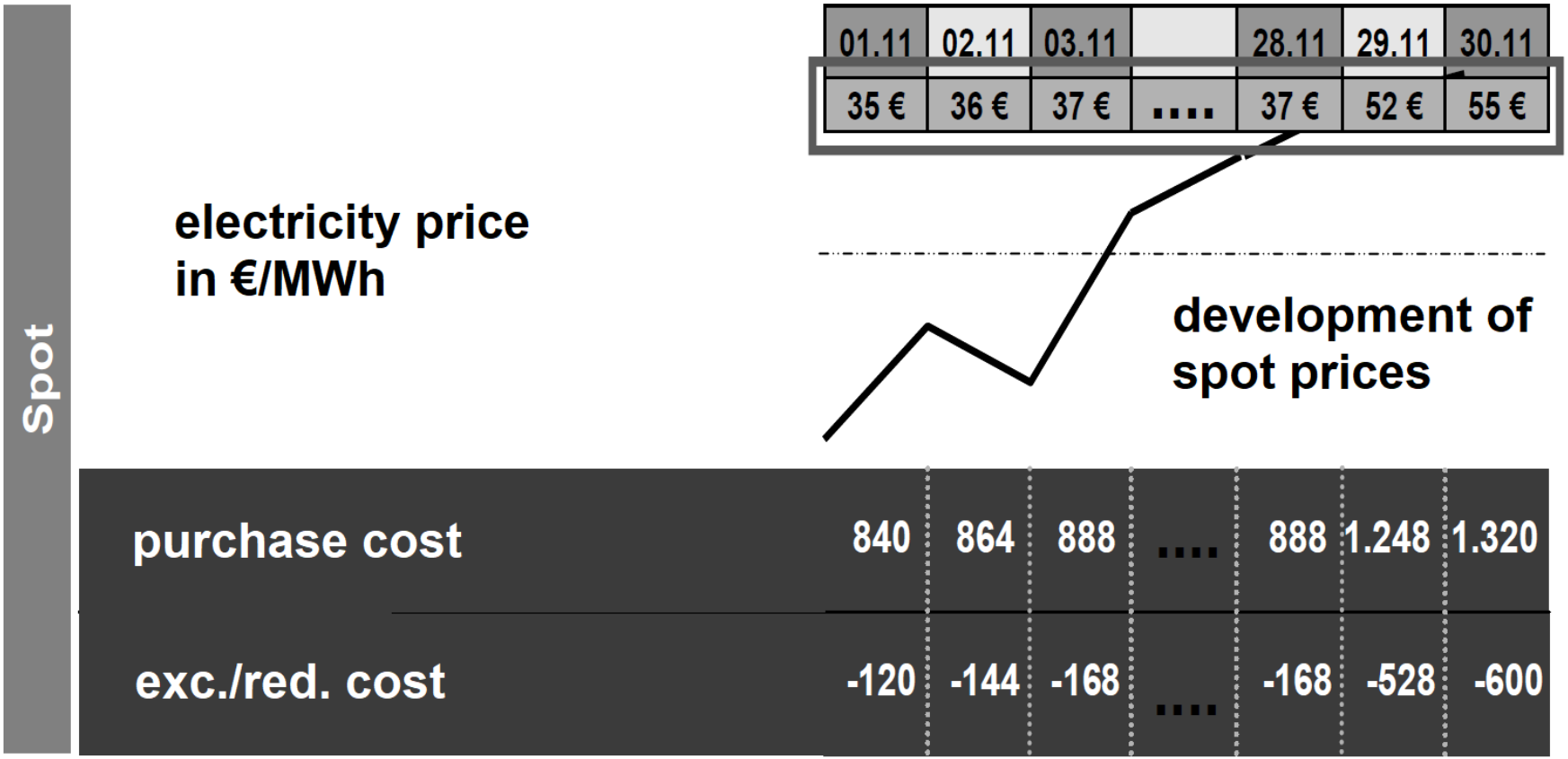

Figure: payments at the spot market for the can manufacturer; taken with adjustments from Schwintowski *et al.* (2021).

Example for a futures contract

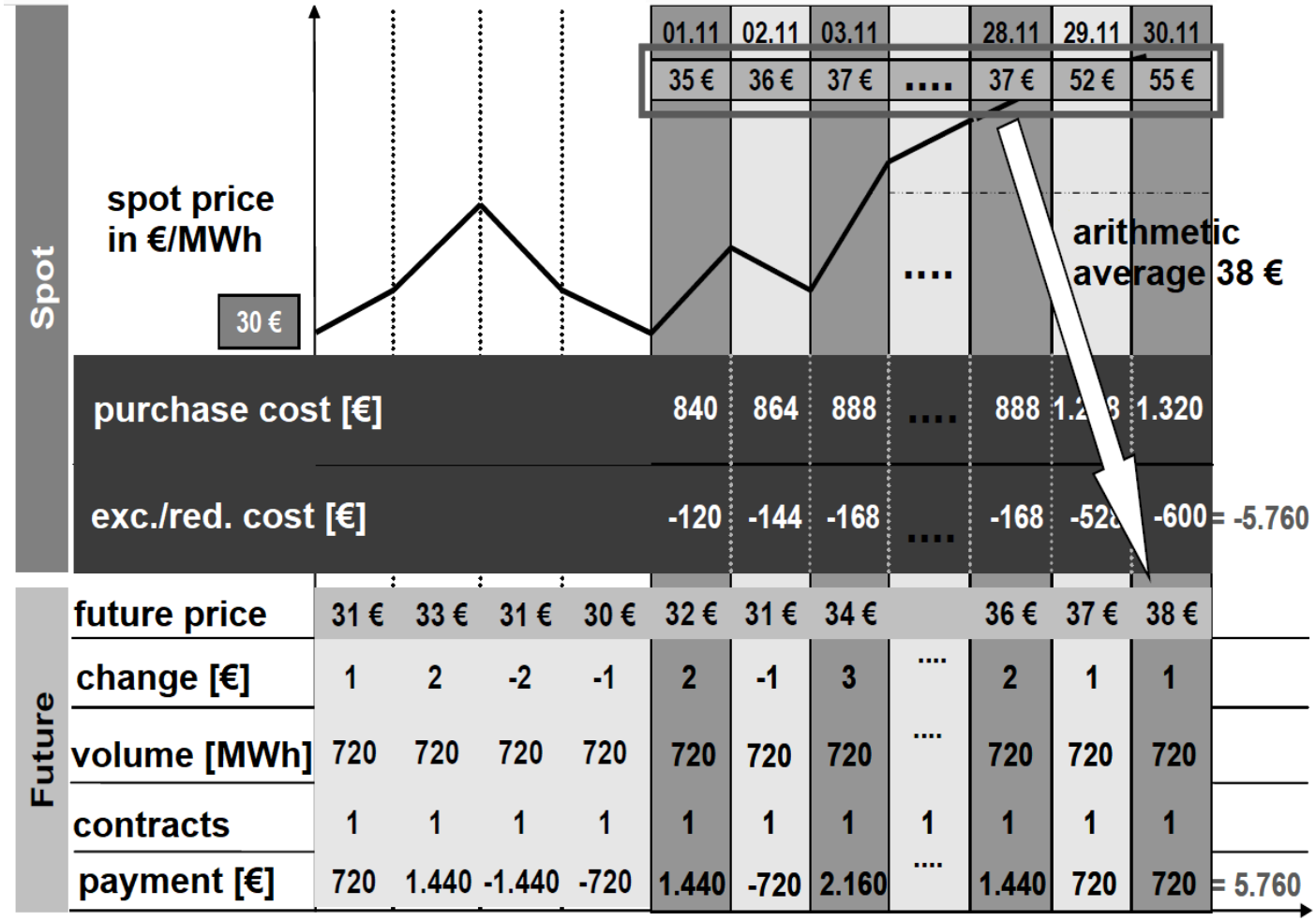

Figure: future and spot market results for the can manufacturer; taken with adjustments from Schwintowski *et al.* (2021).

Example for futures and spot prices

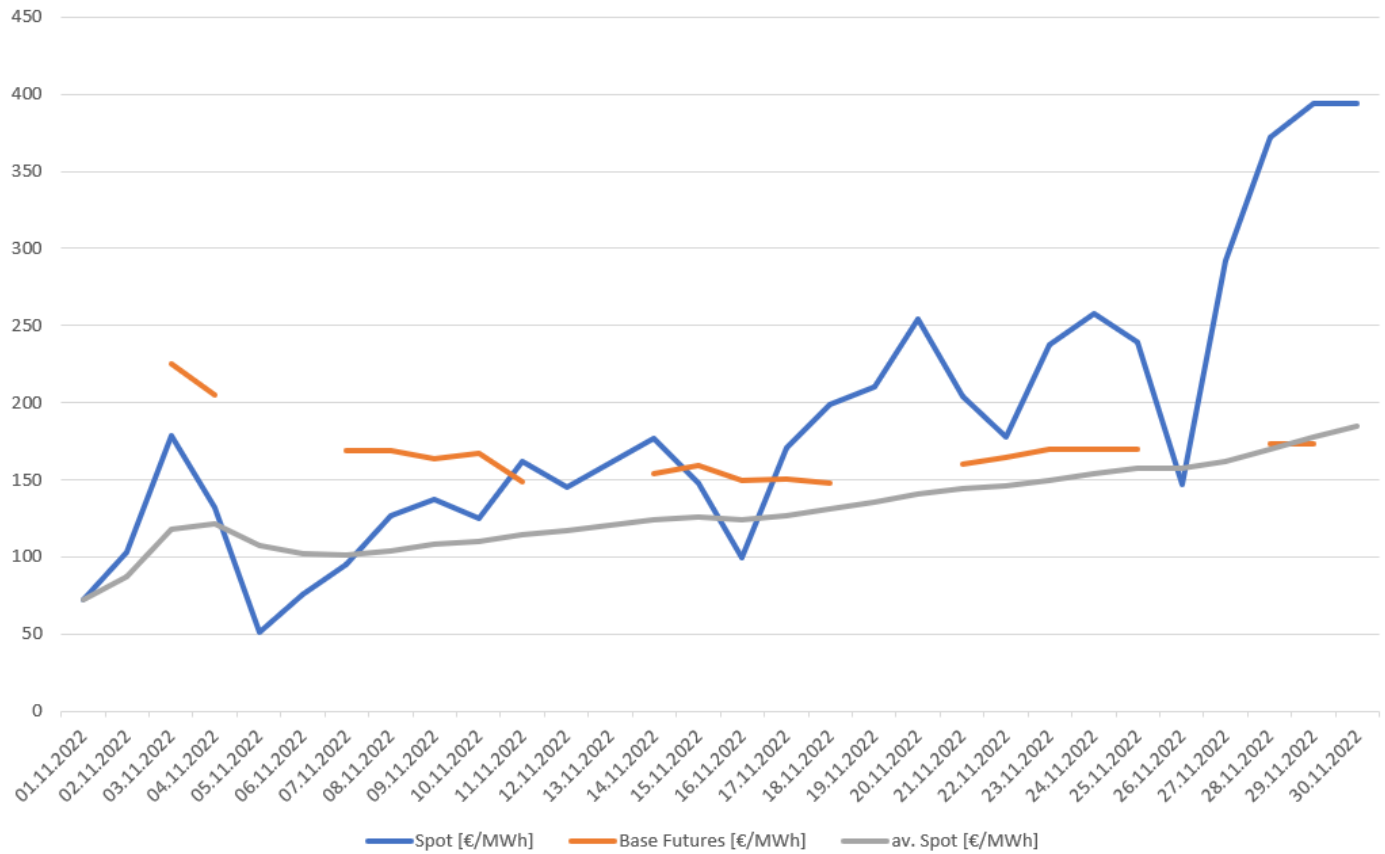

Figure: Prices for the November 2022 futures base contract, spot prices and average spot prices from November 1, 2022 until November 30, 2022; source: (tradingeconomics.com, 2023; EEX, 2022).

Electricity supply and futures markets

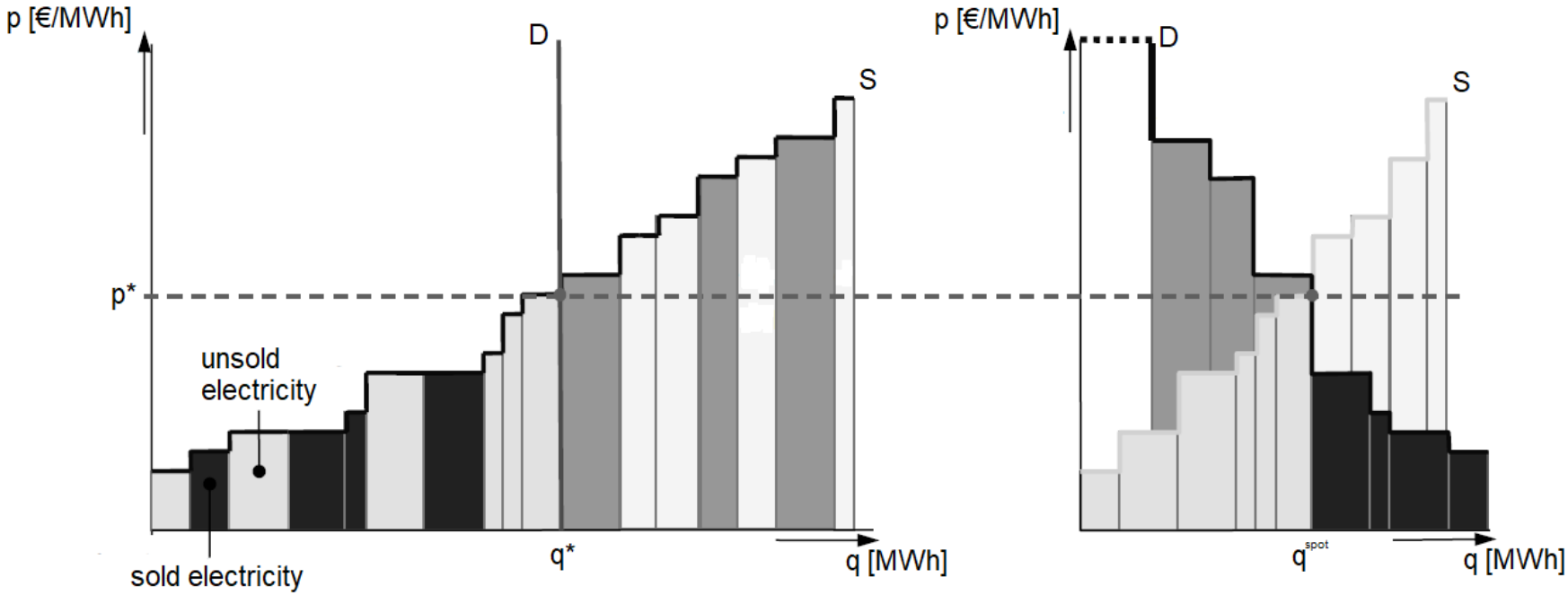

Figure: Schematic illustration for the impact of the future market on the spot market for electricity; taken with adjustments from Schwintowski *et al.* (2021).

Electricity markets - exercise

bidder	b1	**hour**	**0**	**110**	**3000**	b6	**hour**	**0**	**185**	**3000**
		12	0	-5000	-5000		12	0	-3000	-3000
bidder	b2	**hour**	**0**	**40**	**3000**	b7	**hour**	**0**	**120**	**3000**
		12	0	-6000	-6000		12	0	-6000	-6000
bidder	b3	**hour**	**0**	**15**	**3000**	b8	**hour**	**0**	**45**	**3000**
		12	0	-6000	-6000		12	0	-11000	-11000
bidder	b4	**hour**	**0**	**20**	**3000**	b9	**hour**	**0**	**125**	**3000**
		12	0	-9000	-9000		12	0	-3000	-3000
bidder	b5	**hour**	**0**	**200**	**3000**	b10	**hour**	**0**	**65**	**3000**
		12	0	-4000	-4000		12	0	-10000	-10000

Table: Summary of bids with electricity sold in advance (red)

Assume the "red power plant operator" sold the capacity at the futures market

- Calculate the new equilibrium demand and price.
- Draw the new merit order with demand and equilibrium price.

Exercise – merit order

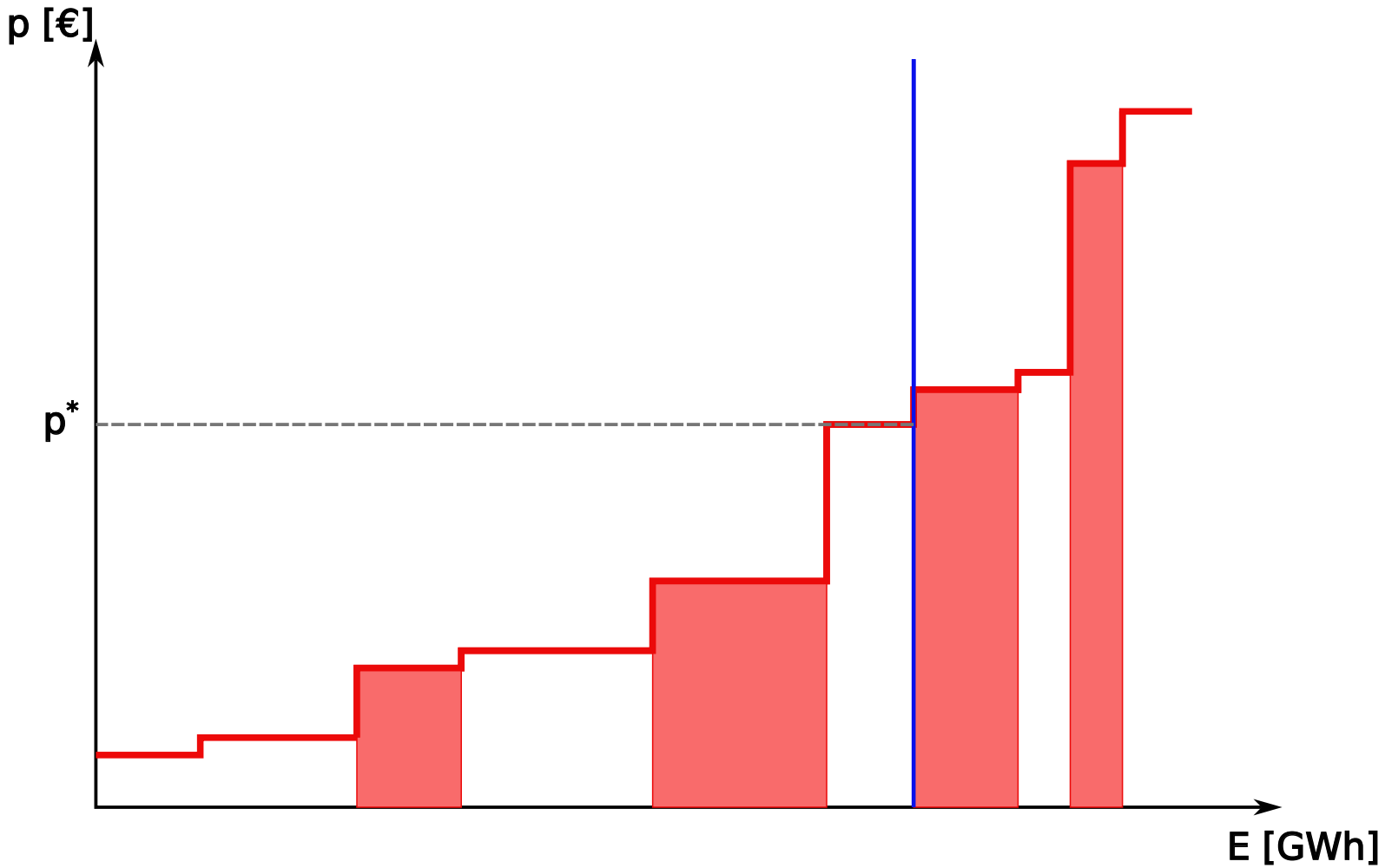

Figure: Schematic illustration of merit order and equilibrium price power plants which electricity was sold in advance (red shaded).

Exercise – new merit order

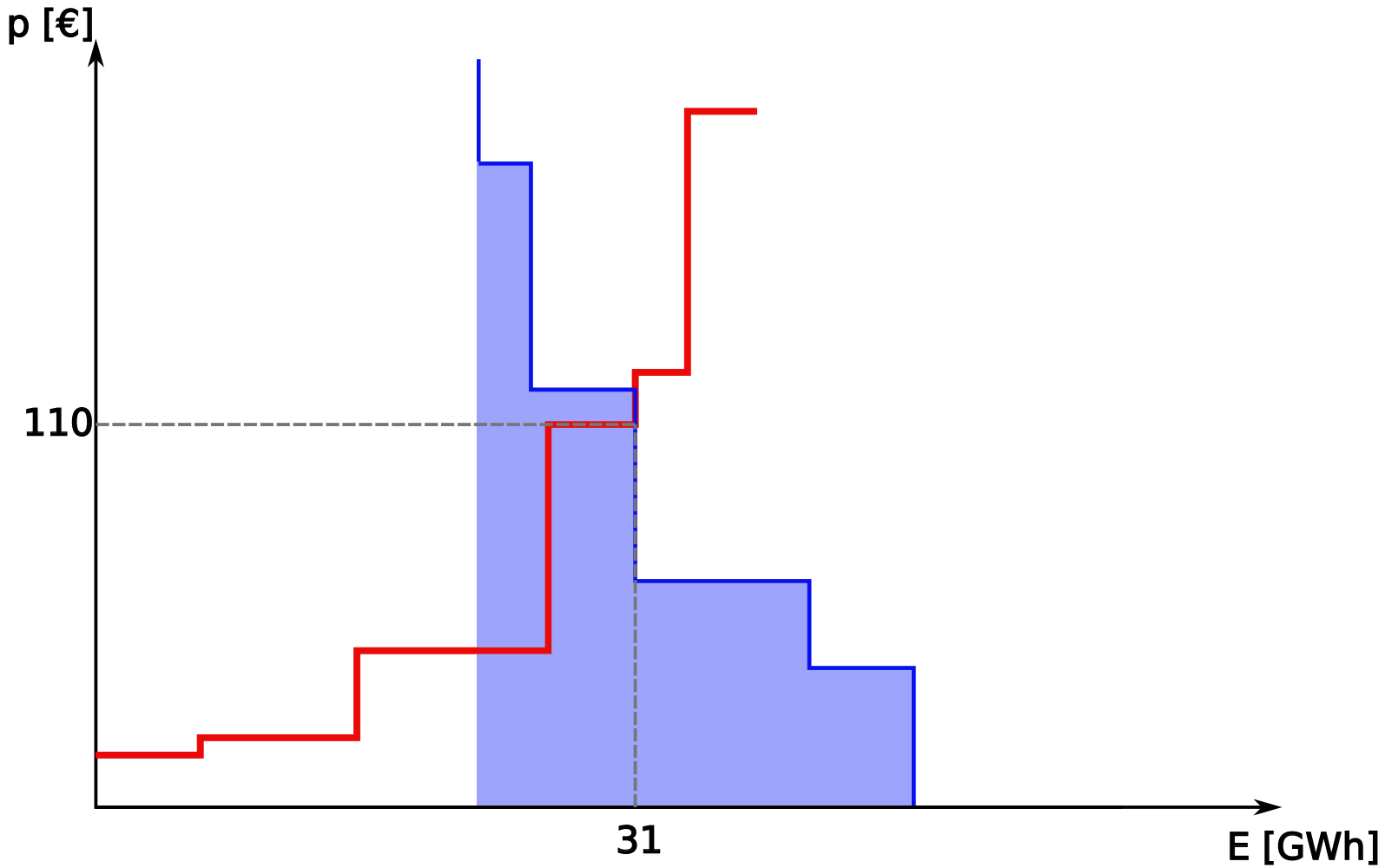

Figure: Schematic illustration of merit order and equilibrium price.

Merit order effect of RES

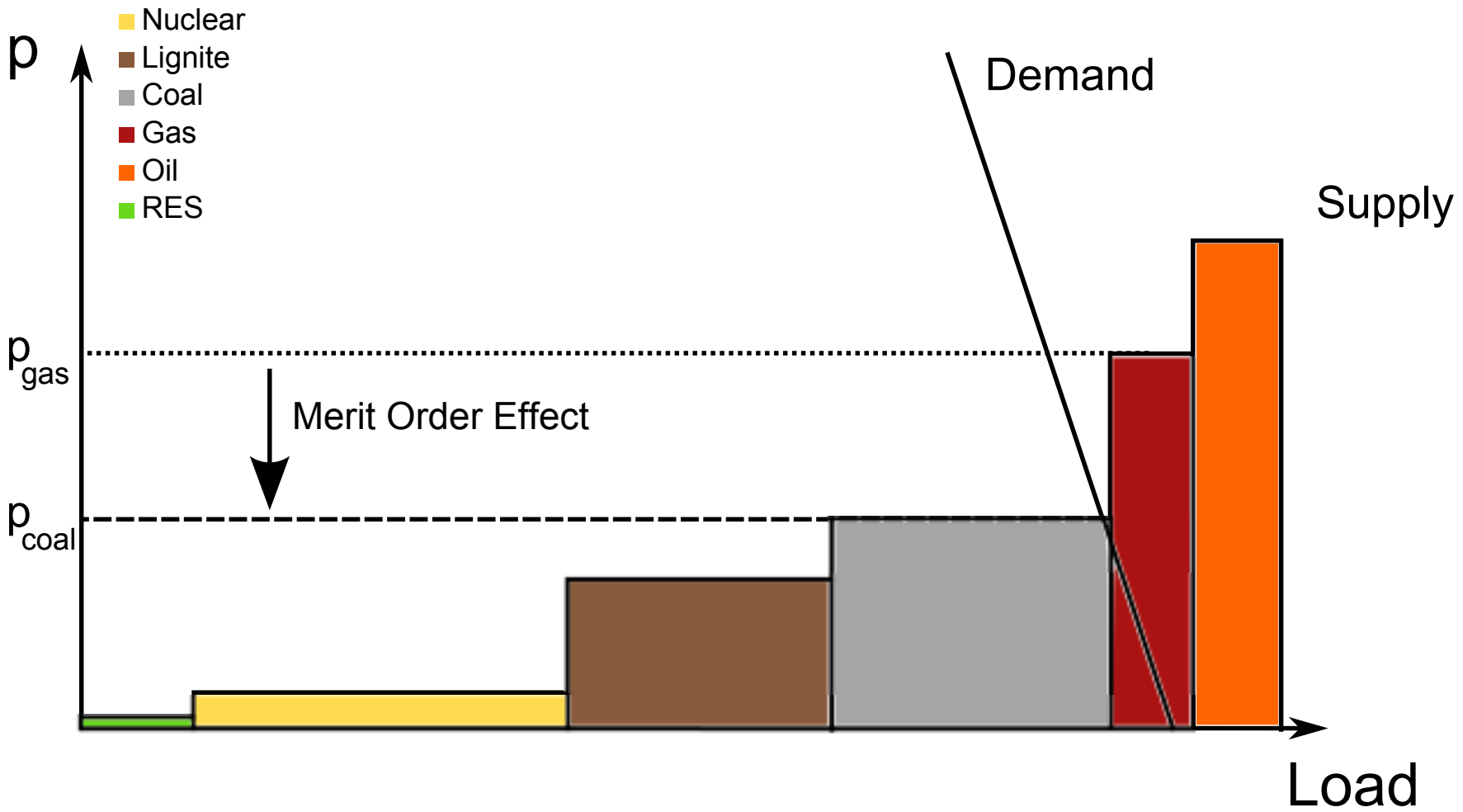

Figure: Schematic illustration of the merit order effect of RES as described by De Miera *et al.* (2008); Sensfuß *et al.* (2008); own illustration.

Electricity markets – Exercise

Assume an electricity market with sufficient capacity and an optimal power plant mix (the electricity market is in its equilibrium). Now a feed-in tariff for RES-based electricity generation is introduced.

- Which type of power plants "suffers" most from the merit order effect of RES in the short-run?
- What does the decrease of gas turbine capacity mean for the flexibility of electricity supply?
- How does the decrease of gas turbine capacity affect the occurrance of negative prices?
- How does it affect incentives for investments?
- What will happen to the mix of power plants in the medium-run?

Electricity markets – Exercise

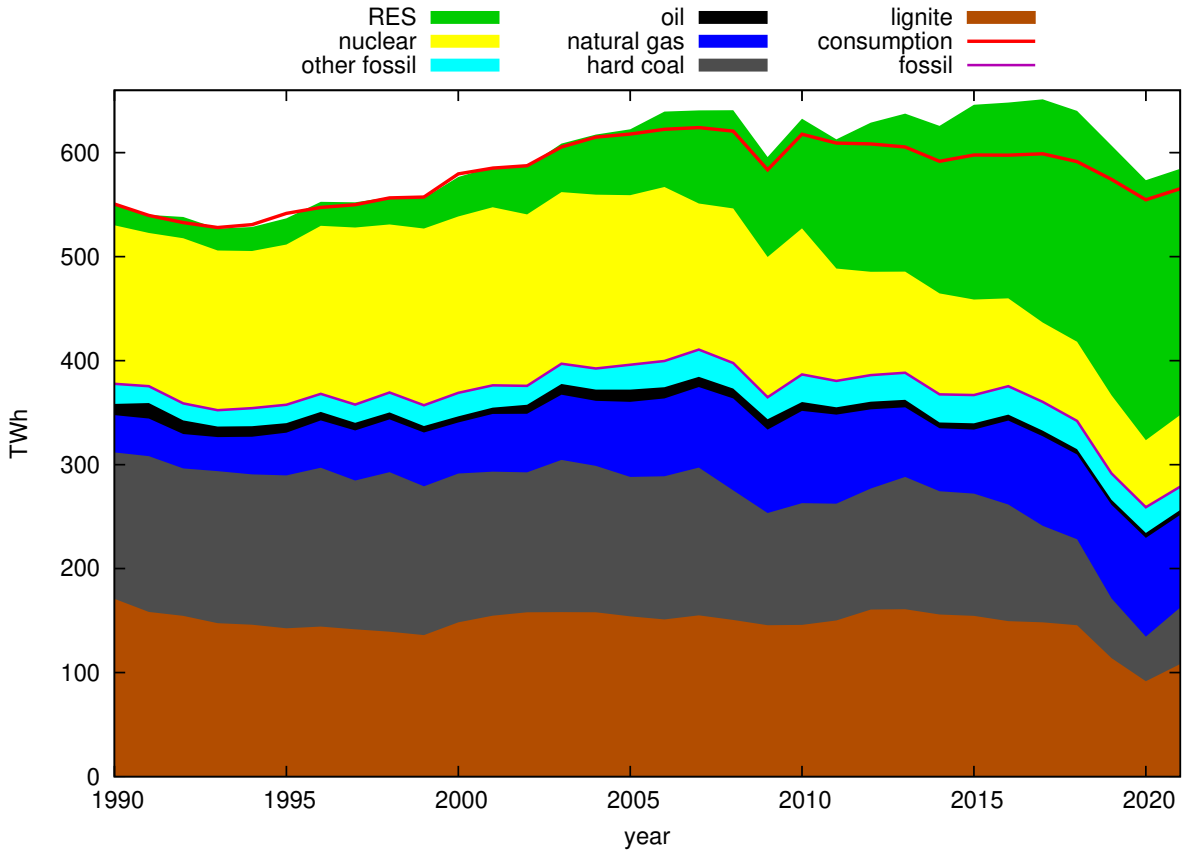

Figure: Stacked area chart illustrating the development of gross electricity output with respect to different energy sources in Germany between 1990 and 2021. The difference between gross electricity generation and gross electricity consumption (red line in the graph) corresponds to electricity exports; own illustration based on data provided by Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen e.V) (2018), Information Platform of the German Transmission System Operators (Informationsplattform der deutschen Übertragungsnetzbetreiber – netztransparenz.de) (2018)

Liberalization of electricity markets

- single provider for electricity generation, transport and distribution
- natural monopoly for electricity transport and distribution
- consumer has no choice

$\Rightarrow$ unbundling electricity grid and generation

$\Rightarrow$ formation of new fields: electricity trading and sales

Transmission system operators in Germany

Figure: German states assigned to the four transmission system operators (TSO); source: Wikipedia.

Grid organization in Germany

- grid access is regulated

$\Rightarrow$ criteria and fees are controlled by the regulation authority

- high voltage grid is operated by the TSOs
- medium and low voltage grids are operated by local grid operators
- TSOs are responsible for balancing electricity demand and supply in their region including all grid levels
- electricity suppliers are responsible for balancing electricity demand and supply for their clients

$\Rightarrow$ balancing group

Balancing demand and supply

- one day ahead till 2 pm the responsible person for the balancing group has to submit his/her forecasted balance for every 15 minutes for the next day
  - \+ forecasted electricty generation
  - \+ purchased electricity
  - \- sold electricity
  - \- forecasted electricity demand
- deviations from the forecast are balanced by the TSOs on cost of the responsible person for the balancing group

References

De Miera, G. S., del Rio Gonzalez, P. and Vizcaino, I. (2008). Analysing the impact of renewable electricity support schemes on power prices: The case of wind electricity in Spain. *Energy Policy*, **36** (9), 3345–3359.

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