Integrated course „Energy Economics“
- Economics of Generation (continued)

Chair of Energy Systems
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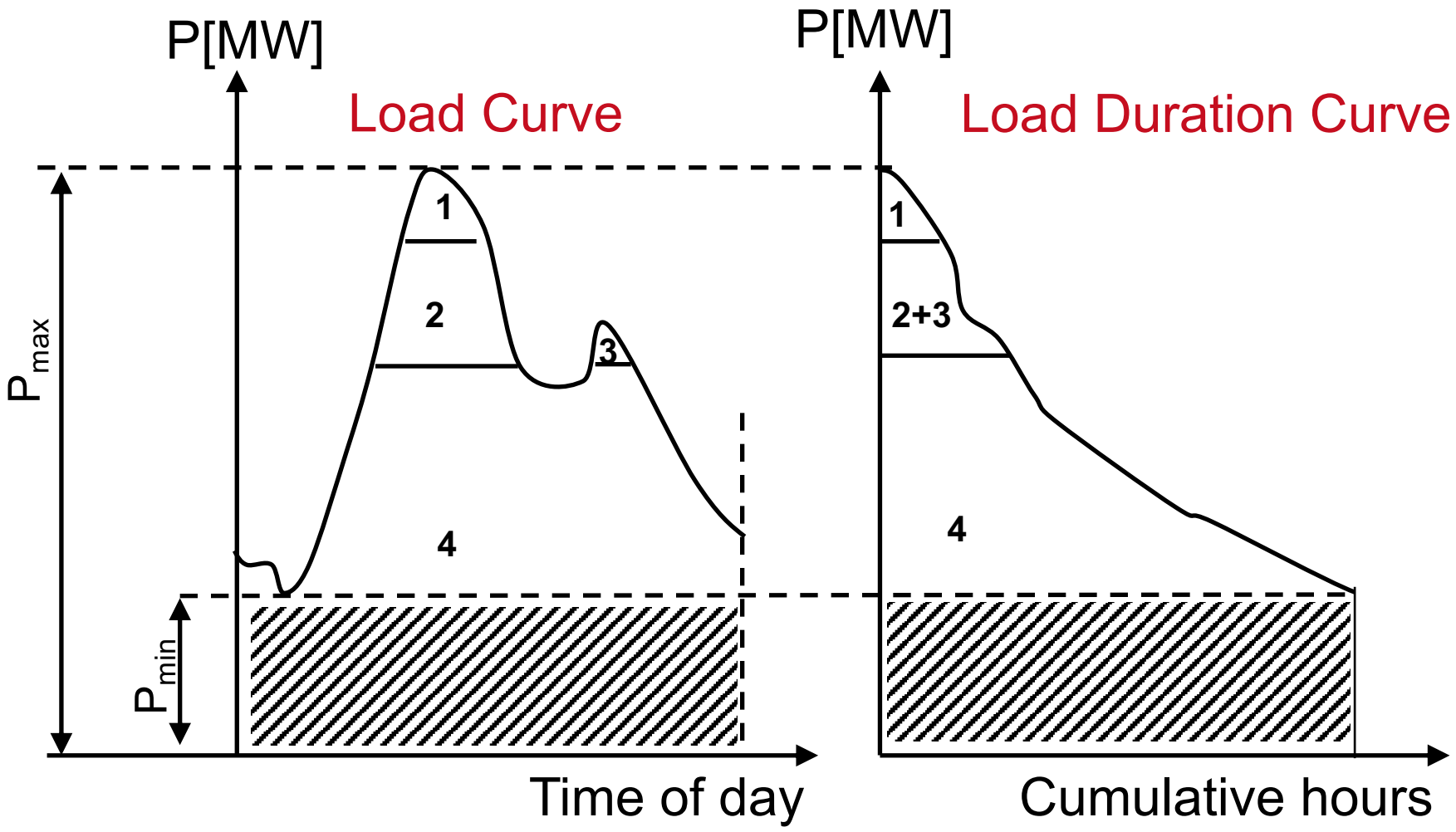
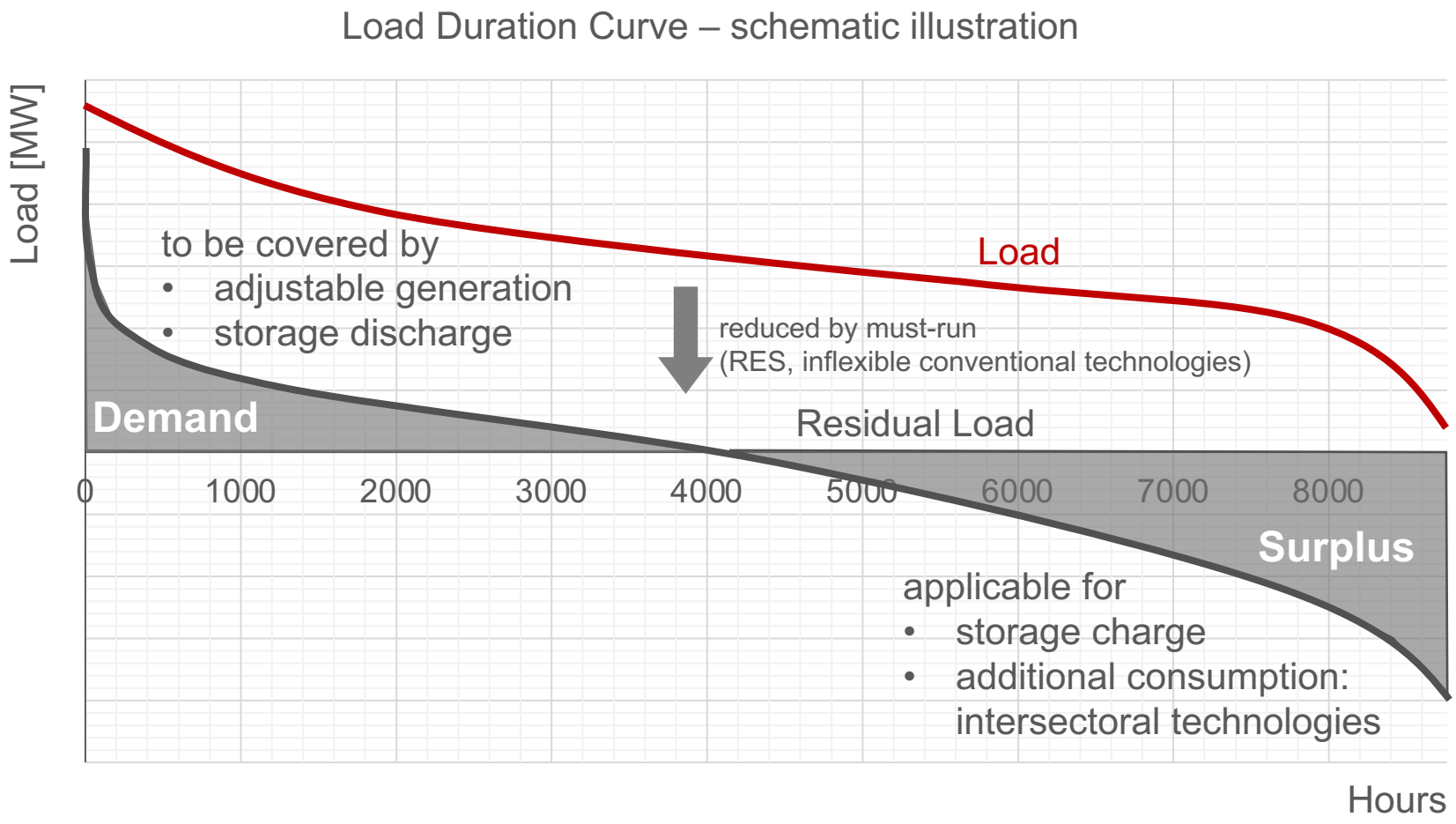
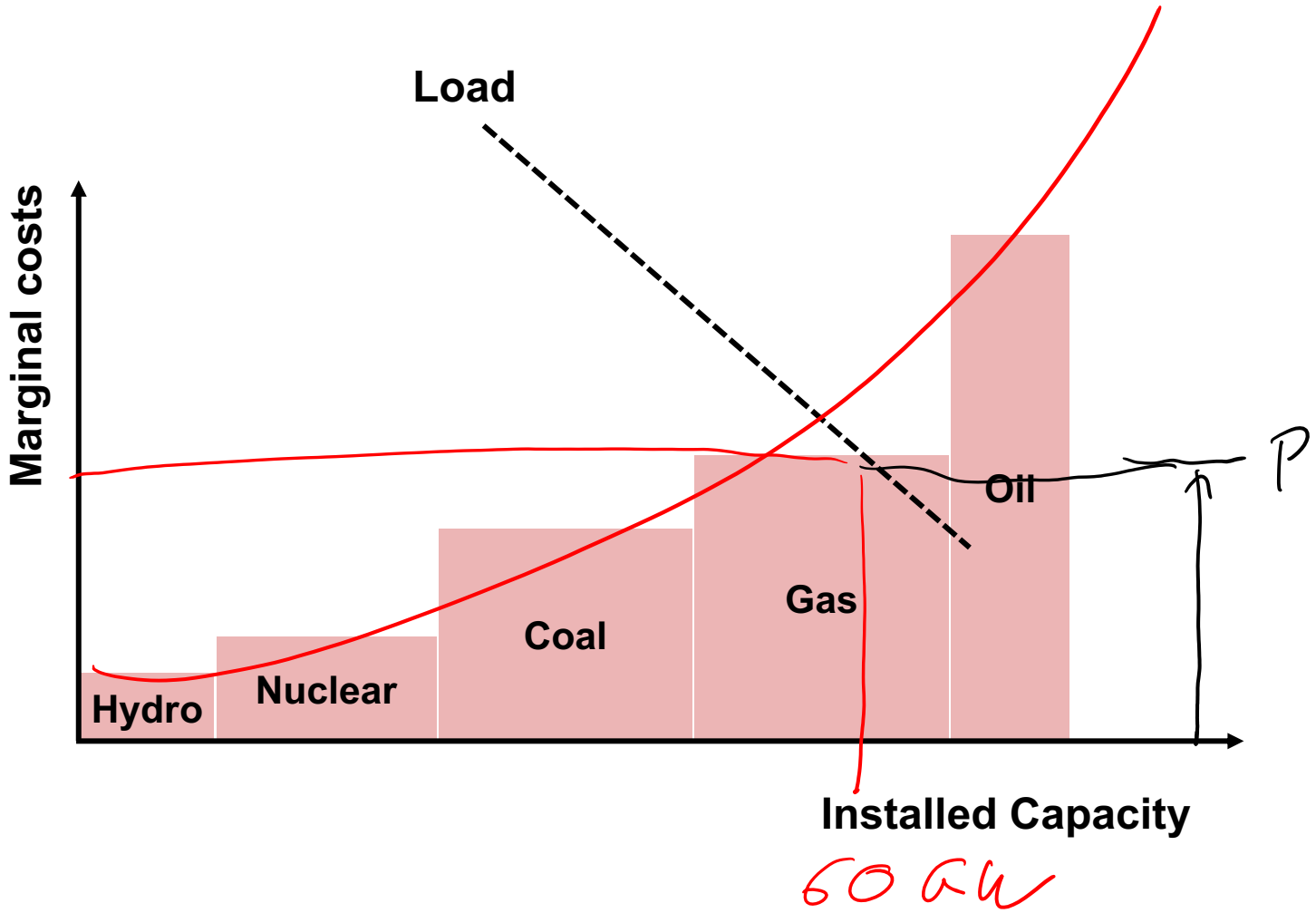
Load Curve and Load Duration Curve



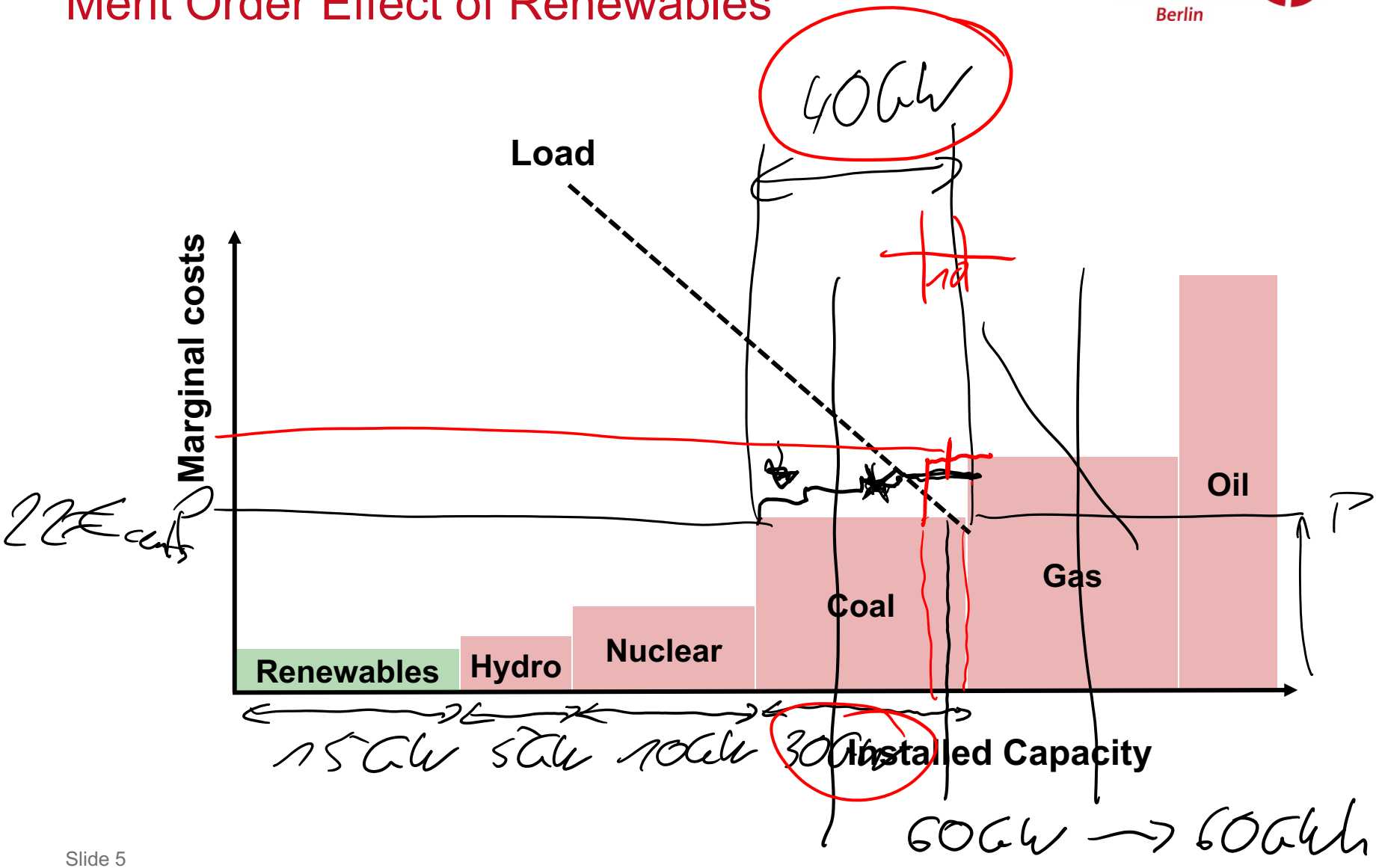
Load and Residual Load



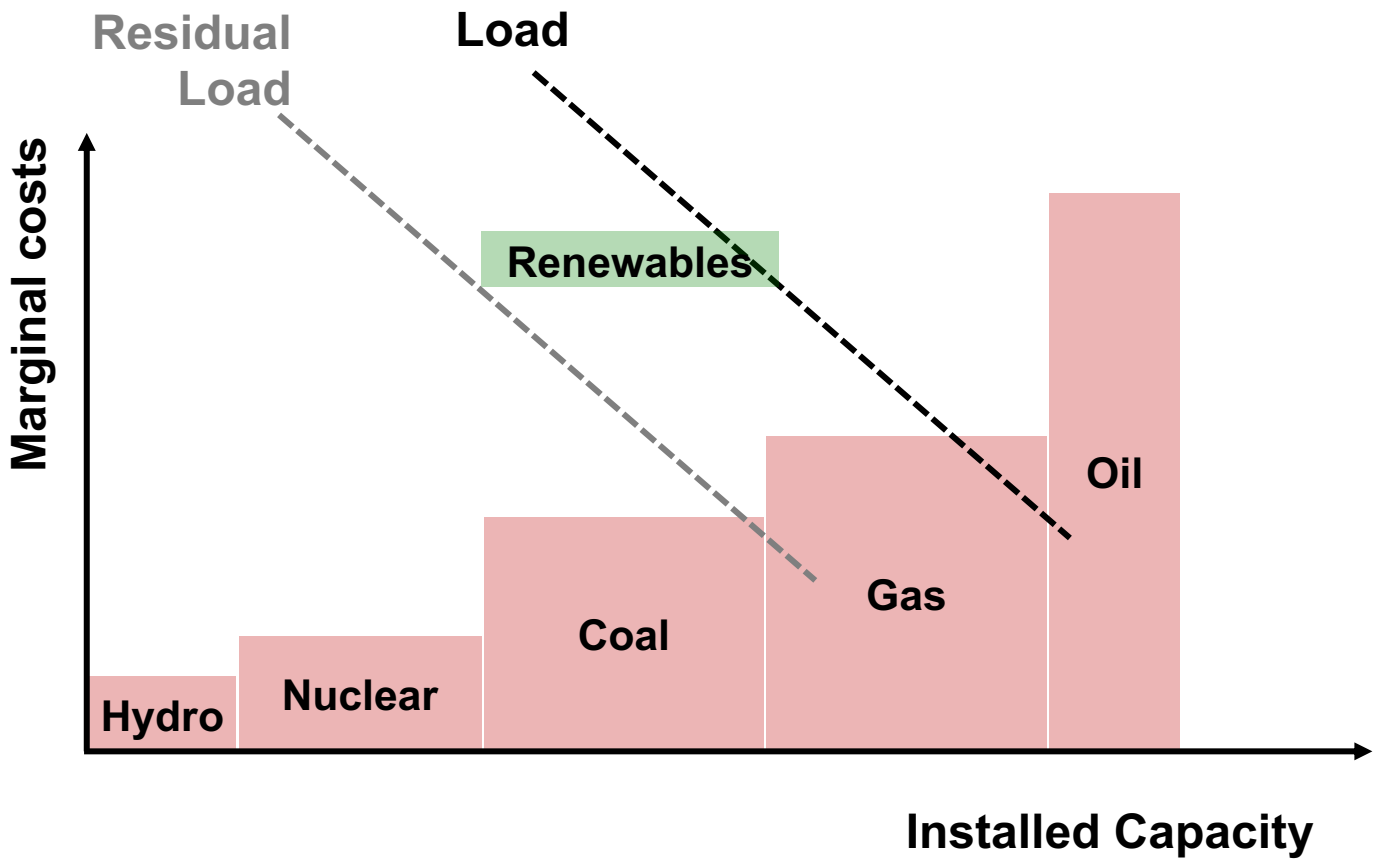
Merit Order


Load
Marginal costs
Hydro
Nuclear
Coal
Gas
Oil
P
Installed Capacity
60 GW

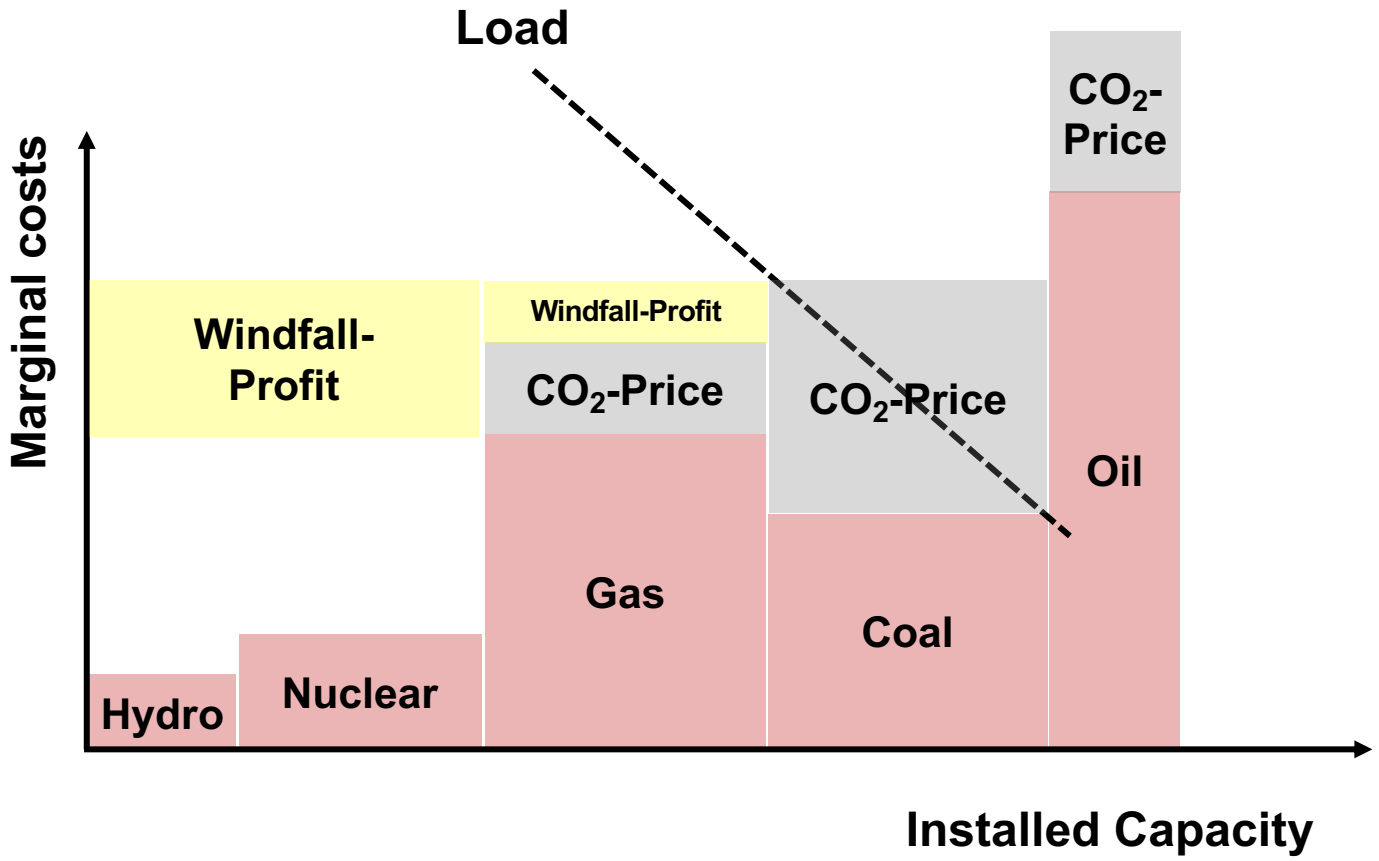
Merit Order Effect of Renewables



Merit Order


Residual Load
Load
Marginal costs
Renewables
Oil
Gas
Coal
Nuclear
Hydro
Installed Capacity

Merit Order - Impact of CO_2 – Prices



Task 5) Merit Order Effect of Renewables

The installed capacity of conventional generation capacity (i.e. capacity that can be dispatched) in a given power system is 80 GW. The corresponding merit order can be approximated by the following supply function: $MC = 0.03 \cdot X^2 + 0.15 \cdot X + 5$, where MC are the marginal generation costs in €/MWh$_{el}$ and X the cumulated capacity in GW. The demand for peak load power is given by $Q(p_{el}) = 70 - \frac{1}{18} \cdot p_{el}$, where $Q(p_{el})$ is the load demand in GW as a function of the electricity price p_{el}.

a) What is the equilibrium price and load in the given example?

b) Assume there is additional supply of wind power. Furthermore, assume that the feed-in of wind power is 10 GW. What is the impact on electricity prices?

c) What is the so called **merit order effect of renewable energy sources**?

d) How does the merit order effect influence the profit of large scale wind power or other intermittent resources?

Task 5) Merit Order Effect of Renewables

The merit order can be approximated by the following supply function:

$$MC = 0.03 \cdot X^2 + 0.15 \cdot X + 5$$

The demand for peak load power is given by

$$Q(p_{el}) = 70 - \frac{1}{18} \cdot p_{el}$$

a) What is the equilibrium price and load in the given example?

$Q(p_{el}) = 70 - \frac{1}{18} \cdot p_{el} \rightsquigarrow p_{el} = 1260 - 18Q$

$MC = p_{el}$

$0{,}03 \cdot x^2 + 0{,}15x + 5 = 1260 - 18x$

$0 = -0{,}03x^2 - 18{,}15x + 1255$

$x_1 = 62{,}6\ GW \Rightarrow p_{el} = 1260 - 18 \cdot 62{,}6\ GW = 133{,}2\ \frac{€}{MWh_{el}}$

$(x_2 = -600\ GW)$??

Task 5) Merit Order Effect of Renewables

The merit order can be approximated by the following supply function:

$$MC = 0.03 \cdot X^2 + 0.15 \cdot X + 5$$

The demand for peak load power is given by

$$Q(p_{el}) = 70 - \frac{1}{18} \cdot p_{el}$$

b) Assume there is additional supply of wind power. Furthermore, assume that the feed-in of wind power is 10 GW. What is the impact on electricity prices?

1) shift supply fct to the right by manipulating the supply curve (merit order effect of RES)

2) shift demand curve to the left by manipulating the demand function (residual load)

Task 5) Merit Order Effect of Renewables

Use option 2)

$$Q_{new}(P_{el}) = 70 - \frac{1}{18} P_{el} - 10 = 60 - \frac{1}{18} P_{el}$$

$$\rightarrow P_{el} = 1080 - 18Q$$

$$MC = P_{el}$$

$$0{,}03x^2 + 0{,}15x + 5 = 1080 - 18x$$

$$0 = -0{,}03x^2 - 18{,}15x + 1075$$

$$x_1 = 54{,}4\ GW \longrightarrow P_{el} = 100{,}8\ \frac{€}{MWh}$$

$$(x_2 = -659{,}4\ GW)\ ??$$

Task 5) Merit Order Effect of Renewables

c) What is the so called **merit order effect of renewable energy sources**?

=> slide 80 & 81 for analytical solution
=> slide 67 & 68 for graphic solution

d) How does the merit order effect influence the profit of large scale wind power or other intermittent resources in a purely market-based system?

- electricity price is affected (decreased) by RES
- under market conditions wind also sells electricity at the MCP
  - => profitability of all market actors, incl. wind farmers decreases with expansion of other RES

Balancing power and variable renewables
– three links –

Authors: C. Hirth & I. Ziegenhagen

→ read the publication

→ get an idea of what they talk about

↳ as if you had to briefly describe to your friends what's in this paper

→ what are your key learnings / key findings?

(3 – 5)

https://neon.energy/Hirth-Ziegenhagen-2015-Balancing-Power-Variable-Renewables-Links.pdf