



ELECTRICITY MARKET 3.0: HEADING TOWARDS SUSTAINABLE AND DEMOCRATIC ELECTRICITY SYSTEMS

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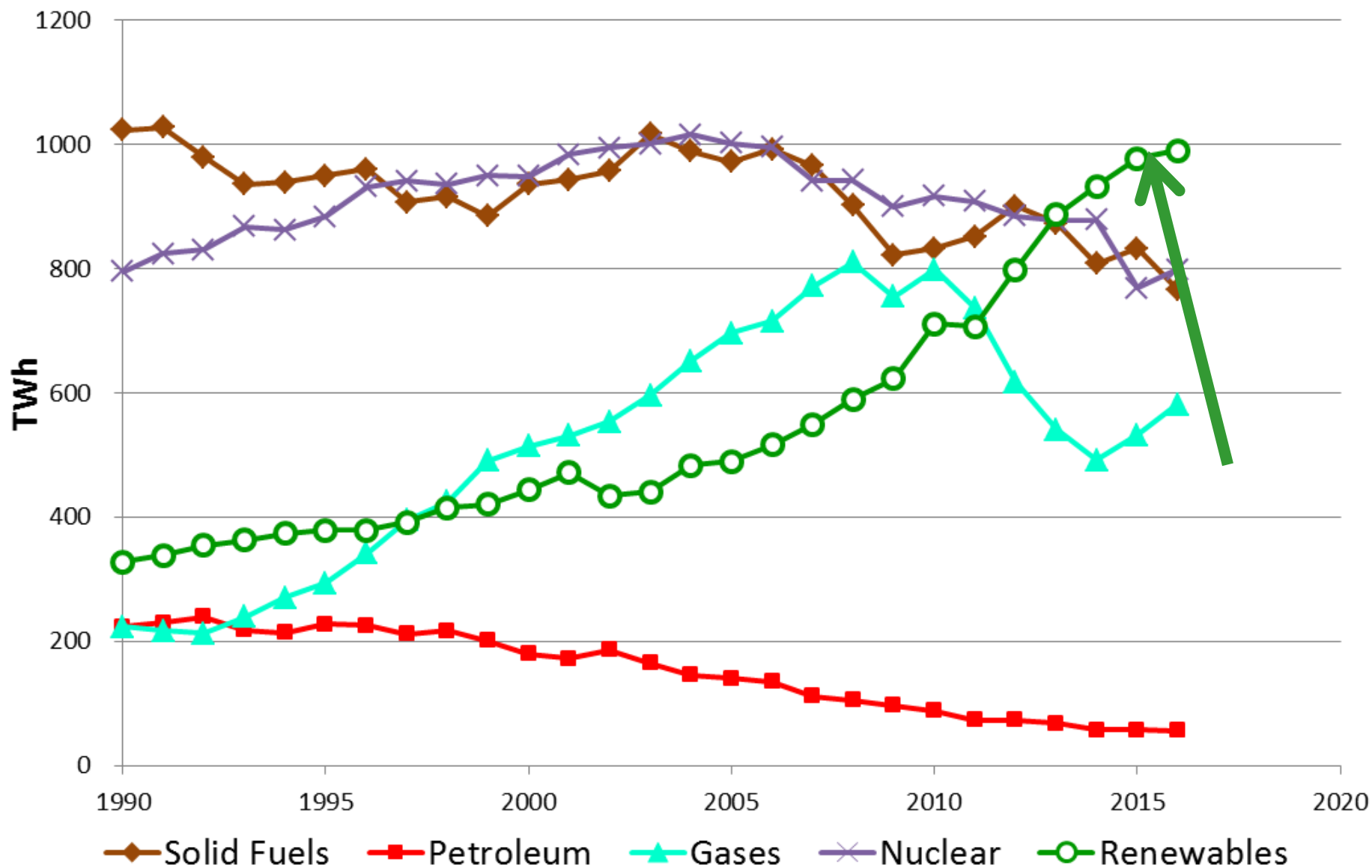
Dresden, 27 April 2018

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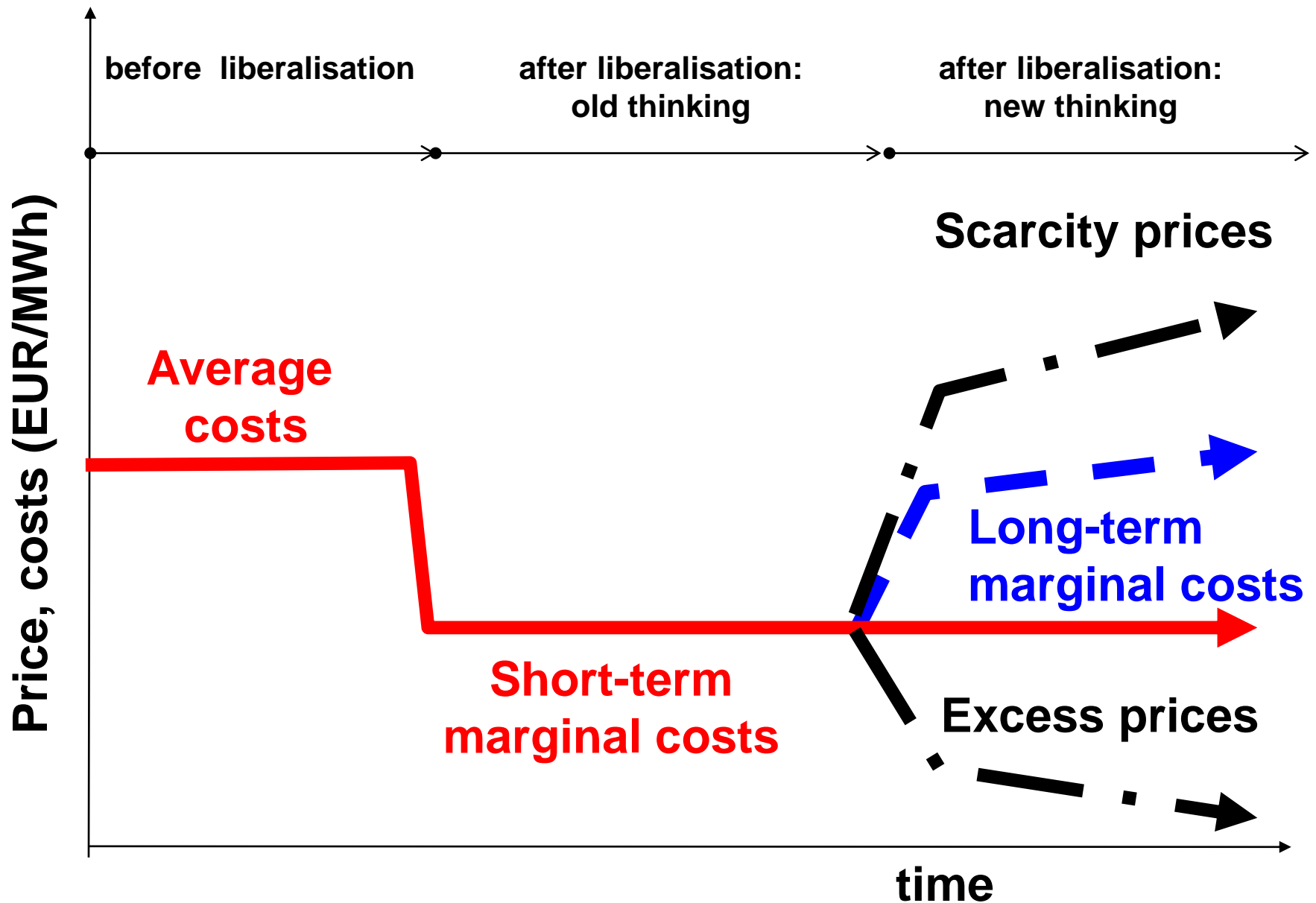
Motivation:

- * **Climate change → Paris agreements**
- * **Targets for renewables**
- * **The clean energy package**
- * **It is not possible to squeeze variable renewables into the system by violence
system integration**

Introduction: Electricity generation EU-28



How prices come about: Three periods of market design



... to identify the major boundary conditions to integrate even larger amounts of variable renewables into the electricity system

Very important:

Our reflections apply in principle to every electricity system world-wide

.... are based on **electricity economic** point-of-view

2. METHOD OF APPROACH

- Identification of hourly residual load over a year for various scenarios with large quantities of variable renewables;
- Applying a fundamental model to calculate (static) hourly residual loads and electricity spot market prices;
- Integration of flexibility in a dynamic framework for price calculation;

Expectation of

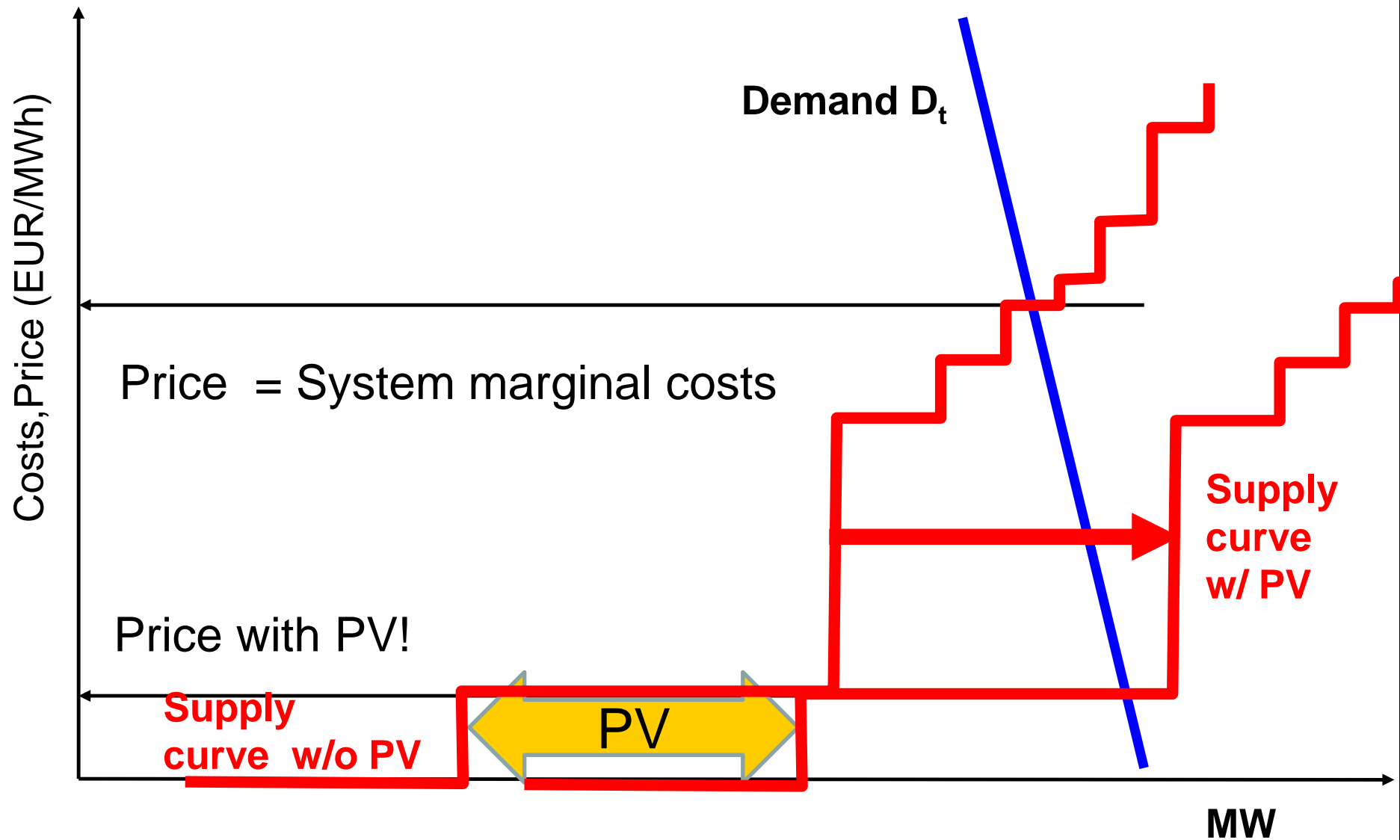
prices = Short-term marginal costs

(Short-term marginal costs = fuel costs)

**due to huge depreciated excess
capacities at the beginning of
liberalisation!**

3 HOW VARIABLE RENEWABLES IMPACT THE ELECTRICITY SYSTEM AND PRICES IN ELECTRICITY MARKETS

Example: prices without and with PV



RES Production

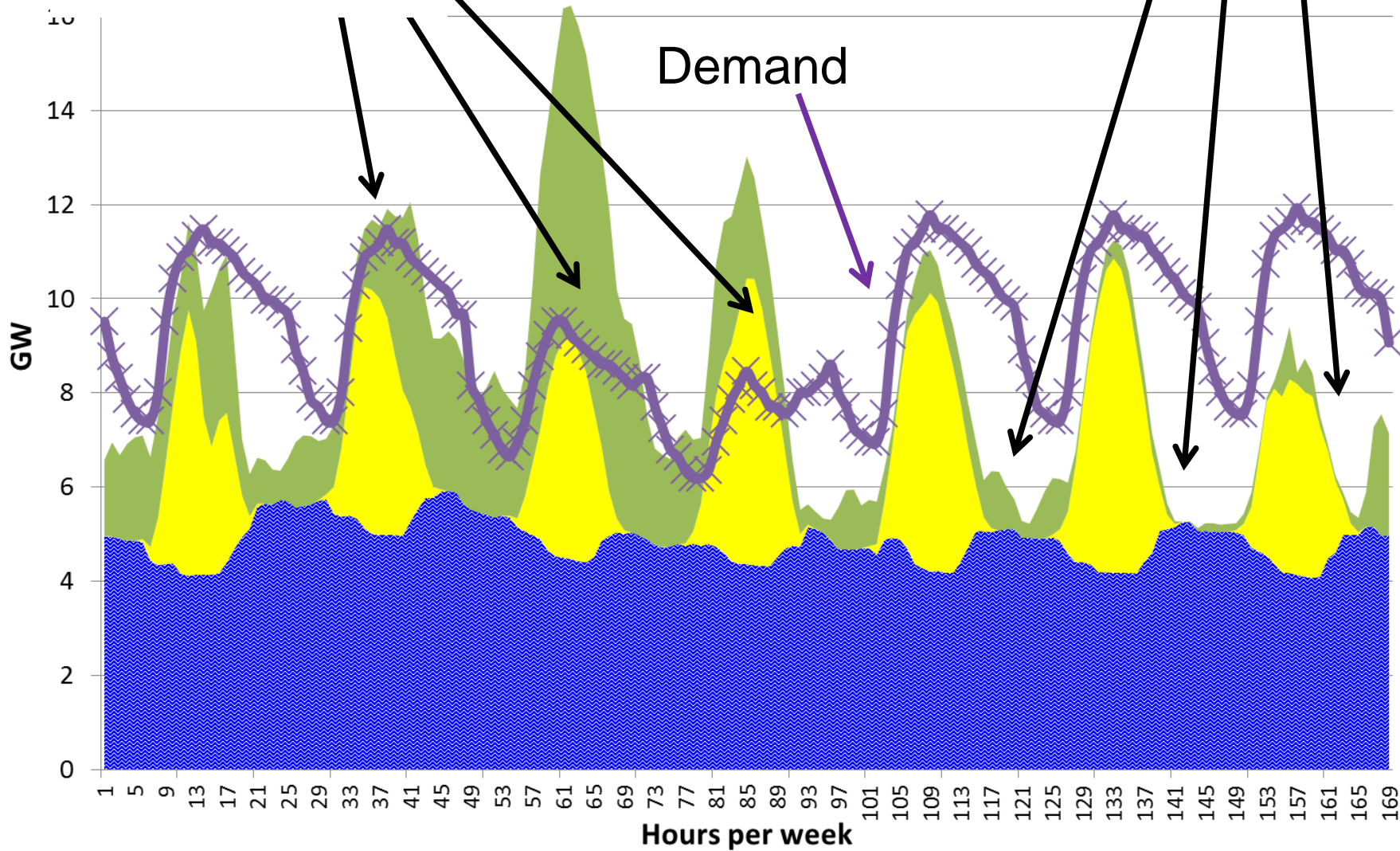
> Demand

on-river hydro PV Wind Load

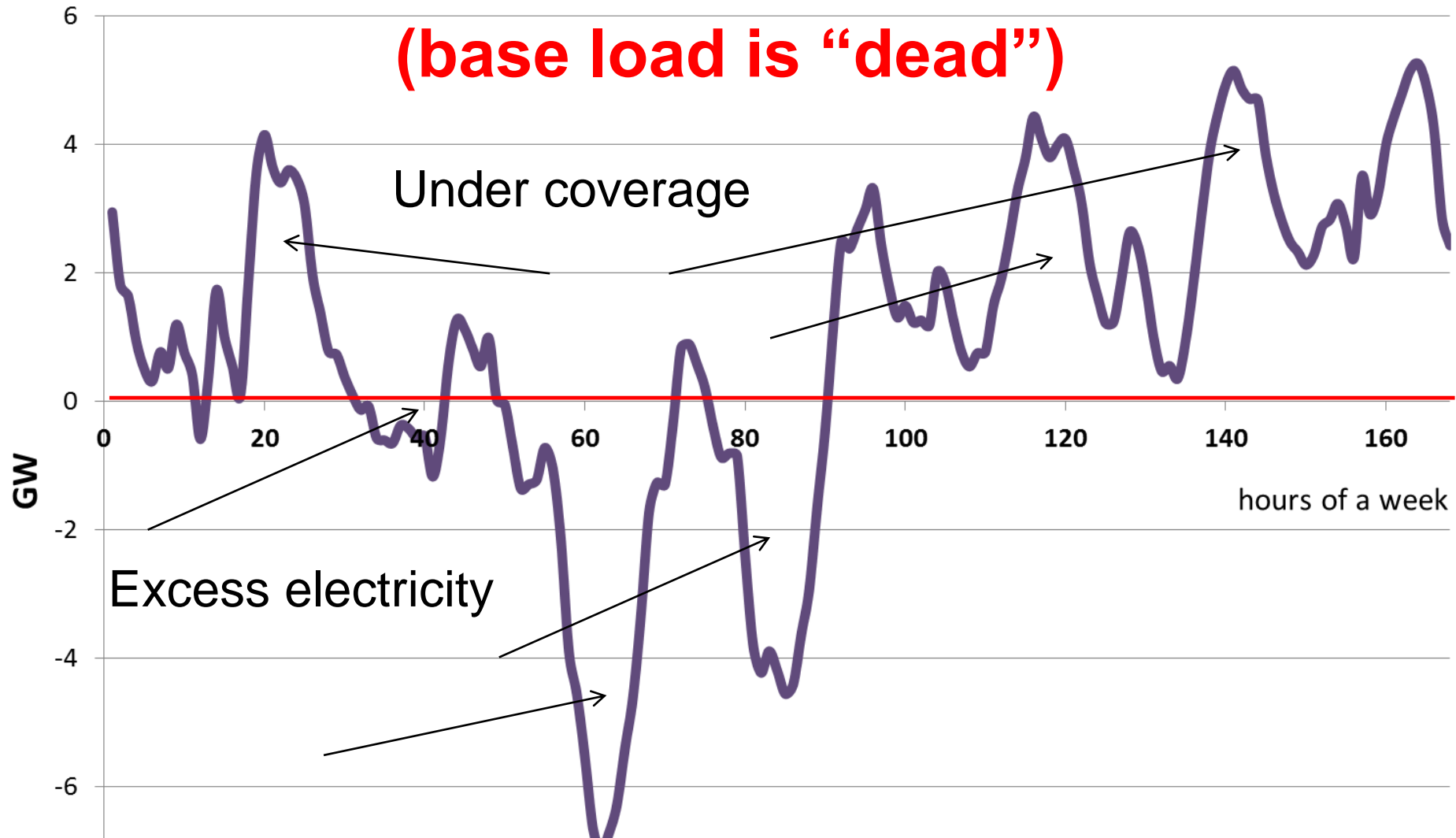
Demand

RES Production

< Demand



Key term of the future: Residual load (base load is “dead”)

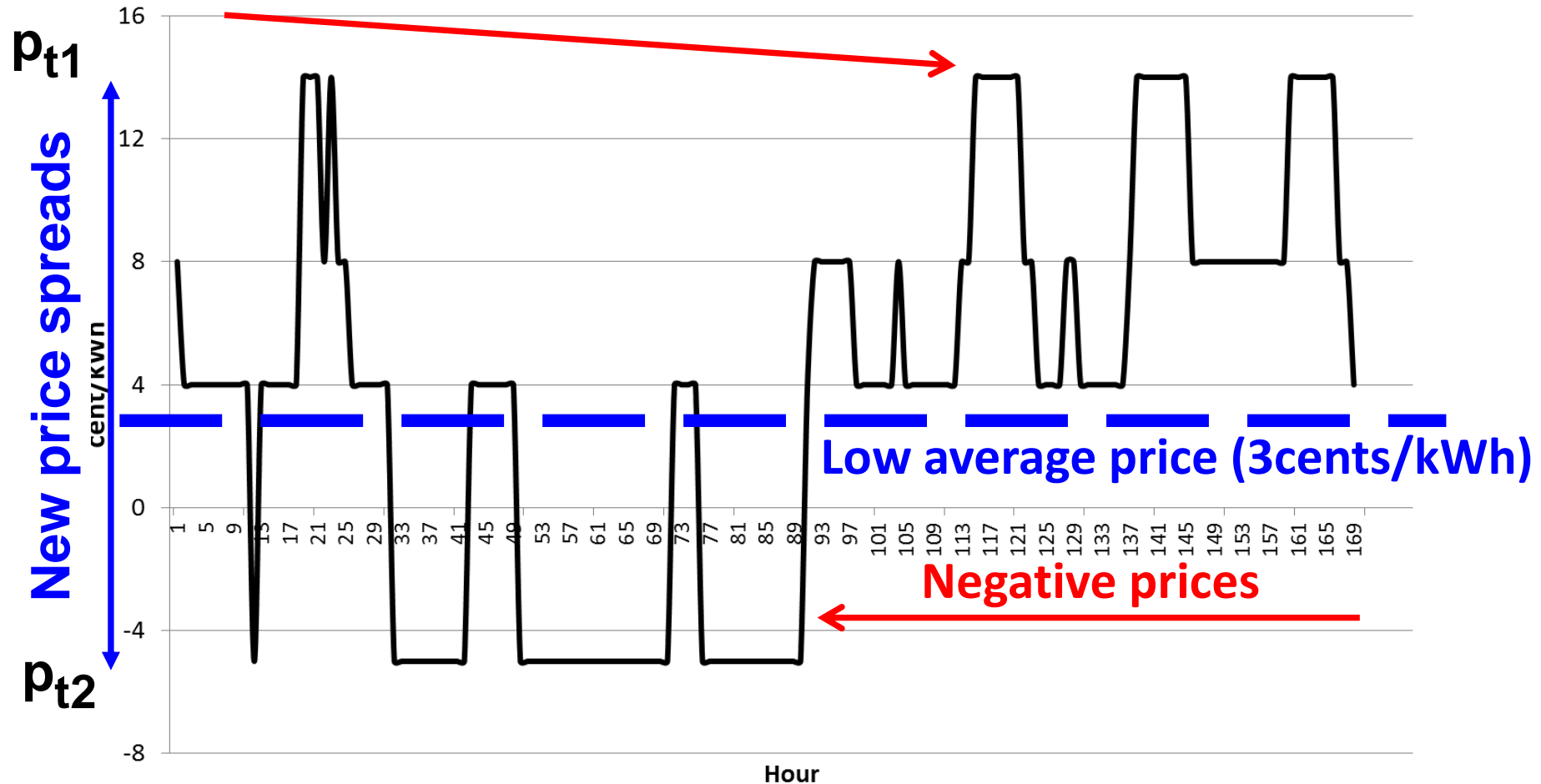


Residual load = Load – non-flexible generation

Deviation from STMC-pricing in spot markets

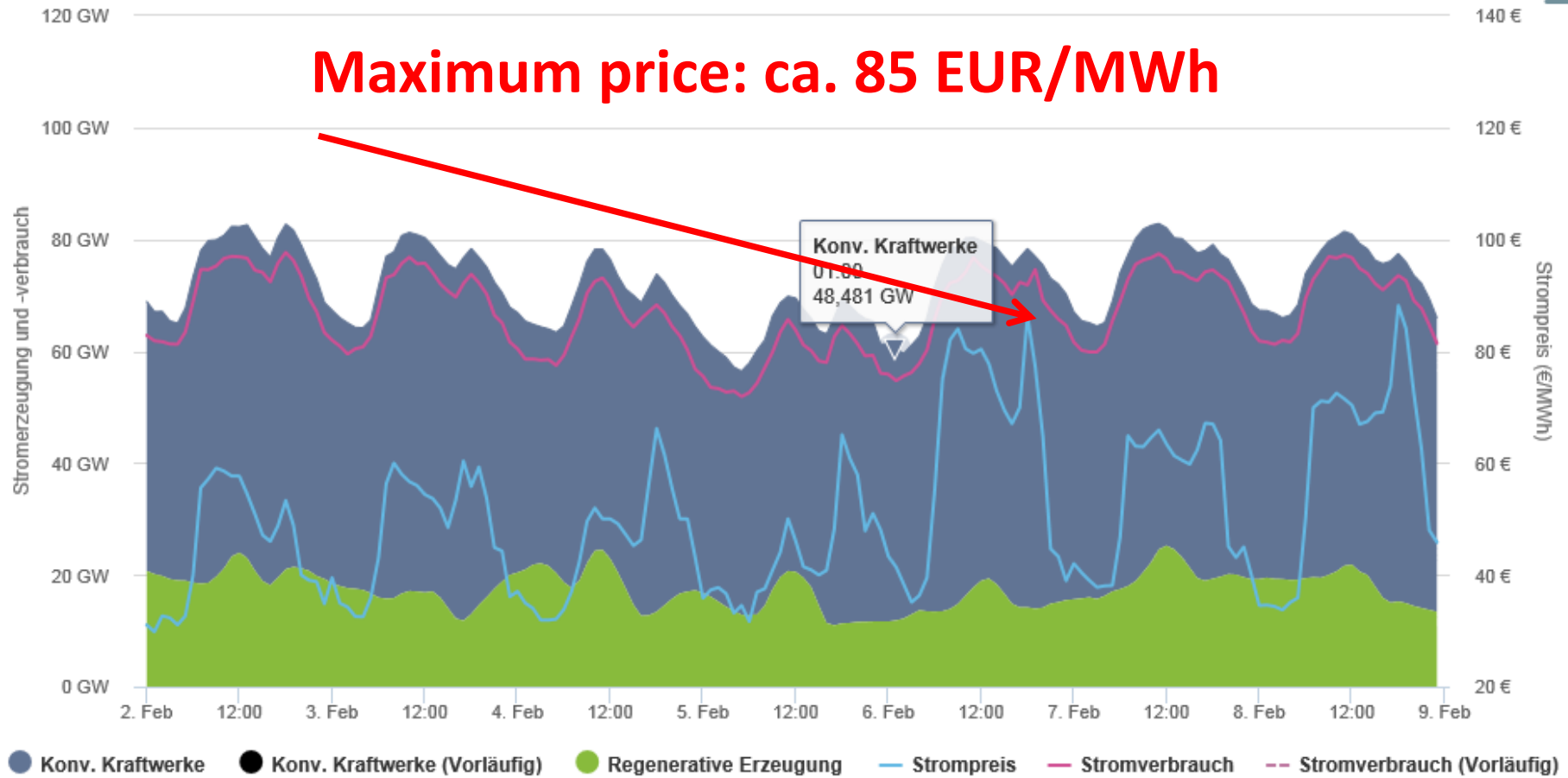
Scarcity prices

Electricity price spot market

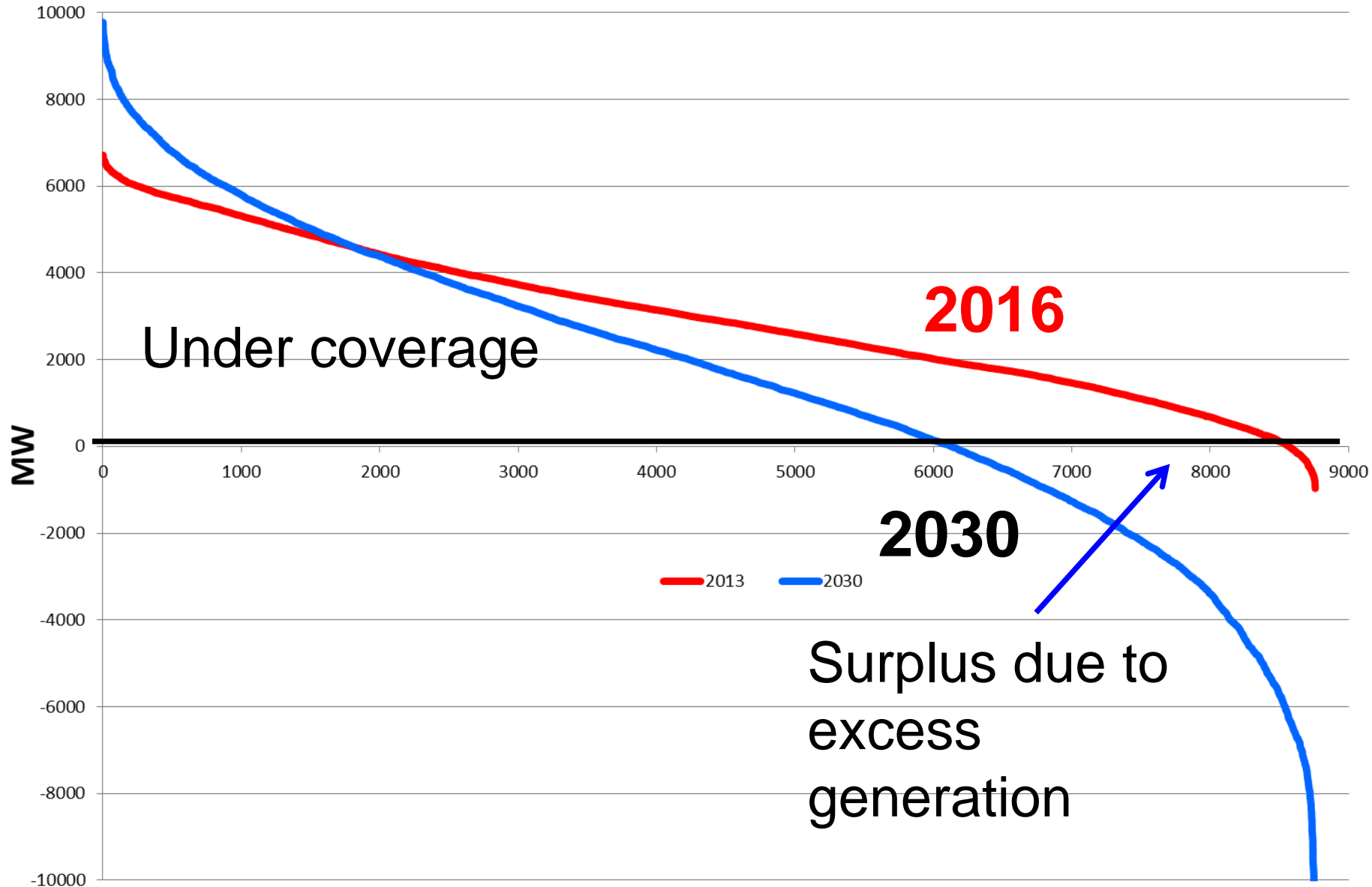


→ These price spreads provide incentives
for new flexible solutions!!!!

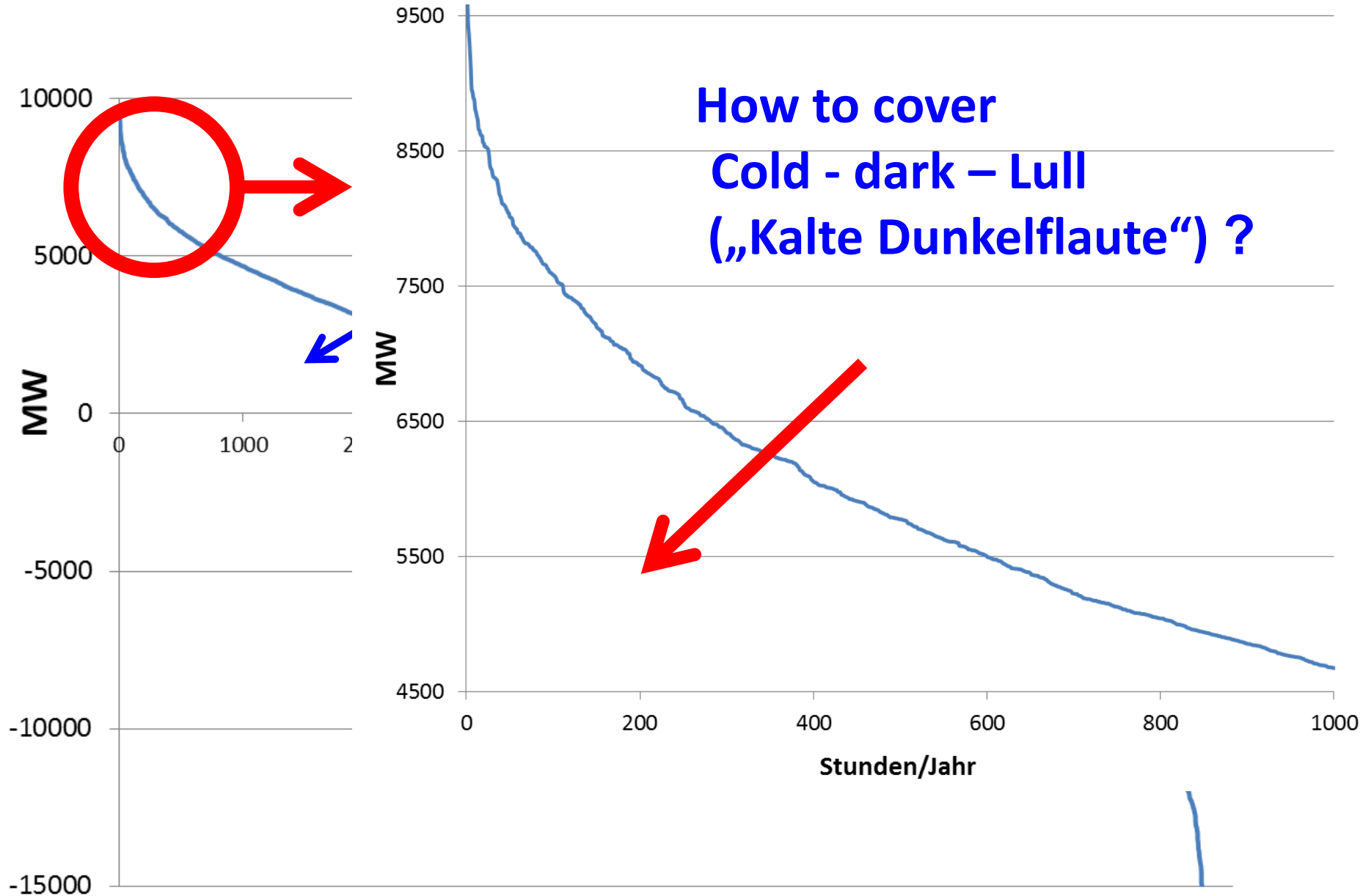
Remark: Cold - dark – Lull („Kalte Dunkelflaute“)



Classified residual load over a year



Classified residual load



By a regulated capacity „market“ with STMC pricing?

or

By competition between supply-side and demand-side technologies and behaviour (incl. Storages, grid and other flexibility options) with correct scarcity pricing signals?

4 THE CORE PROBLEMS OF CAPACITY PAYMENTS

All regulatory capacity payments for power plants distort the EOM and lead to wrong price signals for all other options

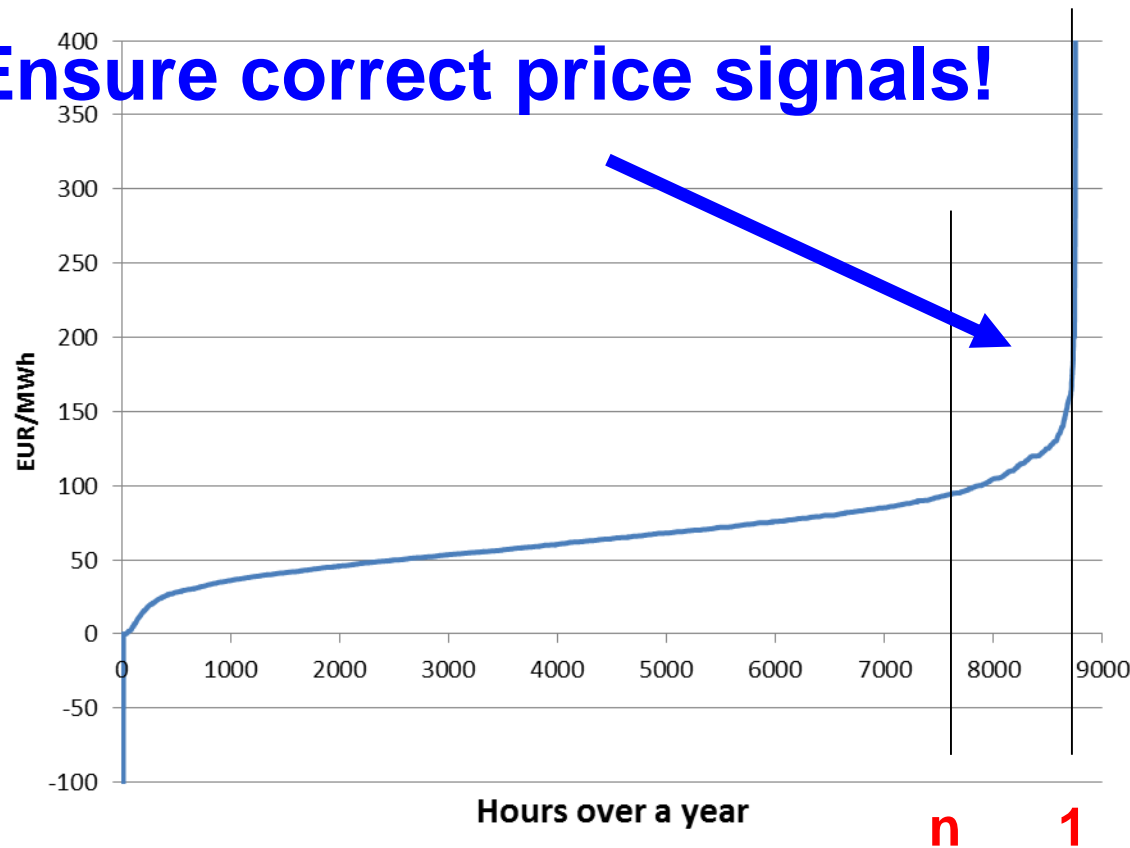
Price peaks at times of scarce resource should revive the markets and lead to effective competition

The higher the excess capacities, the lower is the share of RES

strive to retain system resource adequacy by correct price signals without capacity payments

Cost duration curve

Ensure correct price signals!



Generators stay in the market if:

$$\sum_{t=1}^n (p_{ele_t} \cdot q_{ele_t} - c_{f_t}) > (c_{c_y} + c_{O\&M_y})$$

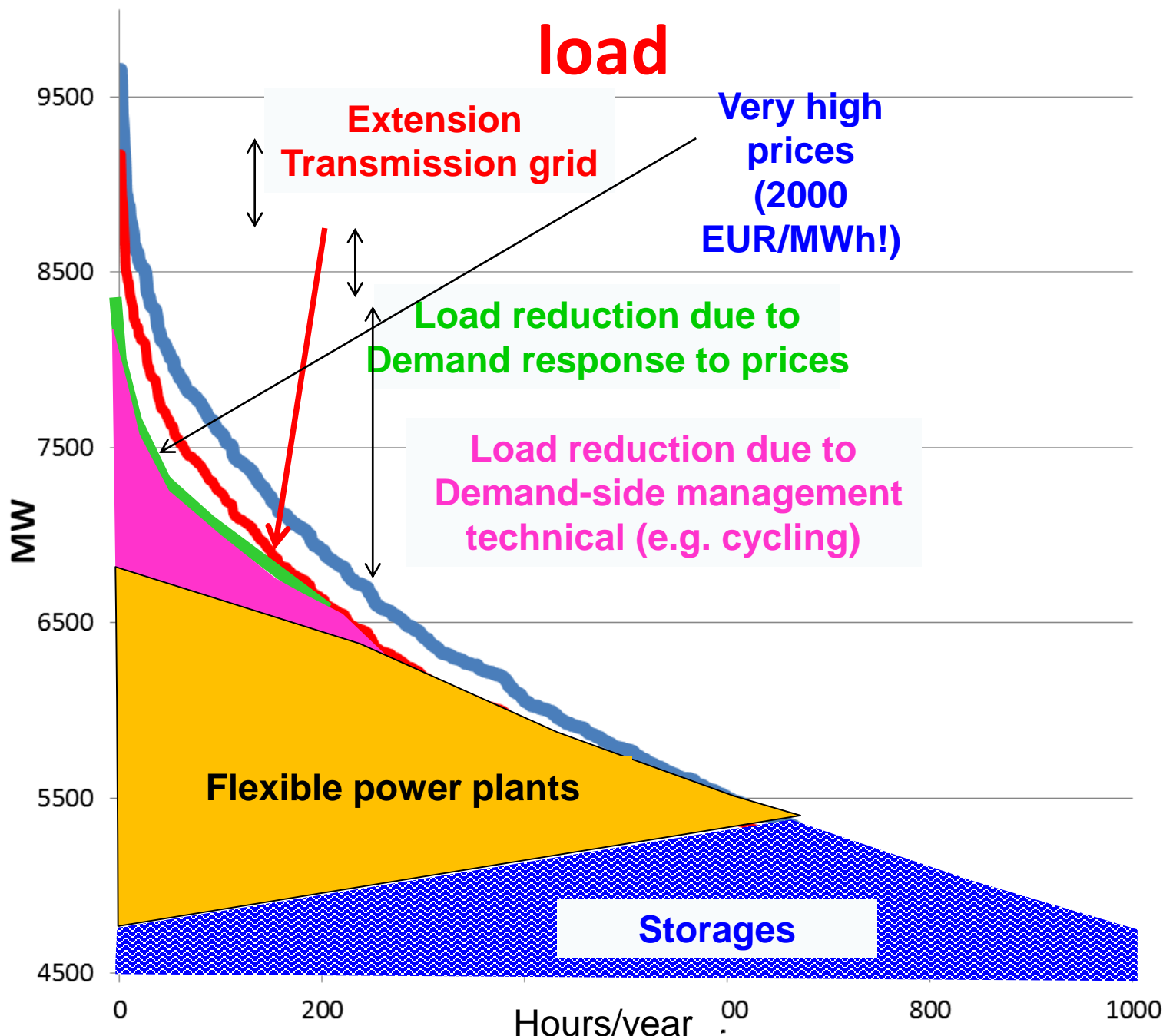
Given a price pattern, showing **excess and scarcity**
prices it would be
attractive for a sufficient number of flexible power
plant operators
to stay in the market!



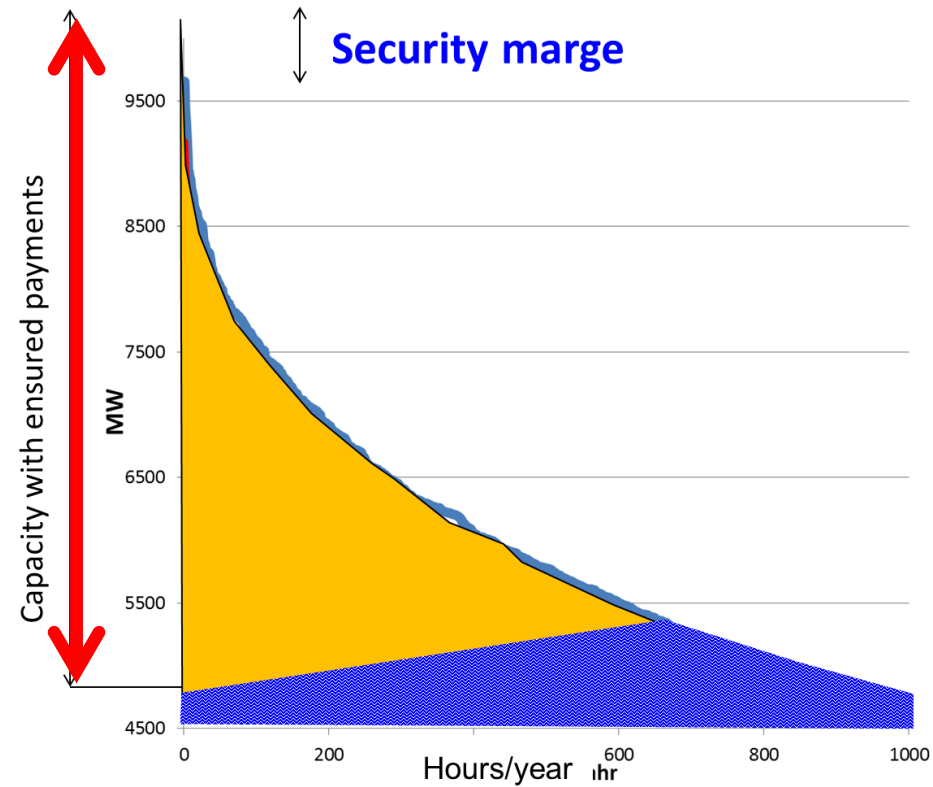
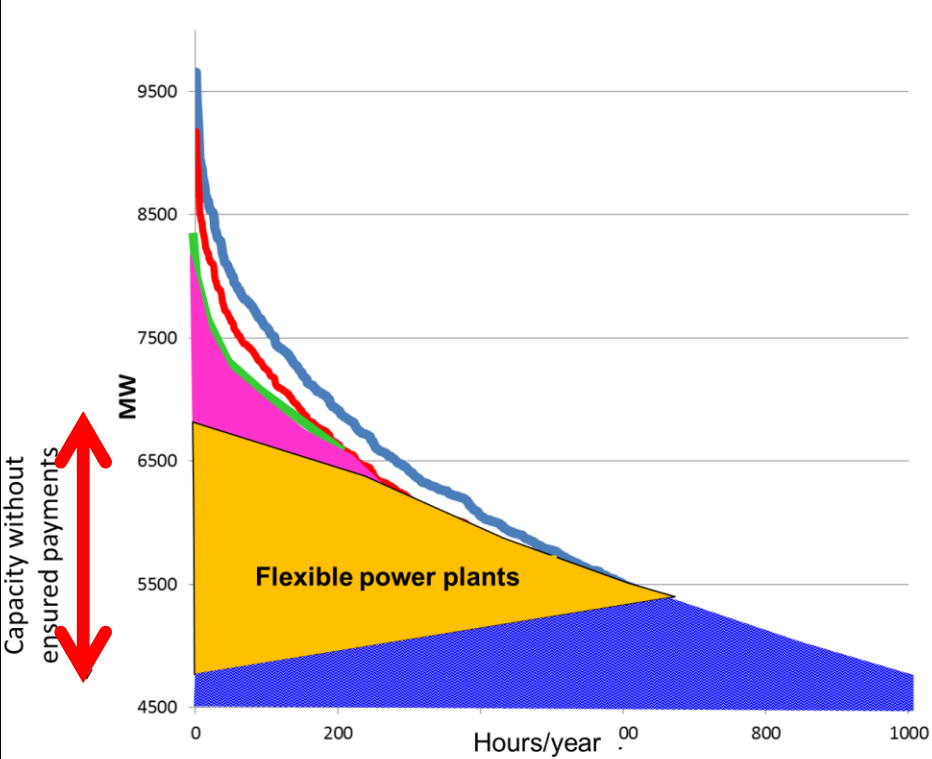
REVISED ENERGY-ONLY MARKET

5 Flexible coverage of residual load

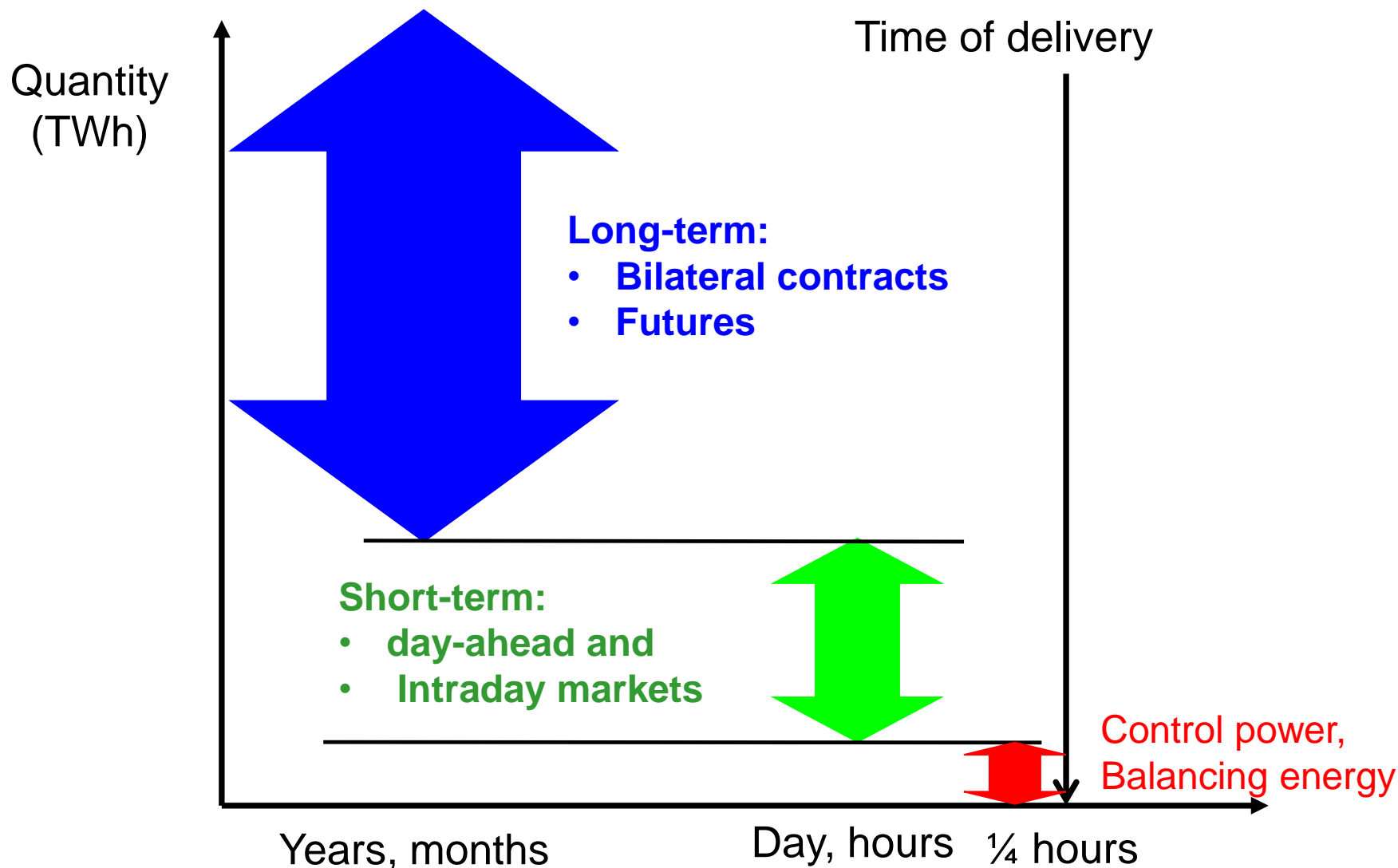
Capacity without
ensured payments

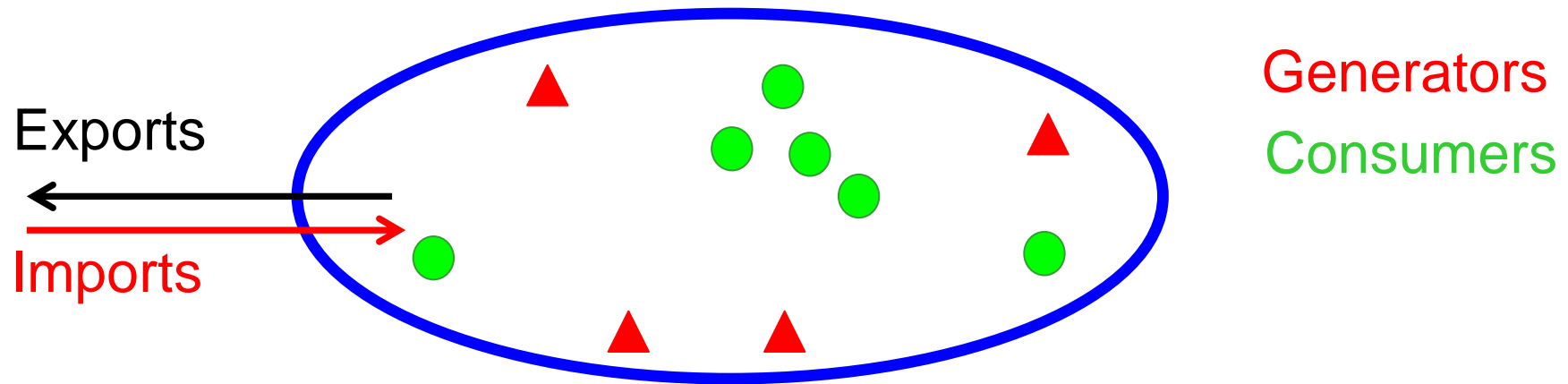


Comparison



6. THE CORE ROLE AND RESPONSIBILITY OF BALANCING GROUPS



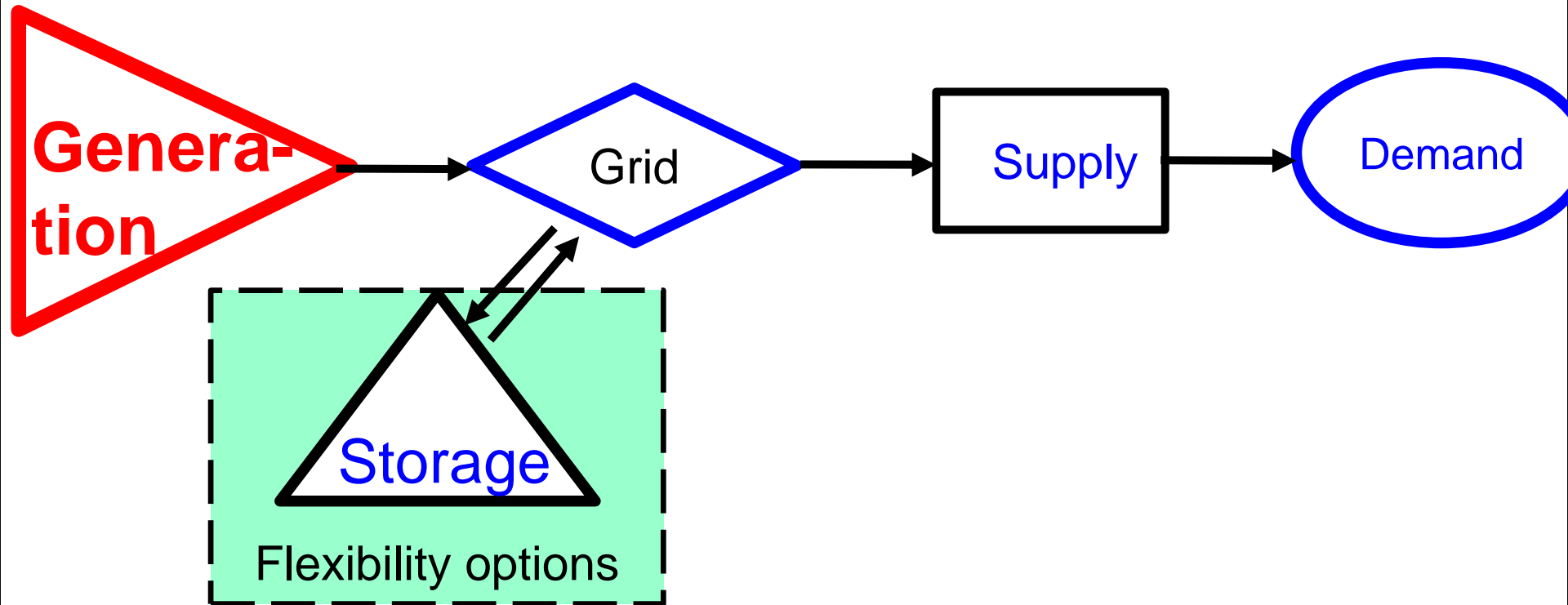


Balancing group: entity in a control area of an electricity system; it has to ensure that at every moment demand and supply is balanced

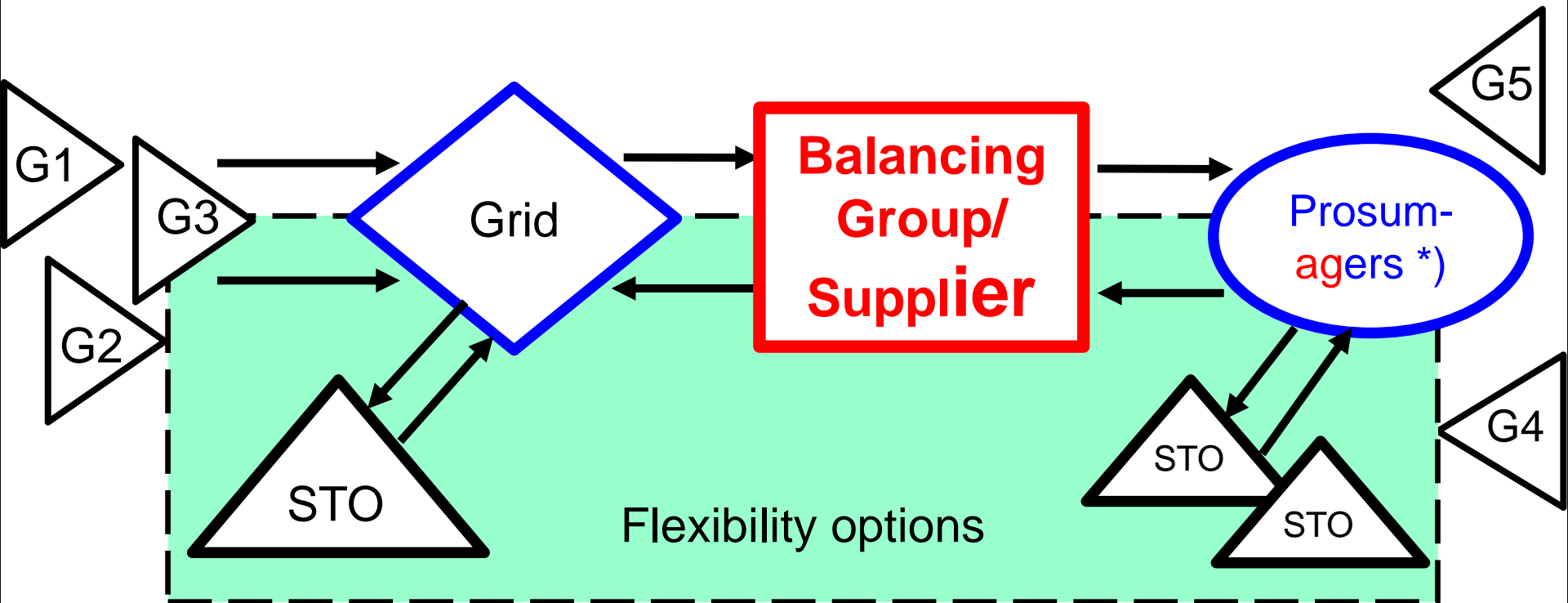
E.g. municipal utility of Vienna, Cologne, Essen

**To meet this target: own generation , storage, flexibility,
Trading in long-term, day-ahead and intraday market**

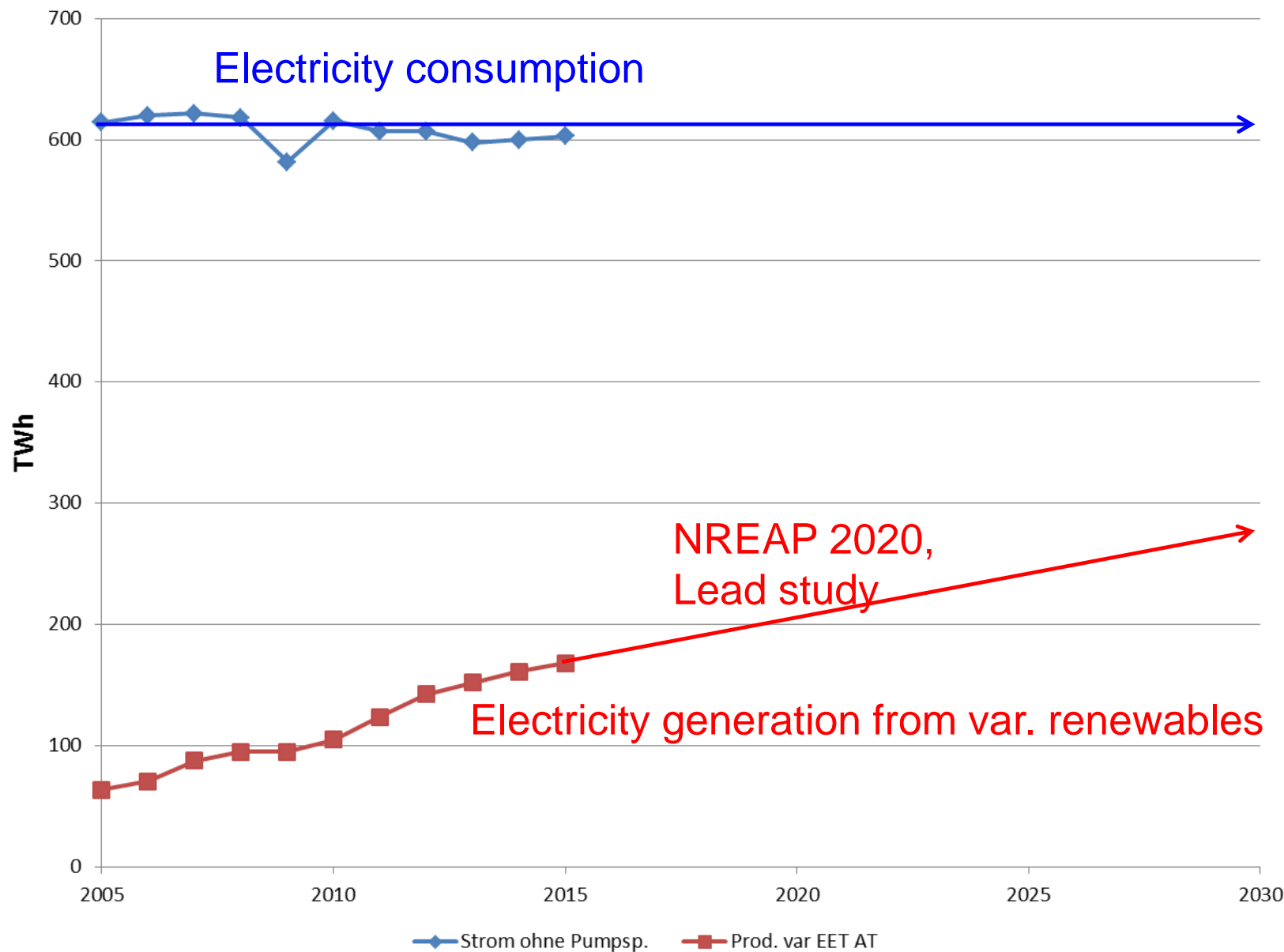
Every difference → high costs!



New Thinking: Making the electricity system more democratic



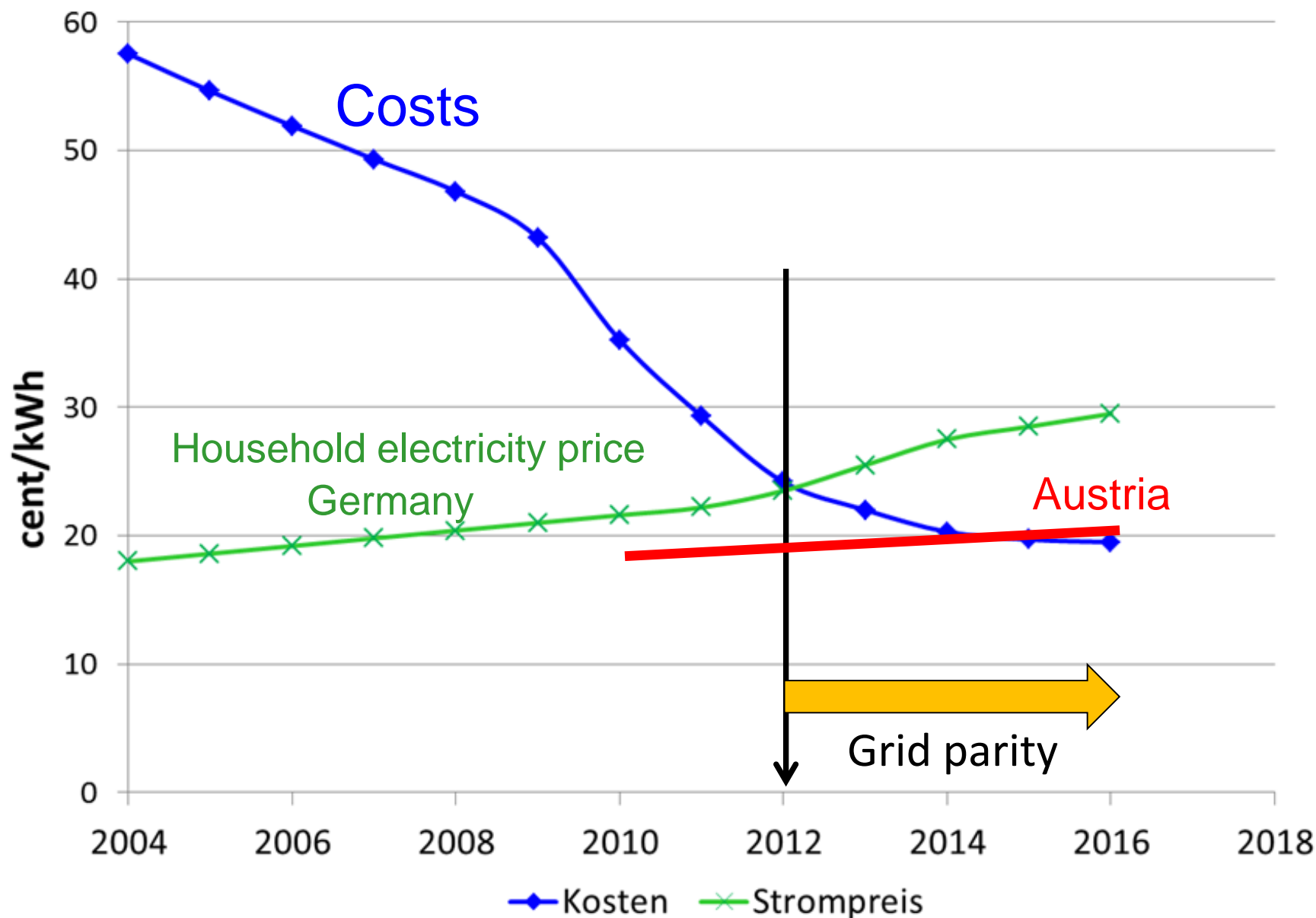
Electricity consumption over time in Germany



7. IS THE TIME FOR SUBSIDIZING RENEWABLES OVER ?

As long there is no price on CO₂

Grid parity: PV-costs and household electricity prices

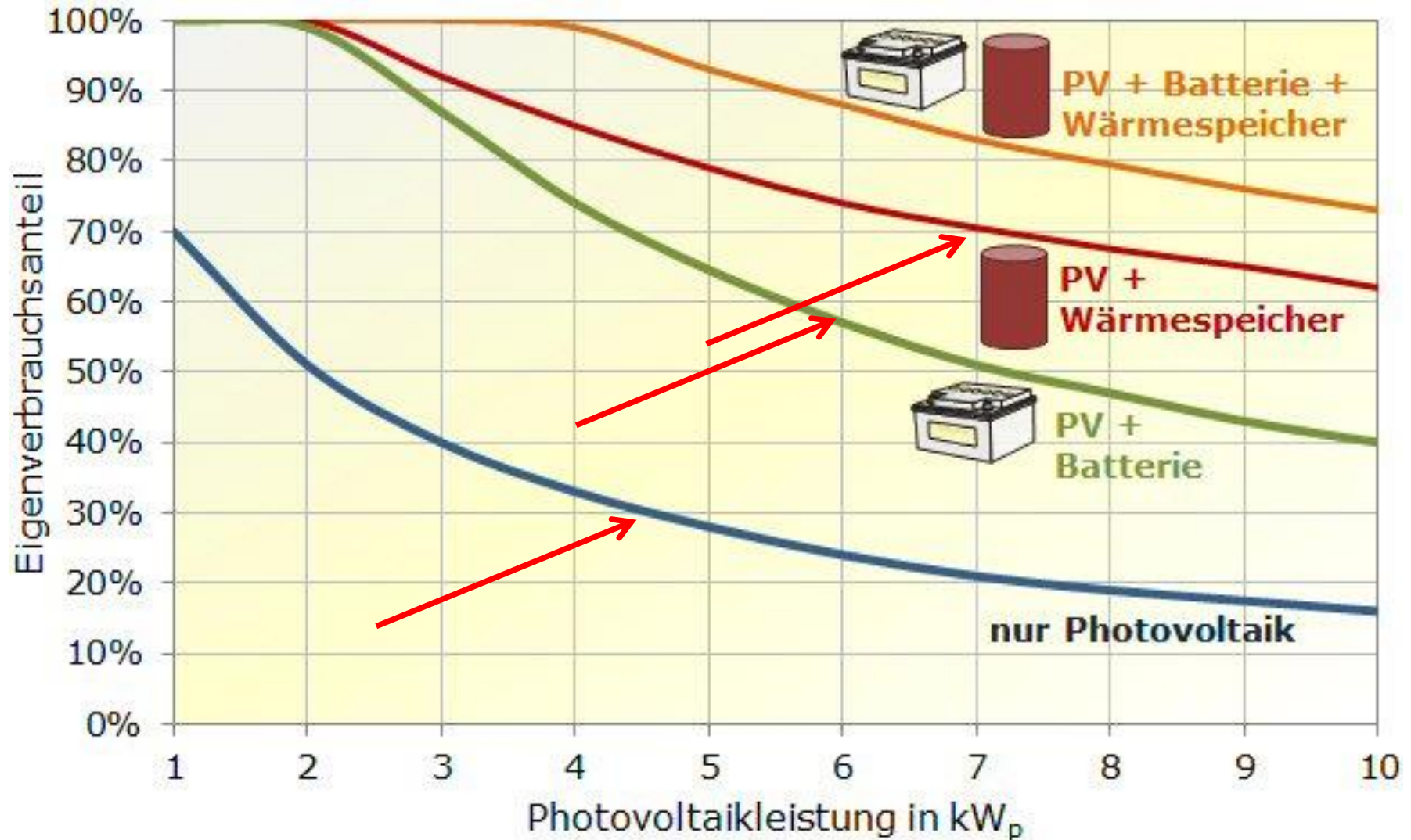


$$\begin{array}{c}
 \text{Savings/revenues} \qquad \qquad \qquad \text{Costs} \\
 \hline
 \text{E}_{\text{Own}} * \text{P}_{\text{HH}} + \text{E}_{\text{Feed-in}} * \text{P}_{\text{feed-in}} > \text{Annuity}
 \end{array}$$

Grid parity term

Subsidy still necessary?

Share of own consumption

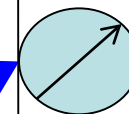


Tenant electricity model and Blockchain

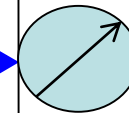
PV-System on the roof

Tenant electricity model:
Contracted PV-electricity

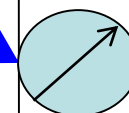
**Balancing
Group/
Supplier**



Customer 1



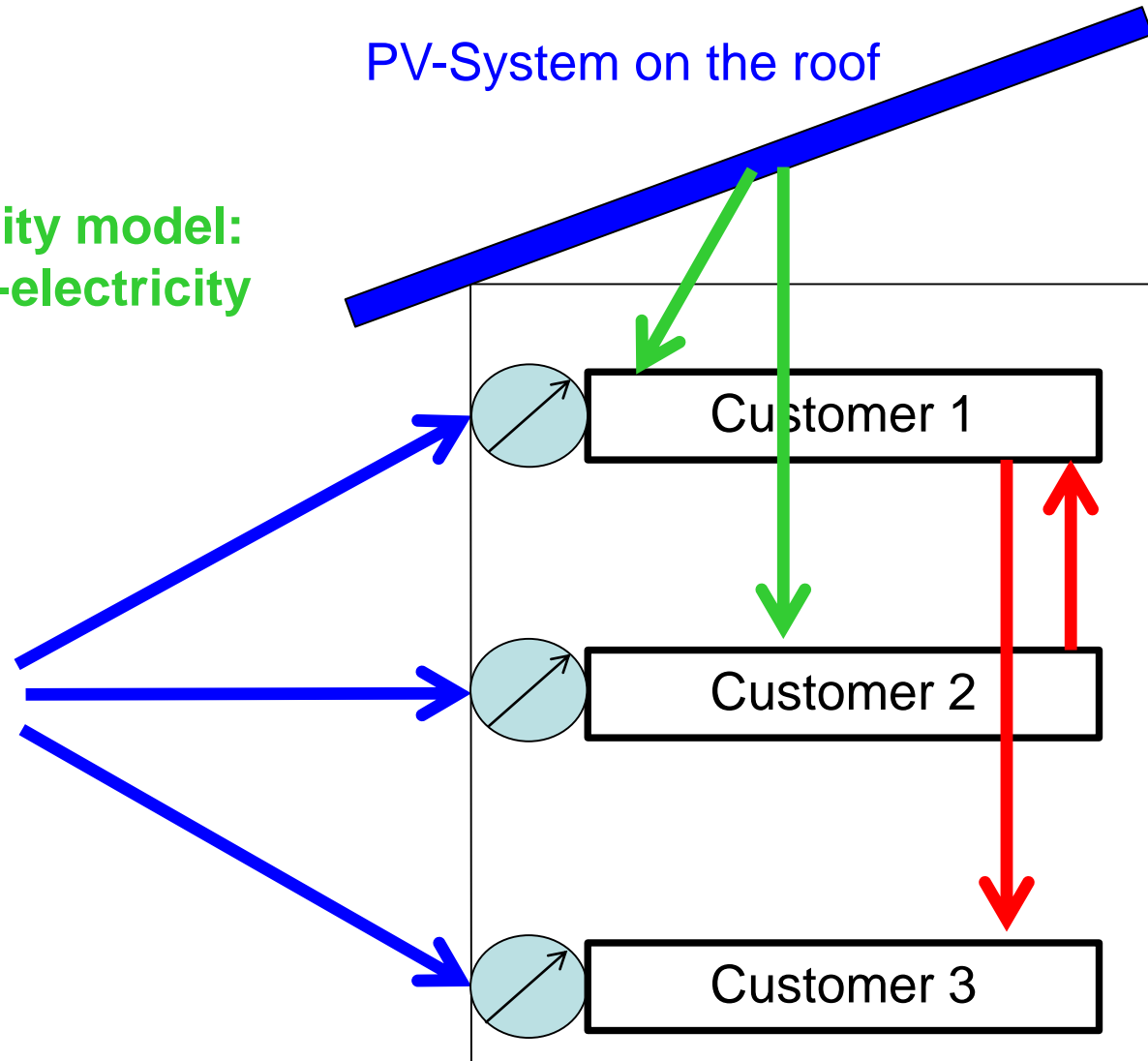
Customer 2



Customer 3

Meter

Blockchain



- Sustainable electric. system → integration of a broad **technology** portfolio & **demand-side options**
- **Larger** market areas **favourable**
- Very important: **correct price signals** (incl. CO₂)
- most urgent: exhaust **full** creativity for **flexibility** of all market participants incl. **decentralised PV systems**
- Capacity payments: **Any CP** will distort the system towards more conv. and less RES capacity
- **New** key player: **Balancing group (Supplier)**, no more the generator