On how to integrate large quantities of variable renewables into electricity systems

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1. INTRODUCTION

Motivation:

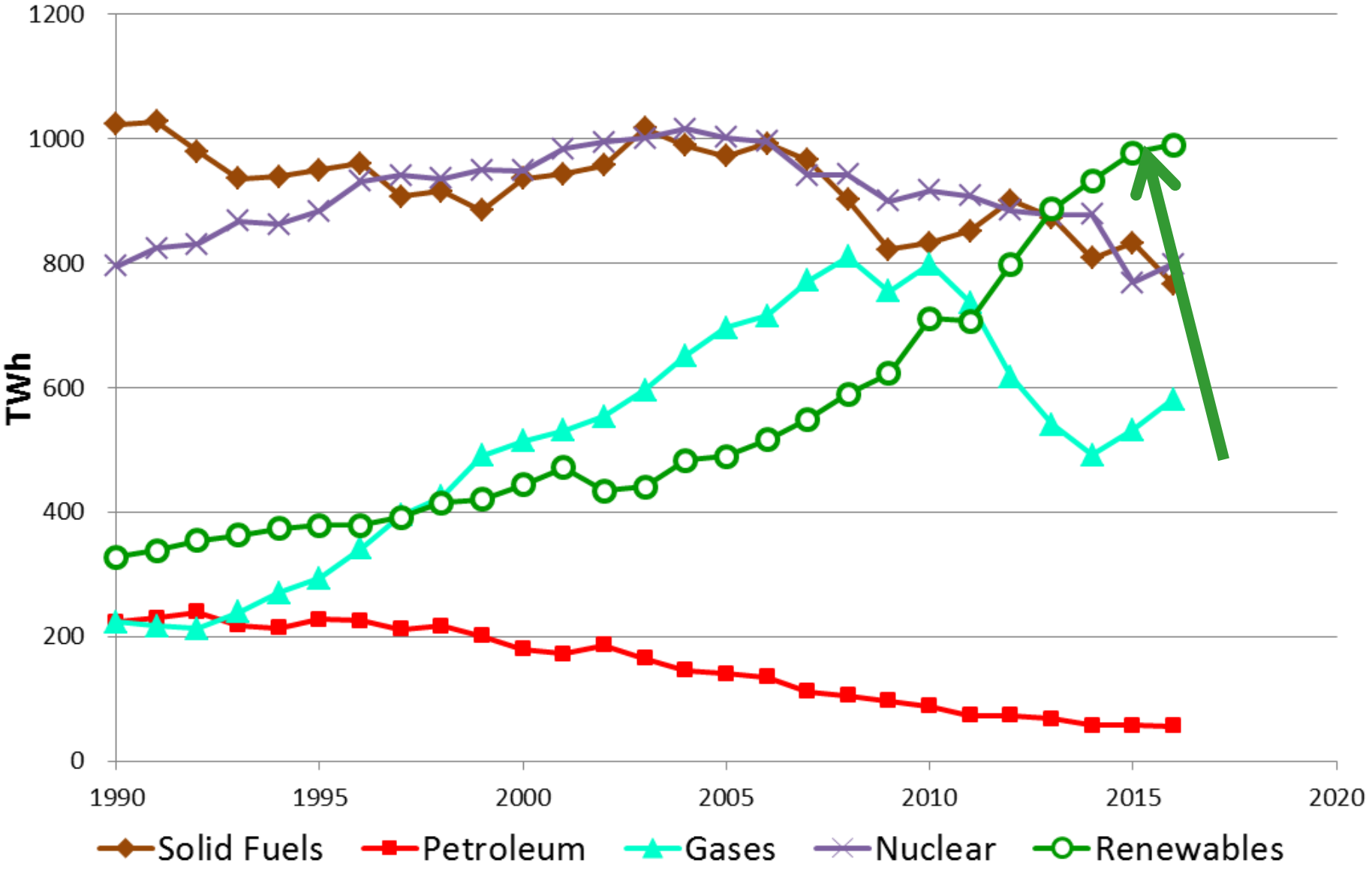
* Climate change → Paris agreements

* European targets for renewables → „Clean energy“ winter package

* Competition & democracy

* It is not possible to squeeze variable renewables into the system by violence

Electricity generation EU-28



Core objective

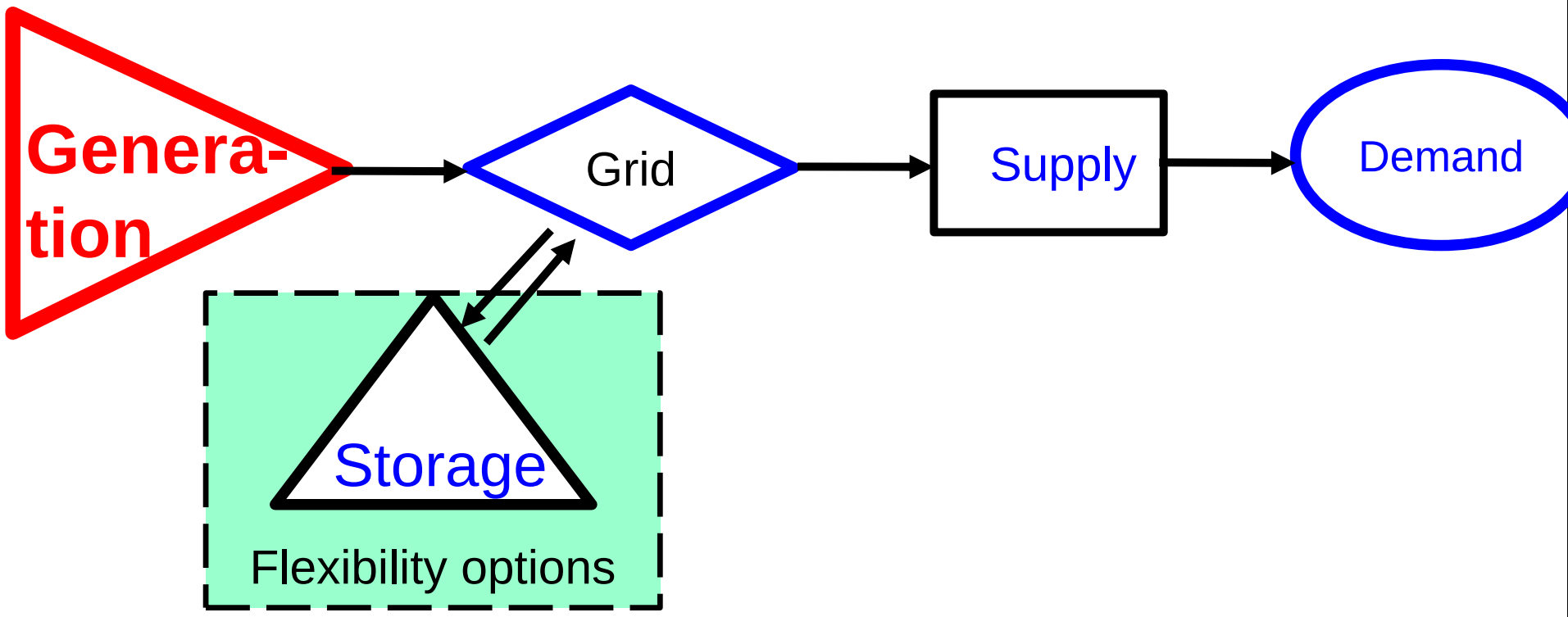
… to identify the major boundary conditions to integrate even larger amounts of variable renewables into the electricity system

Very important:

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

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

Old thinking



Day-ahead electricity markets

Expectation of

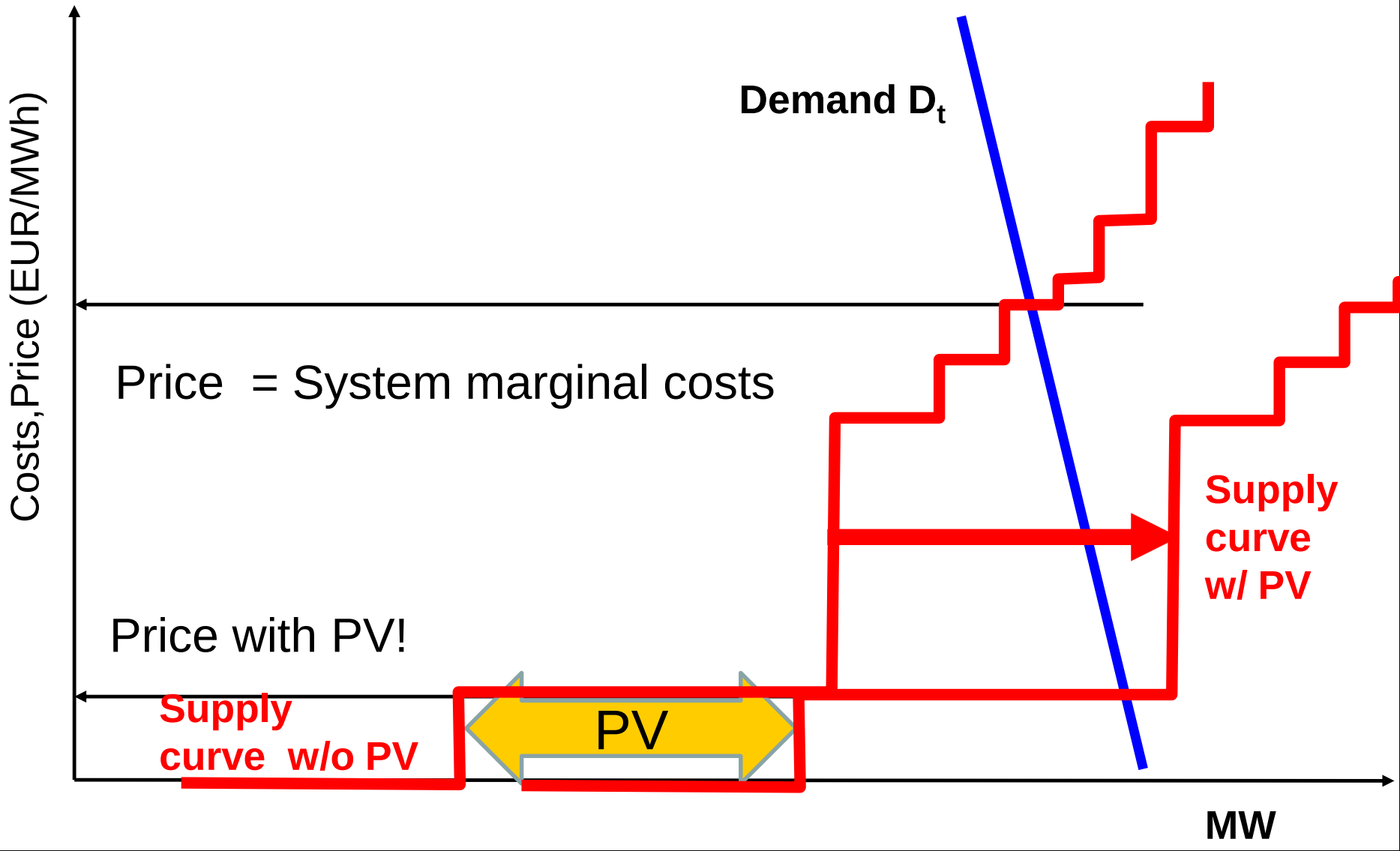
prices = Short-term marginal costs

(Short-term marginal costs = fuel costs)

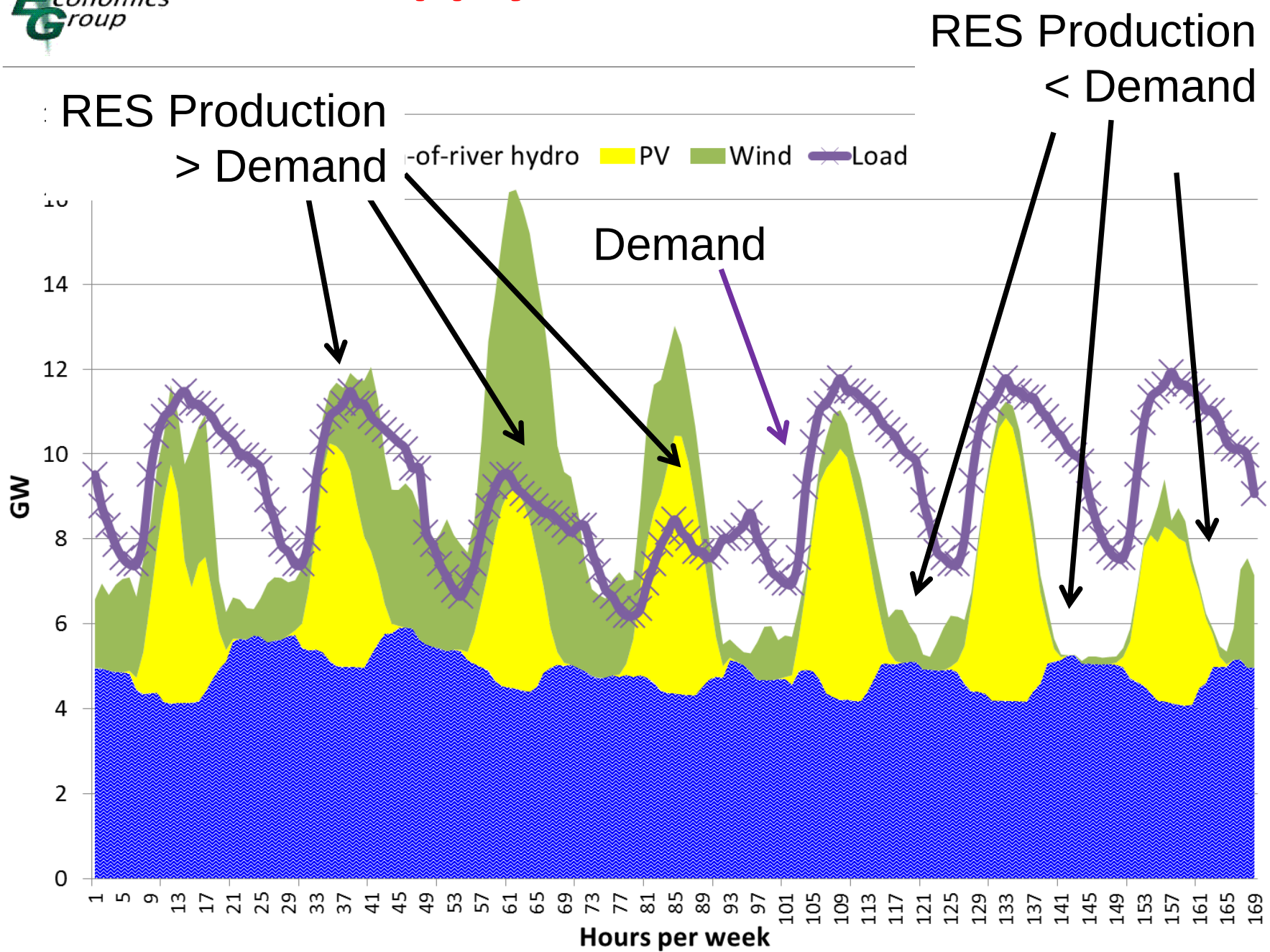
due to huge depreciated excess capacities at the beginning of liberalisation!

2 HOW VARIABLE RENEWABLES IMPACT PRICES IN ELECTRICITY MARKETS

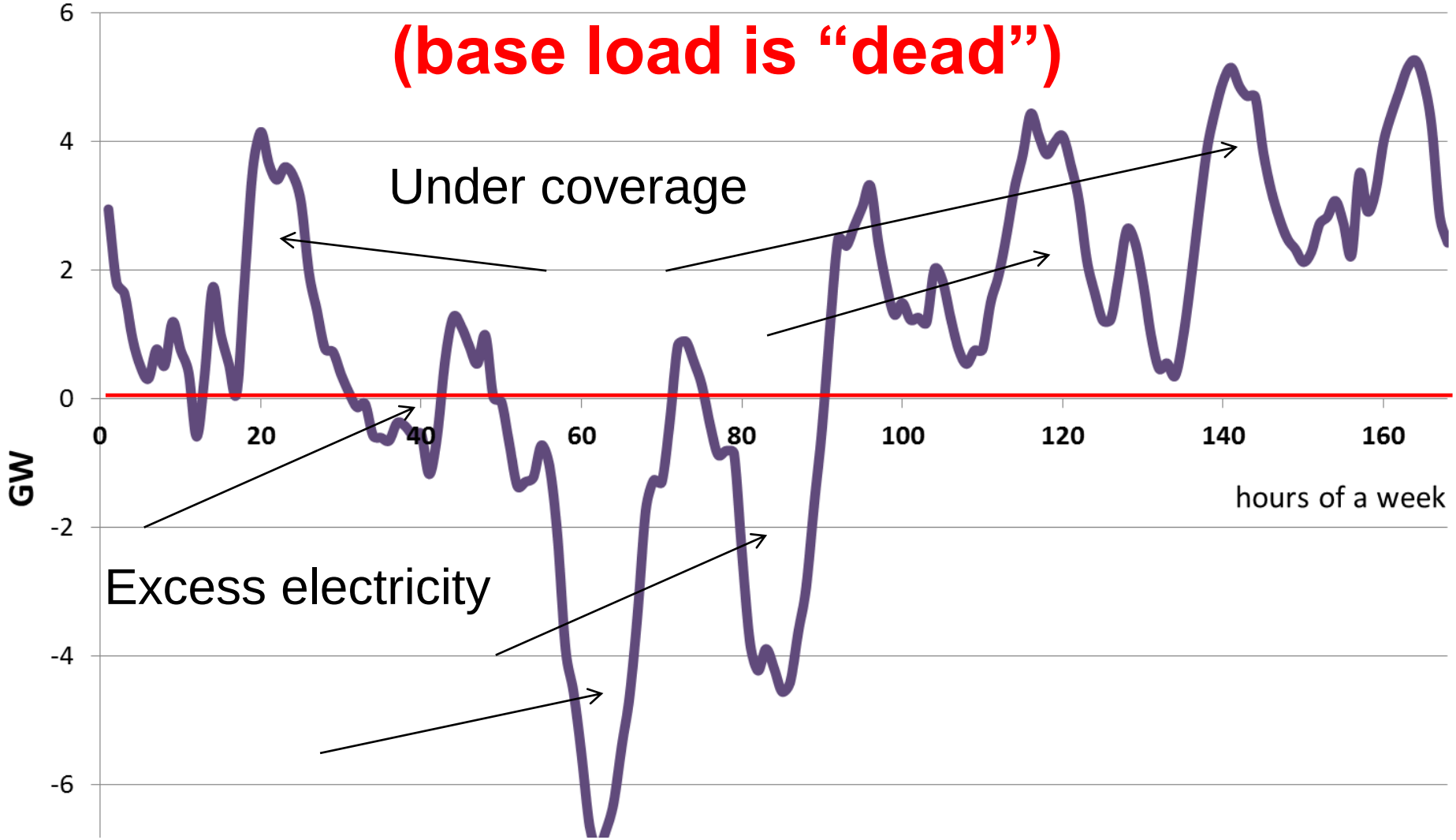
Example: prices without and with PV



Supply and Demand



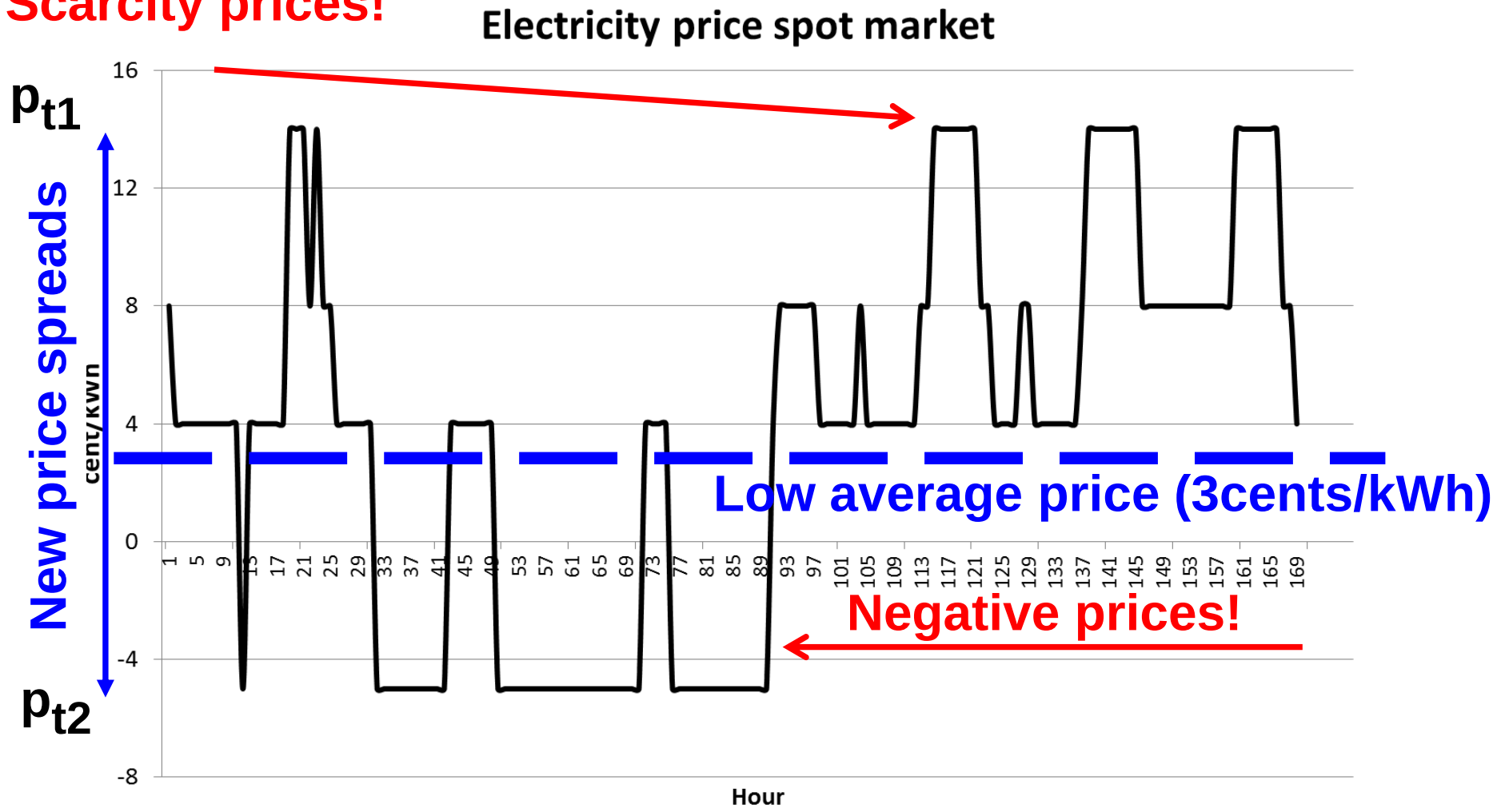
Key term of the future: Residual load (base load is “dead”)



Residual load = Load – non-flexible generation

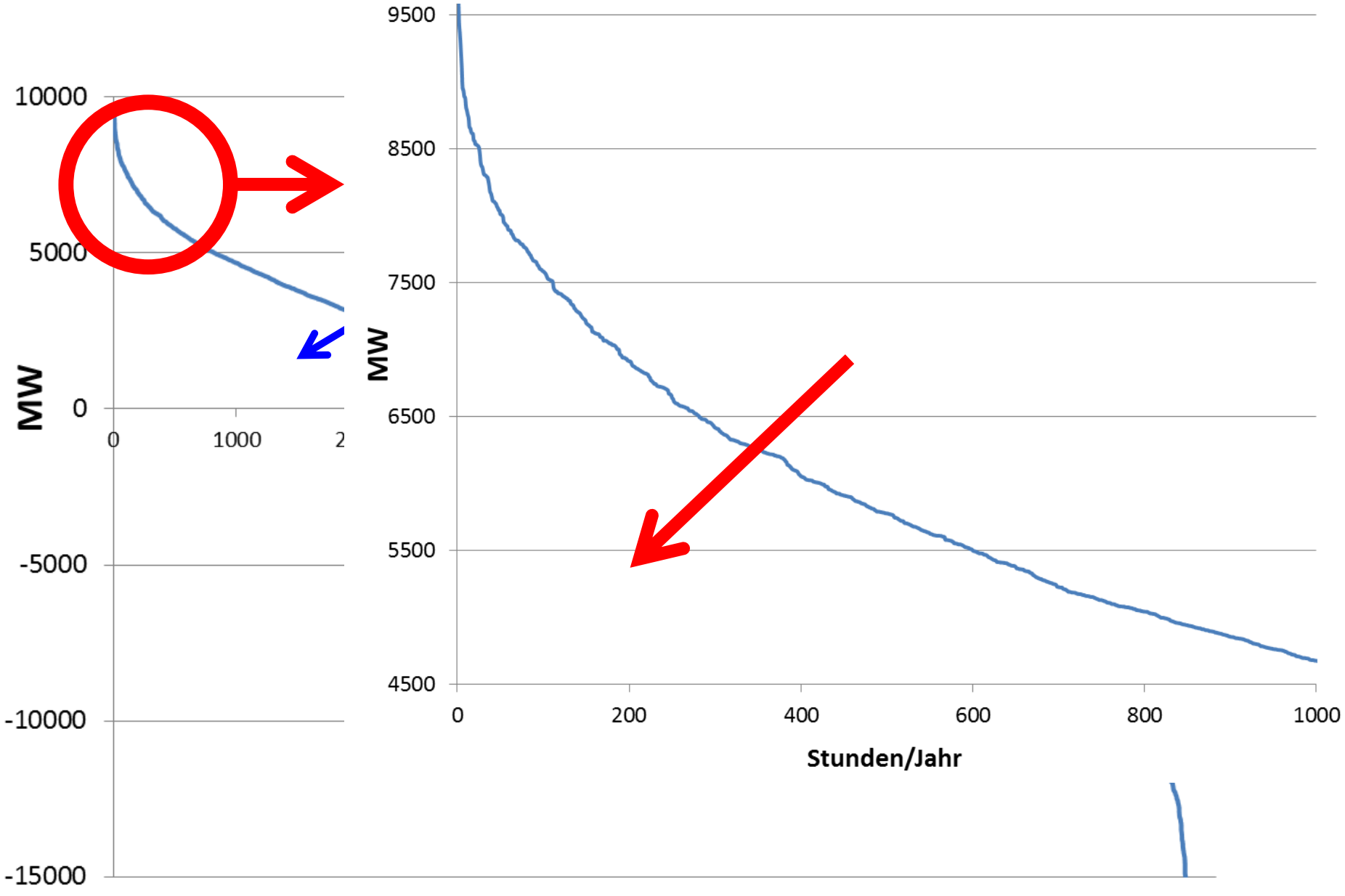
Deviation from STMC-pricing in spot markets

Scarcity prices!



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

Classified residual load



There are two extreme positions:

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??

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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!

→

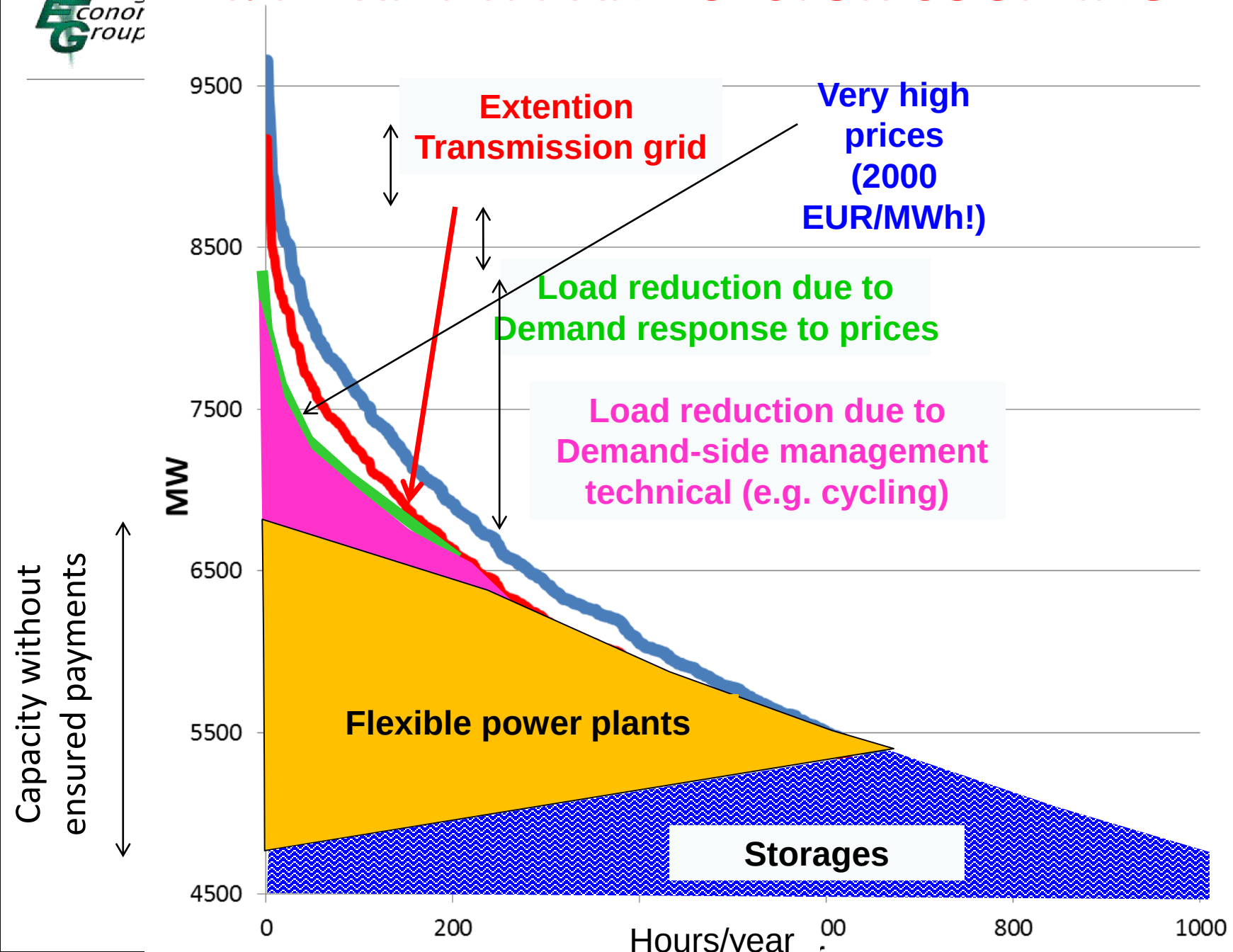
REVISED ENERGY-ONLY MARKET

3 THE CORE PROBLEM OF CAPACITY PAYMENTS

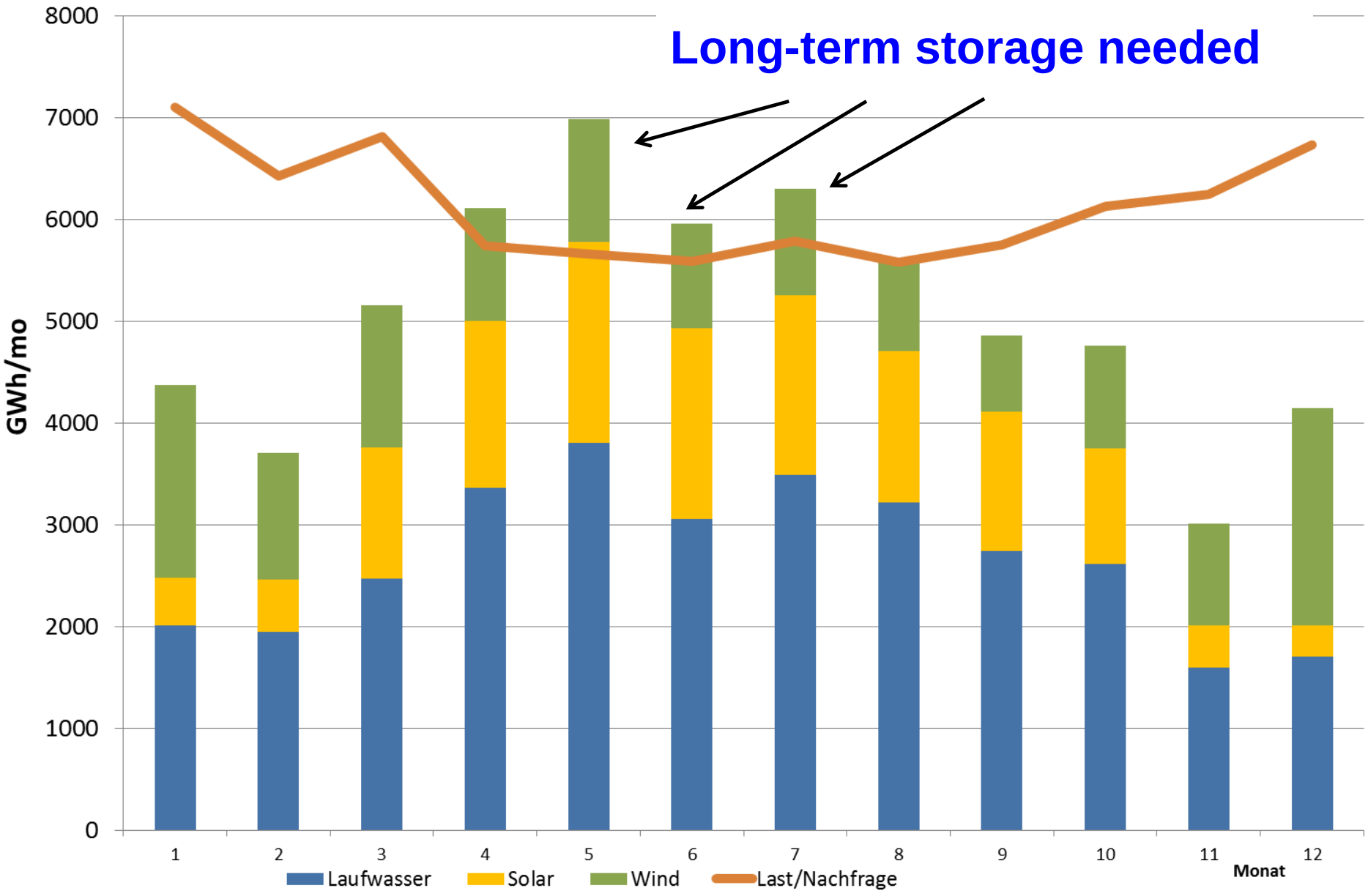
Strategic reserves as well as capacity payments for power plants destroy the EOM by providing misleading price signals!

Price peaks at times of scarce resource should revive the markets and lead to the correct quantities from comp markets point-of-view!

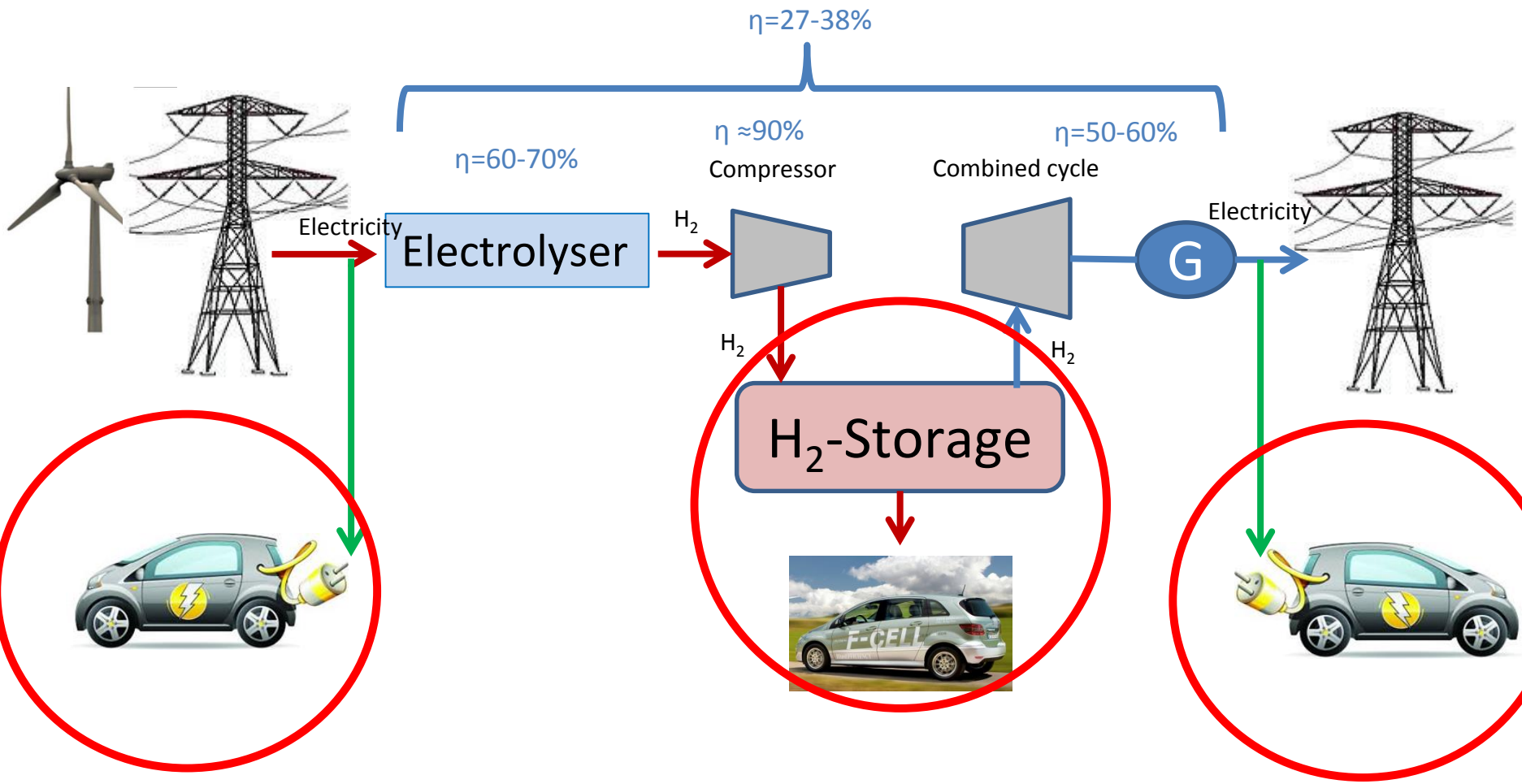
4. FLEXIBILITY AND SECTOR COUPLING



Demand for long-term storage



Sector coupling hydrogen: Storage and fuel in transport?



Problems of Sector coupling

* In times of surplus generation: How to use excess electricity in a meaningful way?

Heating/Cooling

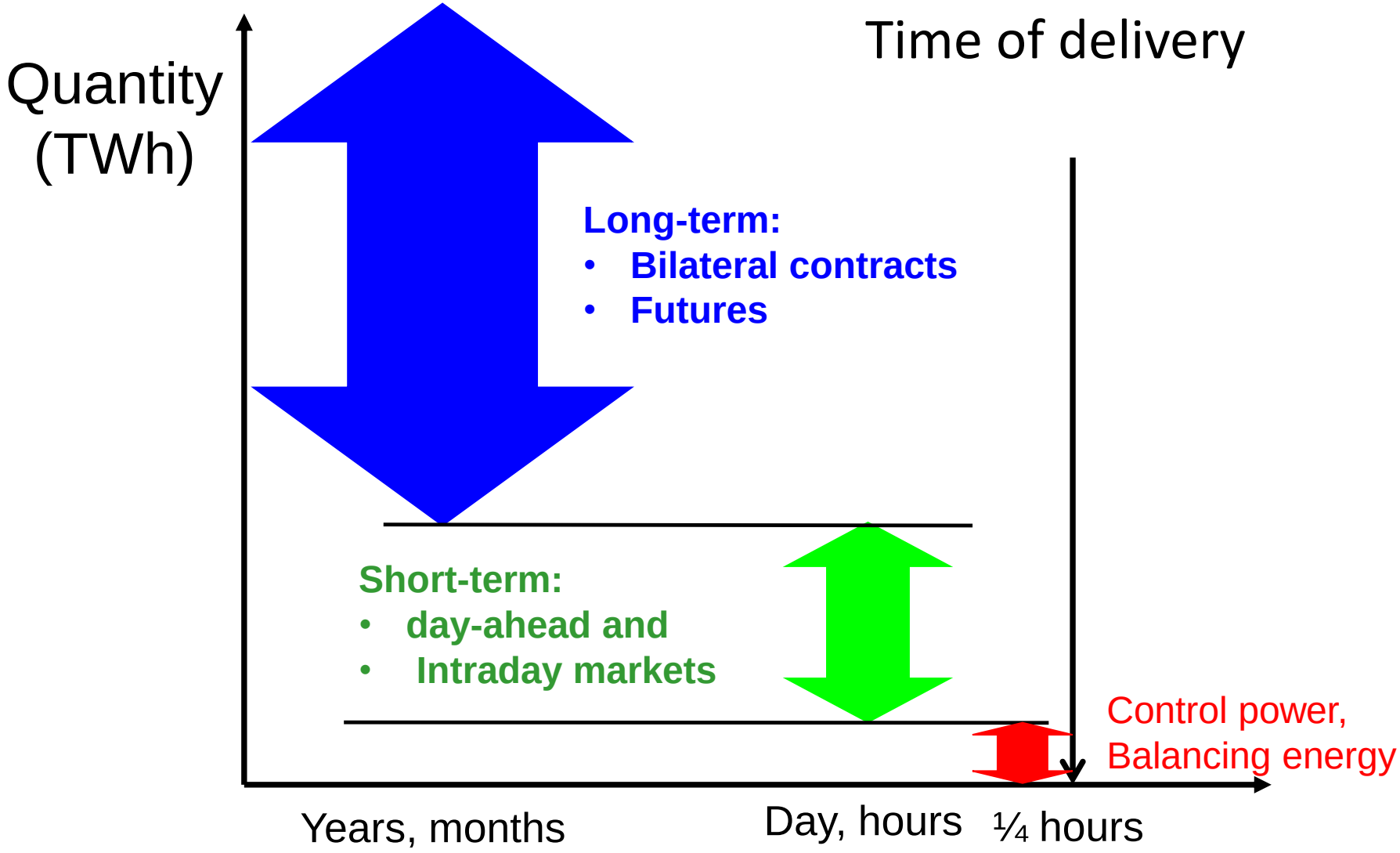
Transport

* Vague simplified suggestions, no convincing long-term solutions

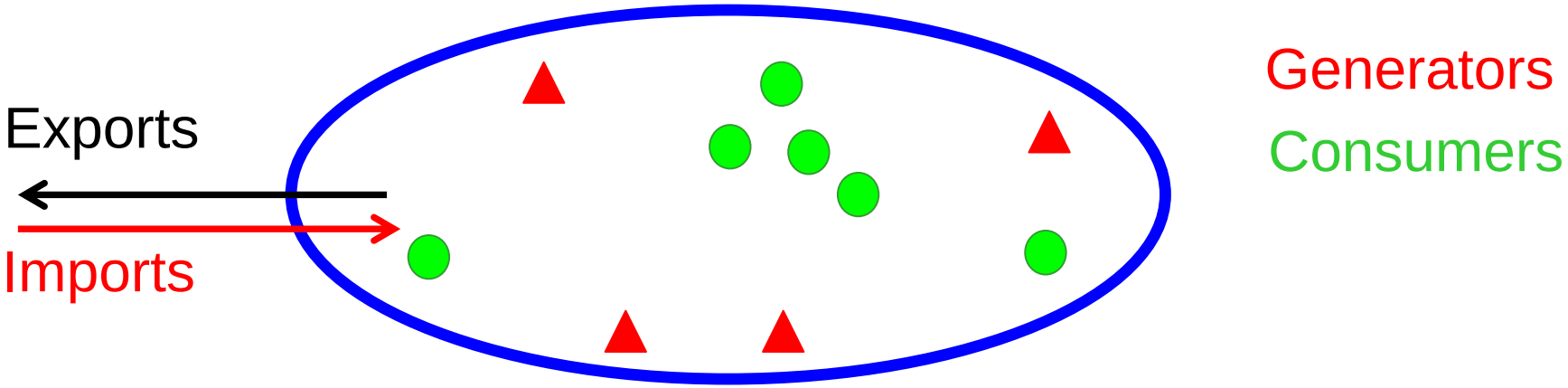
* Central (Ptx approaches, e.g. H2) vs decentral (end user level, E.g. EVs, heat pumps for heating) applications

* How to fit use with time of surplus, e.g of PV for heating ?

Elements of electricity markets



5. THE CORE ROLE OF BALANCING GROUPS



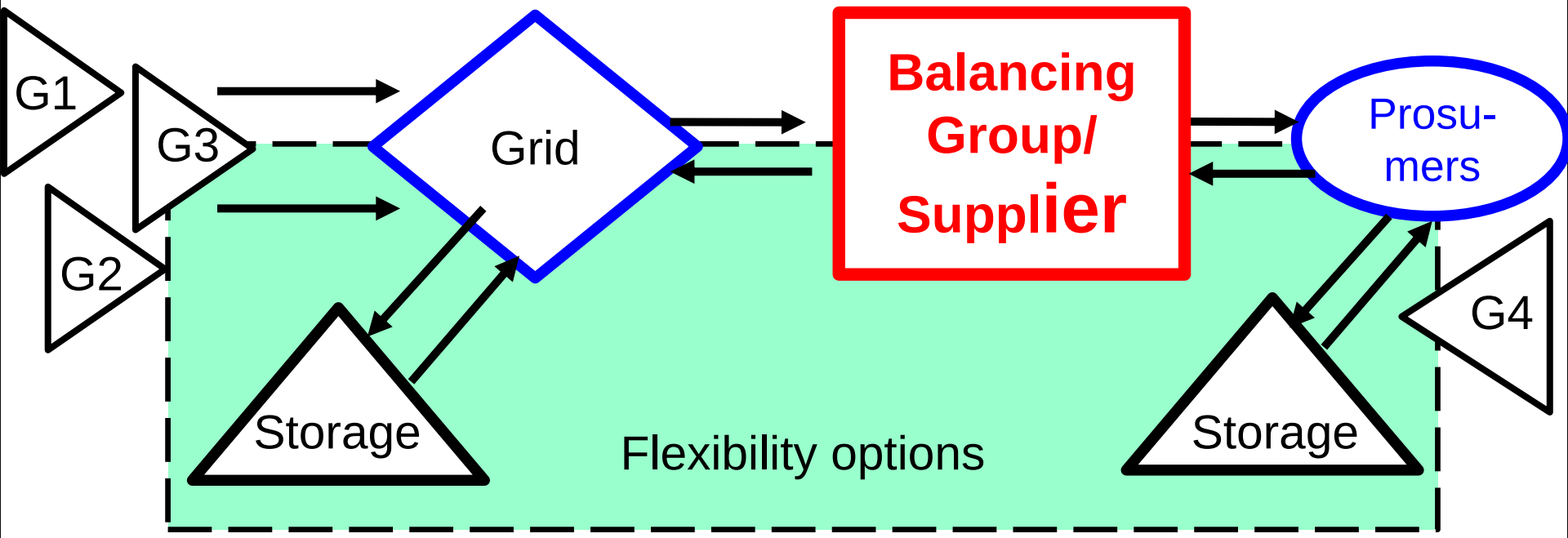
Balancing group: entity in a control area of an electricity system; it has to ensure that at every moment demand and supply is balanced

E.g. municipal utility of Vienna, Singapur, Shanghai

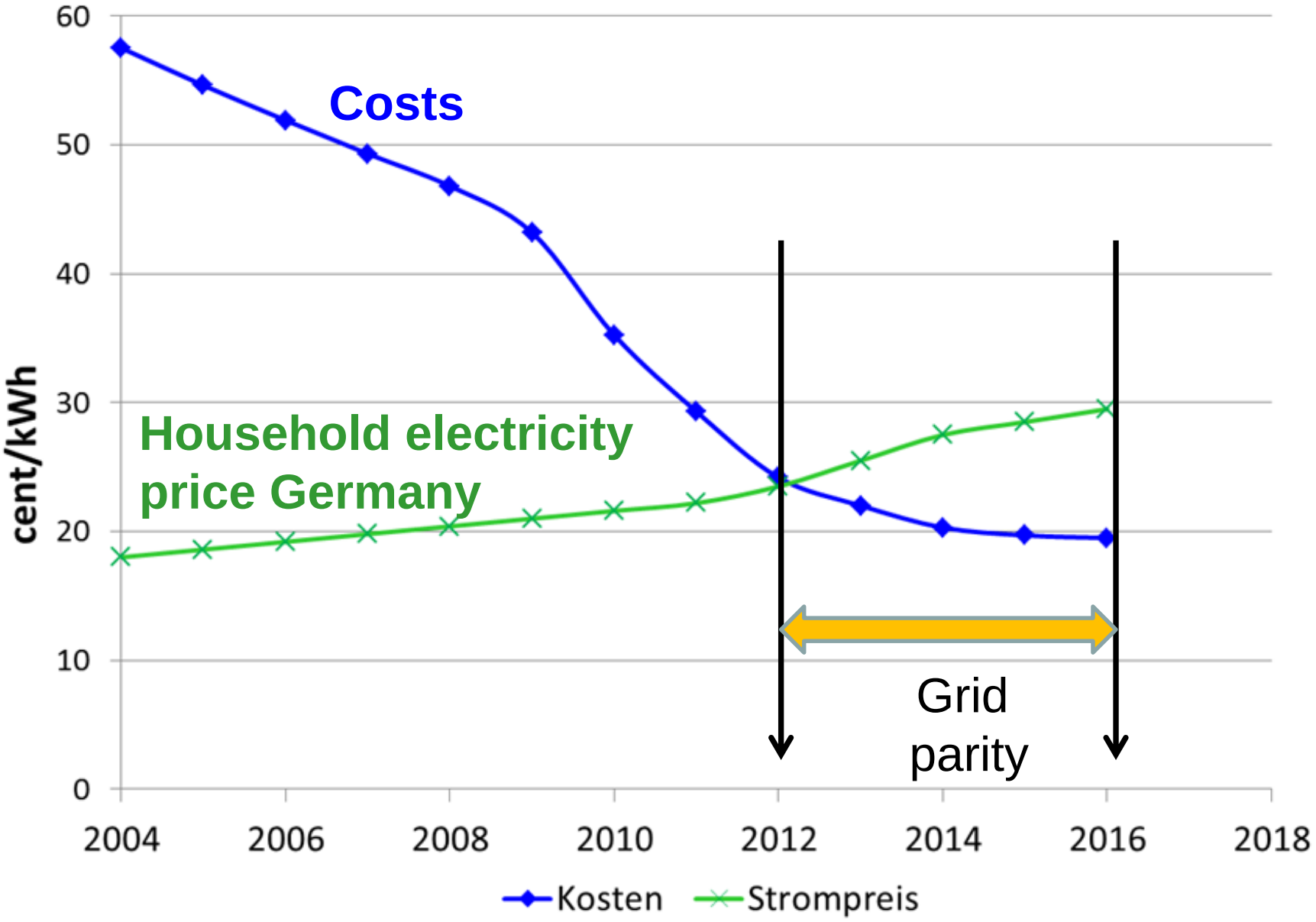
To meet this target: own generation , storage, flexibility, Trading in long-term, day-ahead and intraday market

Every difference → high costs!

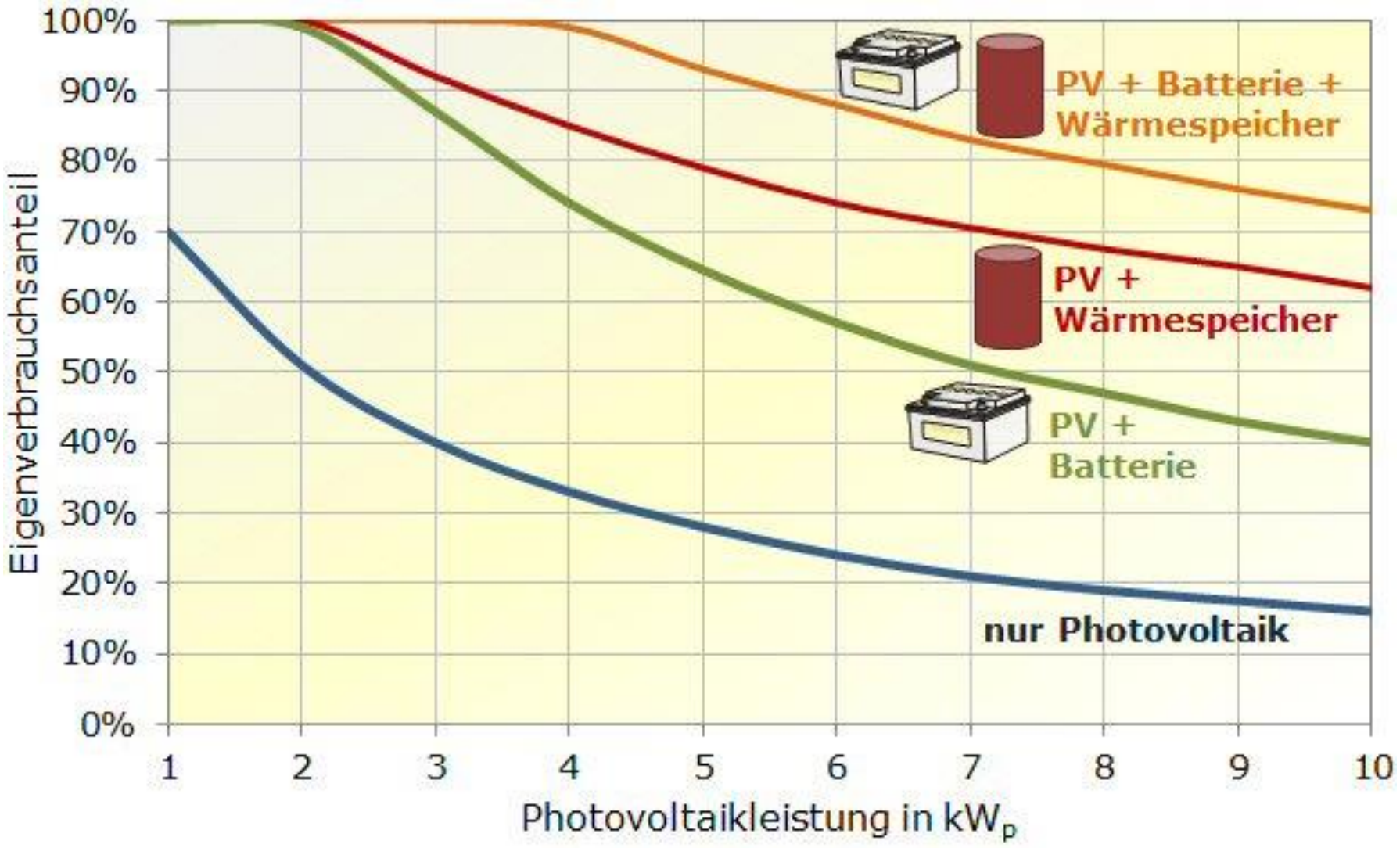
New Thinking: Making the electricity system more democratic



Grid parity: PV-costs and household electricity prices



Share of own consumption



6. CONCLUSIONS

- Sustainable electric. system → integrating many technologies & demand-side options!
- Larger market areas favourable
- Very important: correct price signals (incl. CO2)
- most urgent: exhaust full creativity of all market participants incl. decentralised PV systems
- The key: Flexibility (incl. dispatchable var RES)! Currently low economic incentives but activities started → very promising!
- 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