INTEGRATION OF LARGE SHARES OF RENEWABLES BY MAKING THE ELECTRICITY SYSTEM MORE DEMOCRATIC

Reinhard HAAS,

Energy Economics Group,

TU Wien

Salzburg, 28 August 2018

CONTENT:

1. Introduction: Motivation
2. Method of approach
3. How variable renewables impact prices
4. Capacity payments vs flexibility
5. How much storage do we need?
6. The role of flexibility and sector coupling
7. Balancing groups: A future market design
8. Subsidizing RES: How long?
9. Conclusions

1. INTRODUCTION

Motivation:

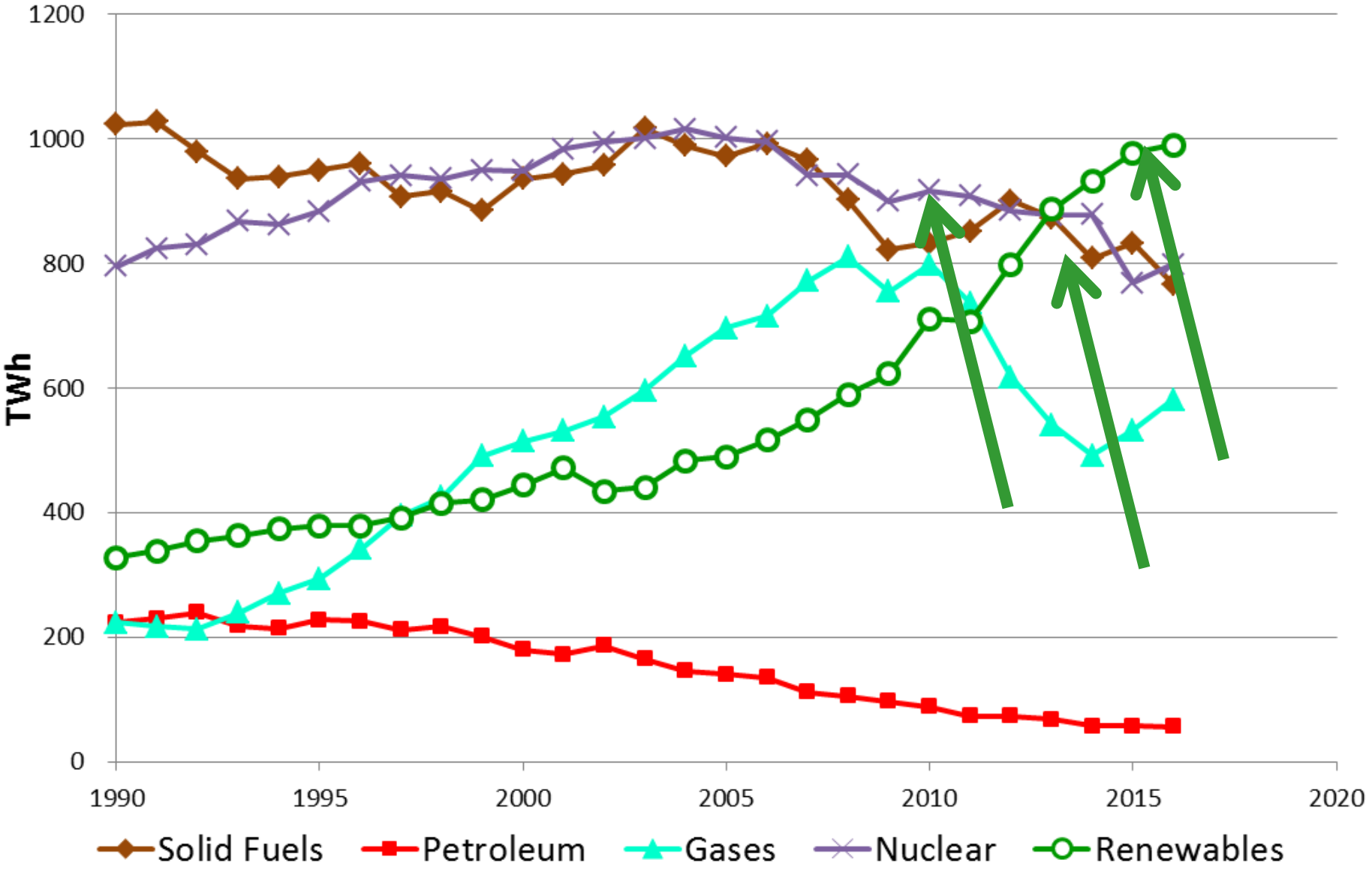
* Climate change → Paris agreements

* Targets for renewables

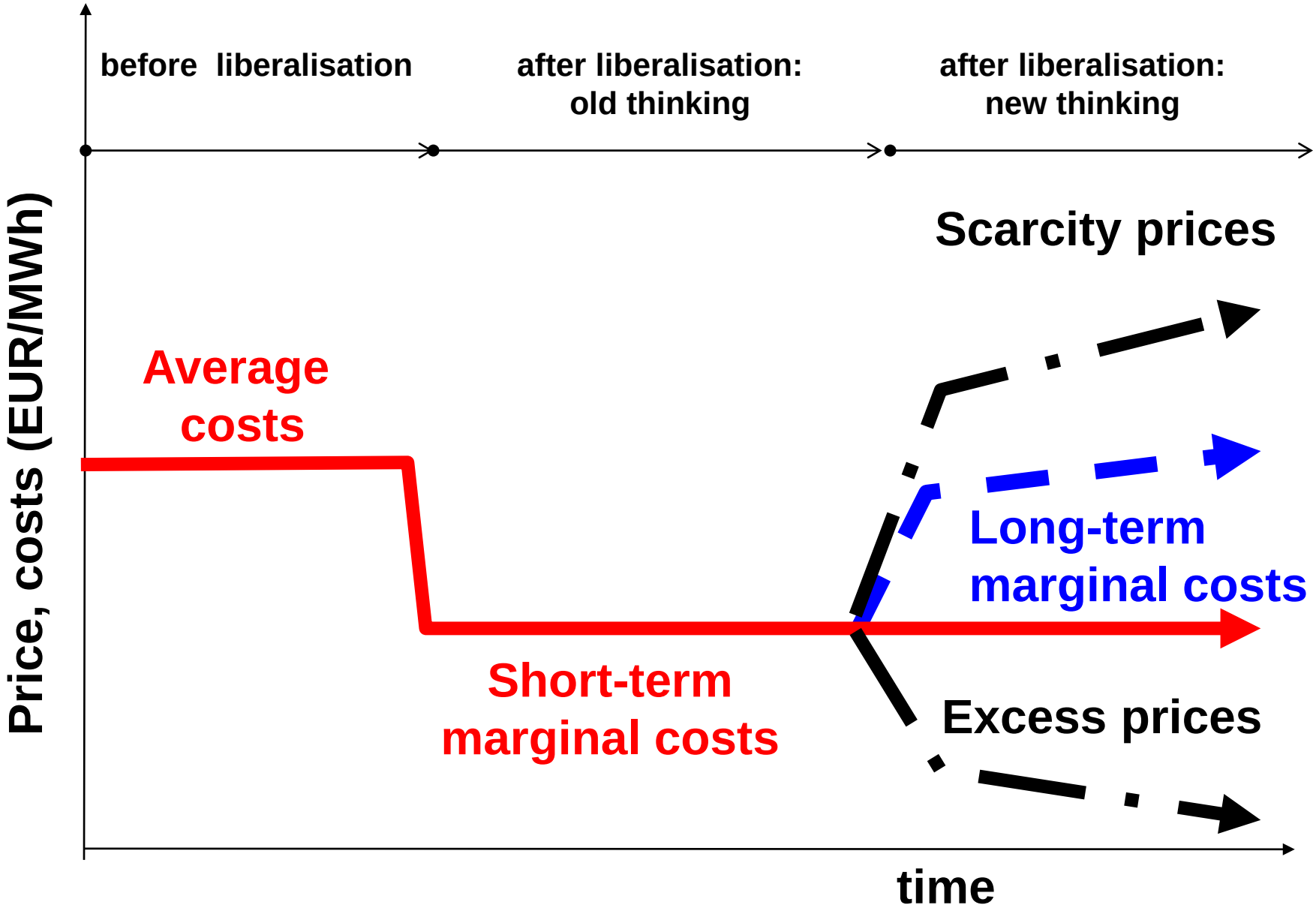
* The clean energy package

* It is not possible to force, to squeeze variable renewables into the system by violence, incentives are needed

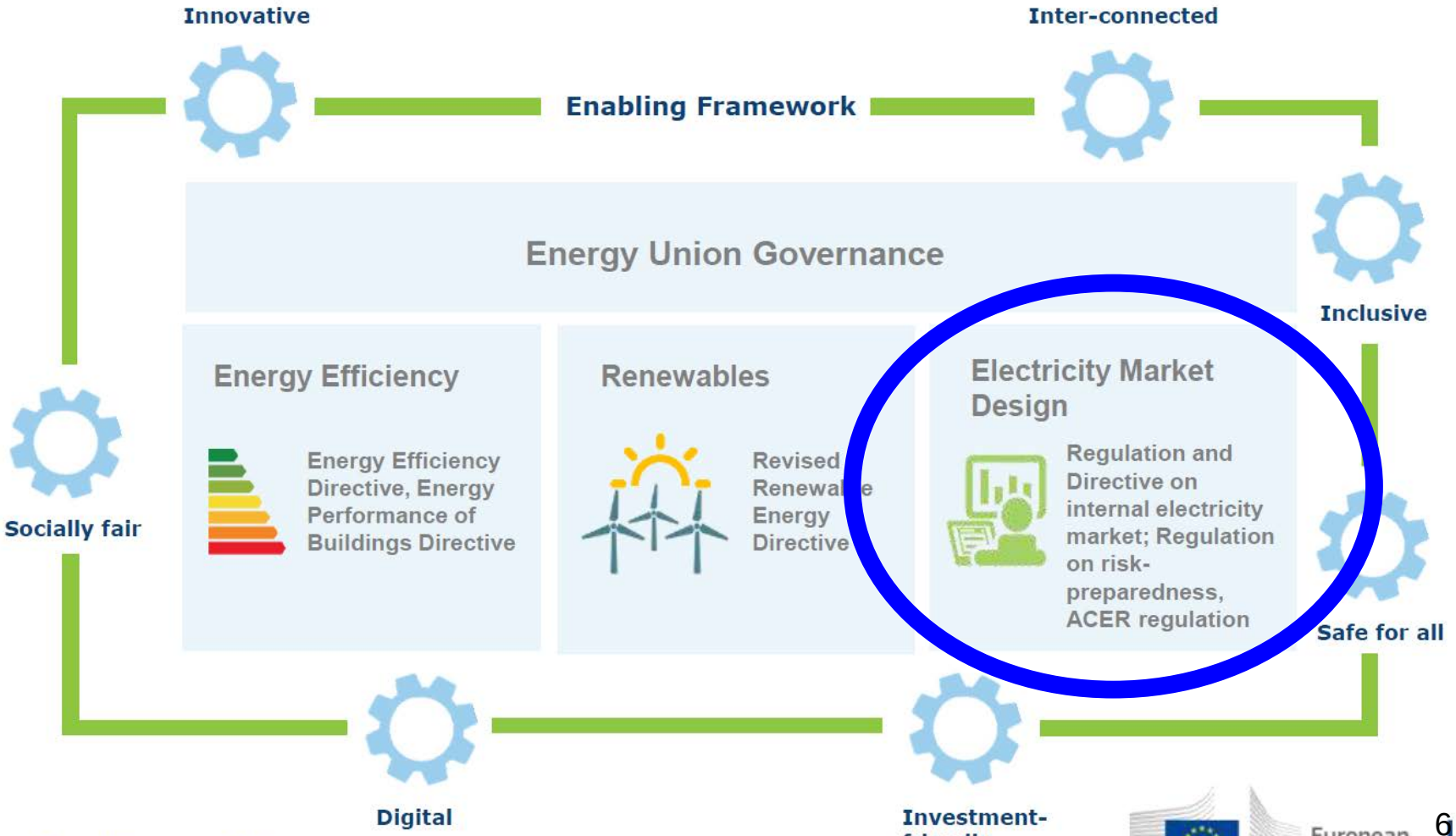
Introduction:
Electricity generation EU-28



How prices come about: Three periods of market design



Structure of the Package



European Commission

Core objective

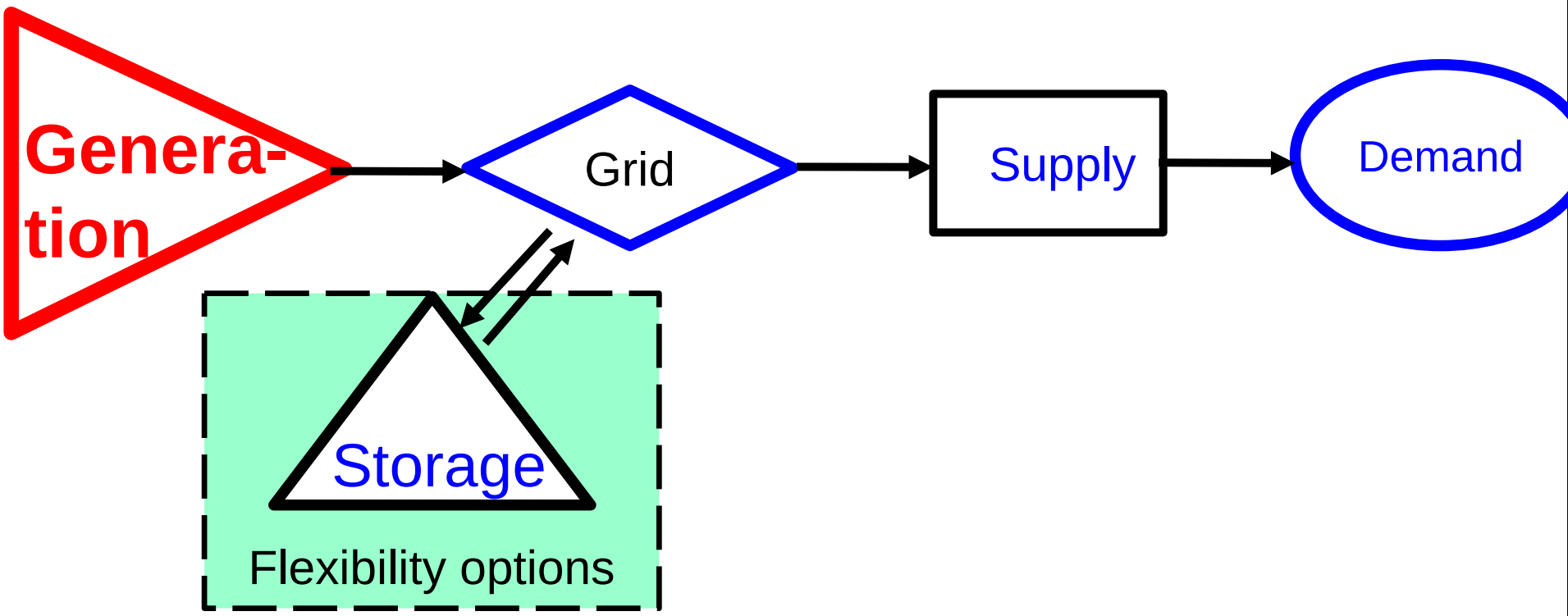
… to identify the major boundary conditions to integrate even larger amounts of variable renewables into the electricity system

Very important:

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

…. are based on electricity economic point-of-view → contrary to energy planning!

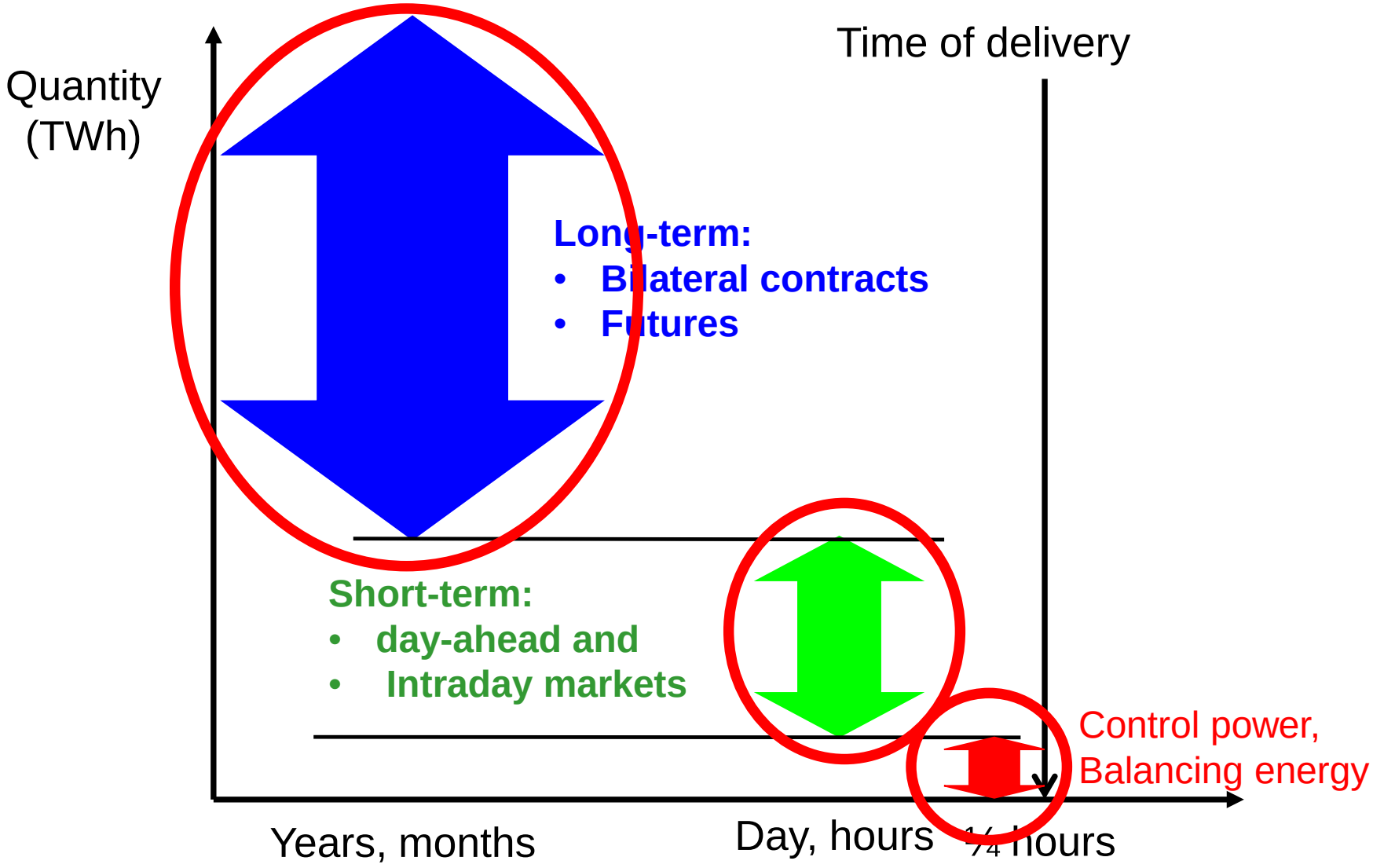
Old thinking



2. METHOD OF APPROACH

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

Elements of electricity markets



Focus on day-ahead electricity markets

In Europe: Expectation of

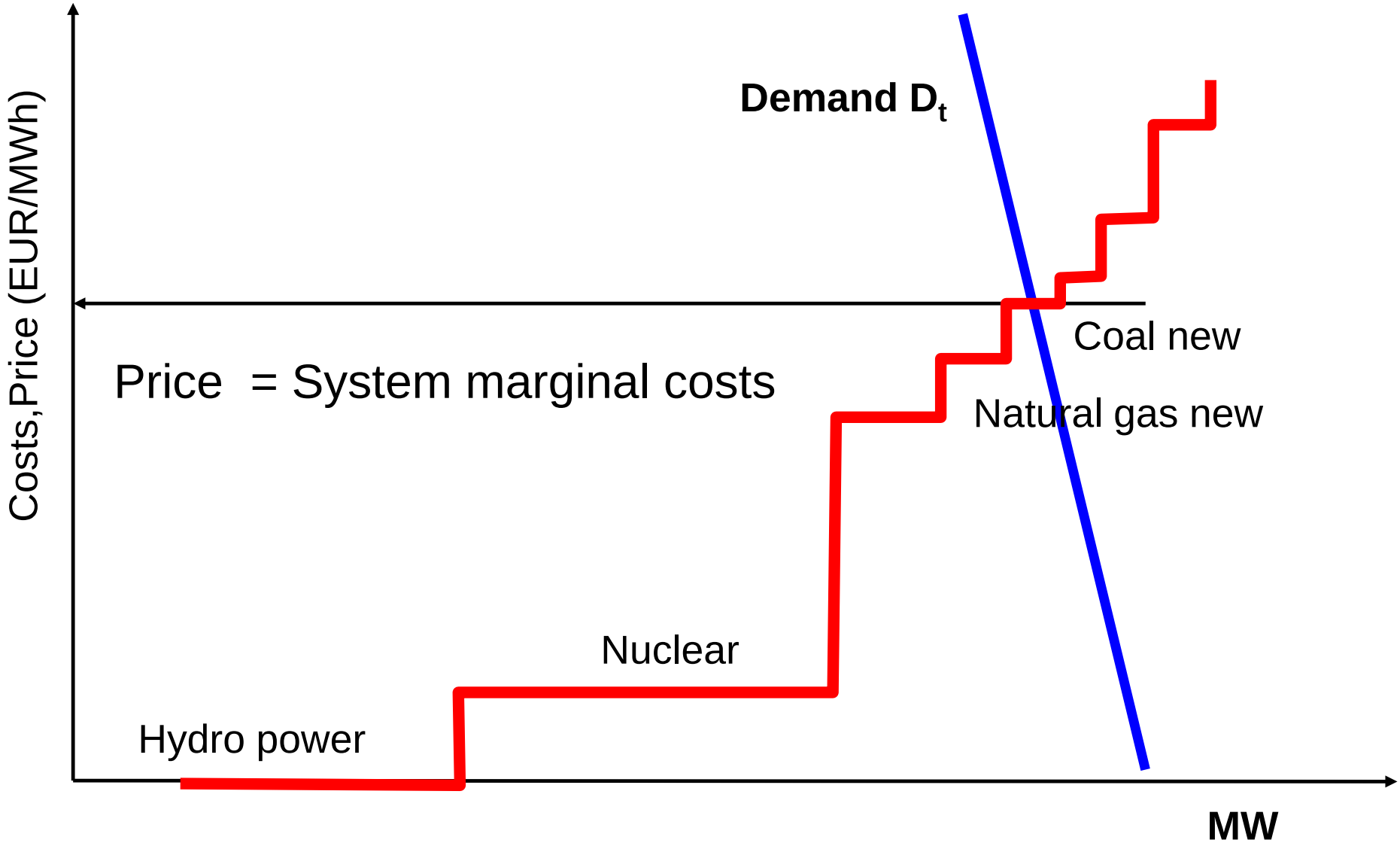
prices = Short-term marginal costs

(Short-term marginal costs = fuel costs)

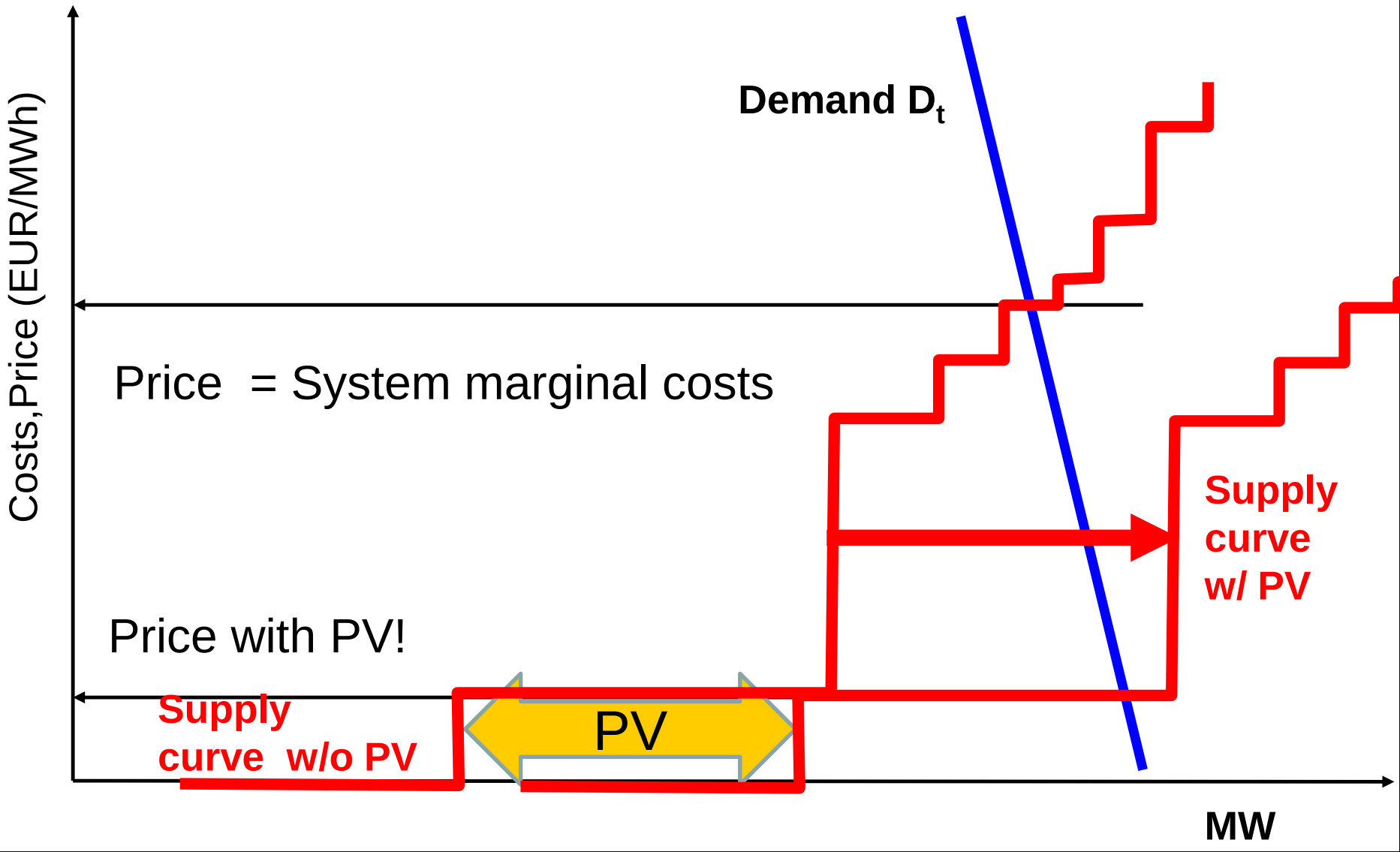
due to huge depreciated excess capacities at the beginning of liberalisation!

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

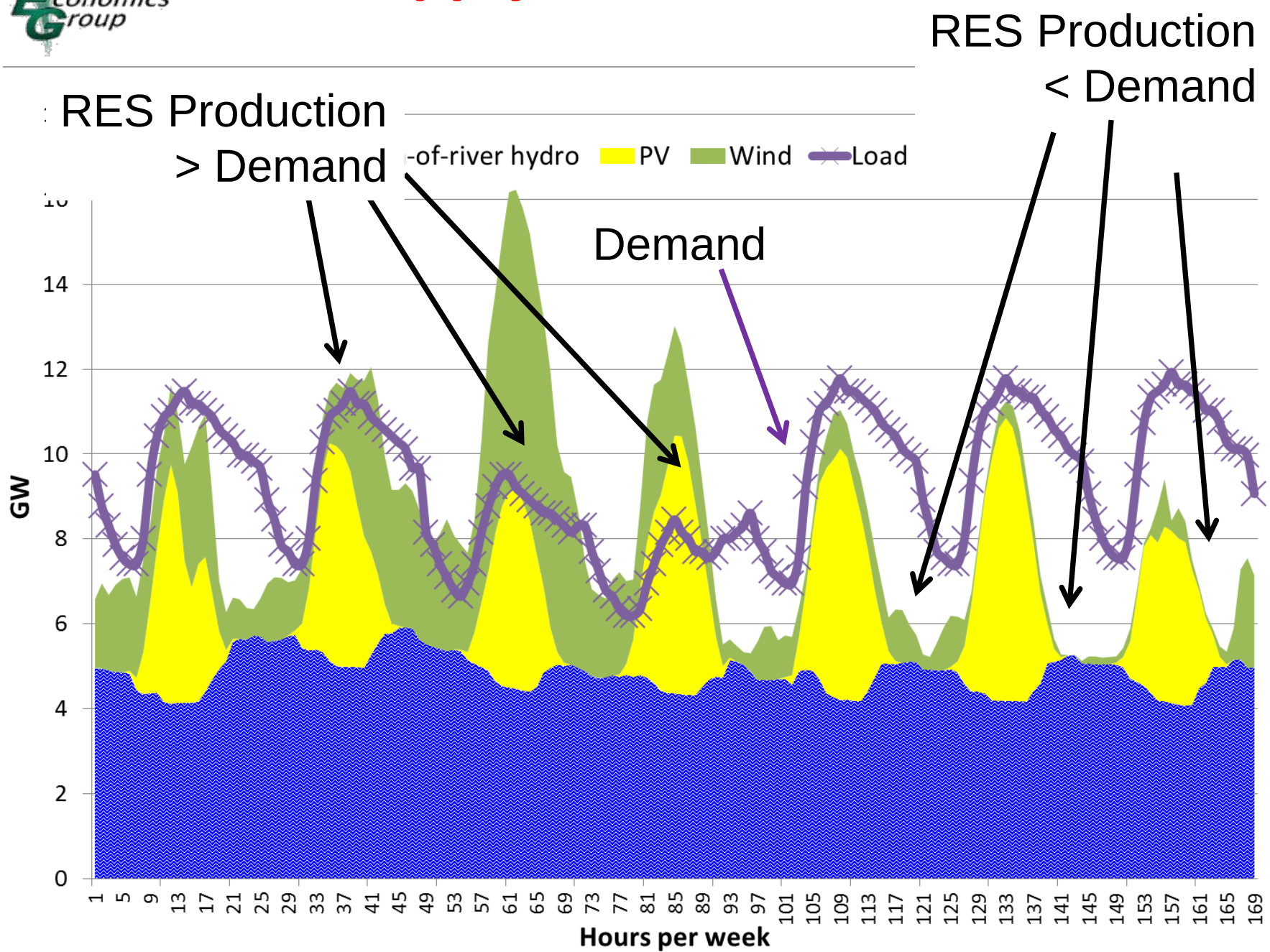
The merit order curve



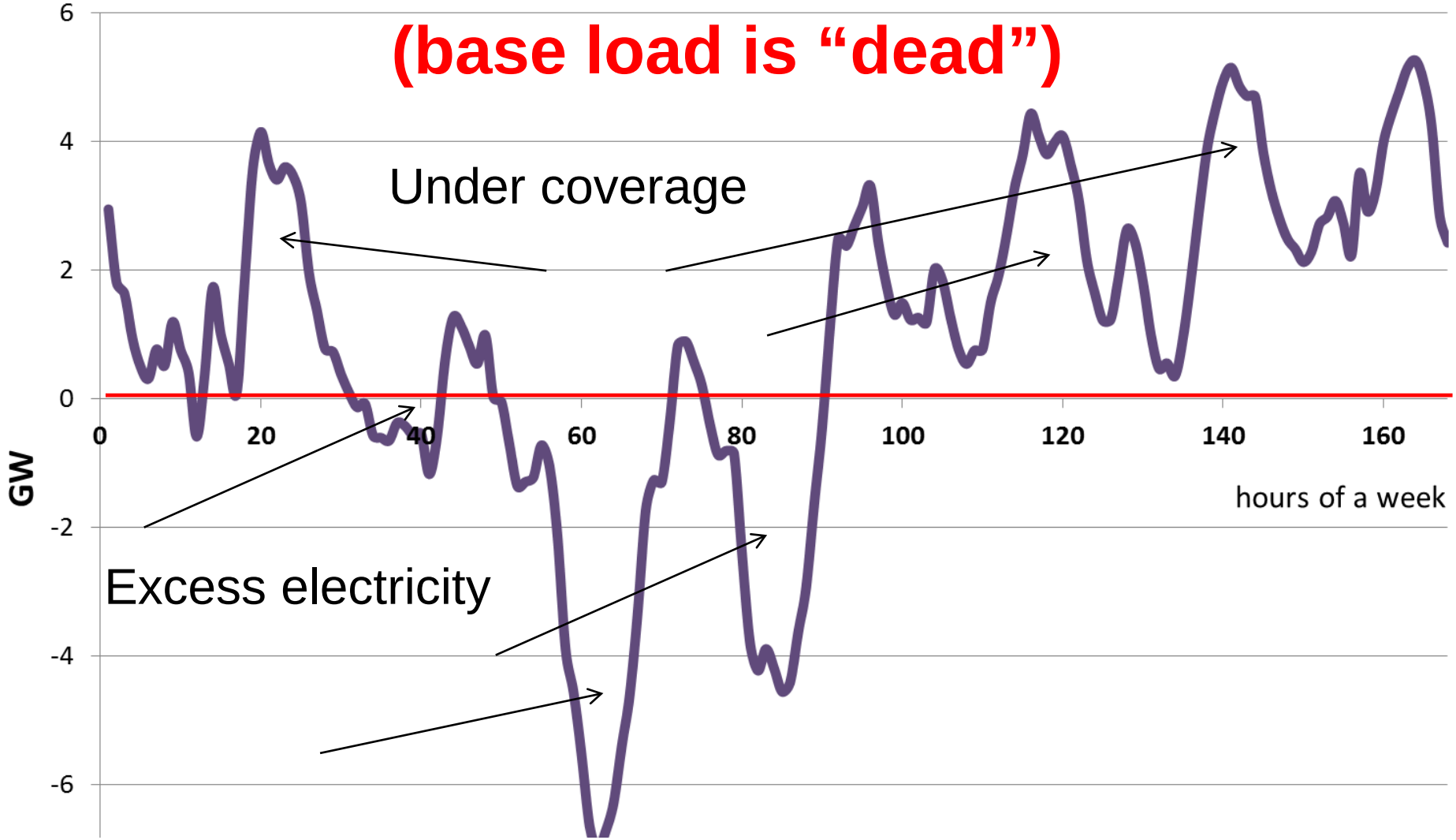
Example: prices without and with PV



Supply and Demand



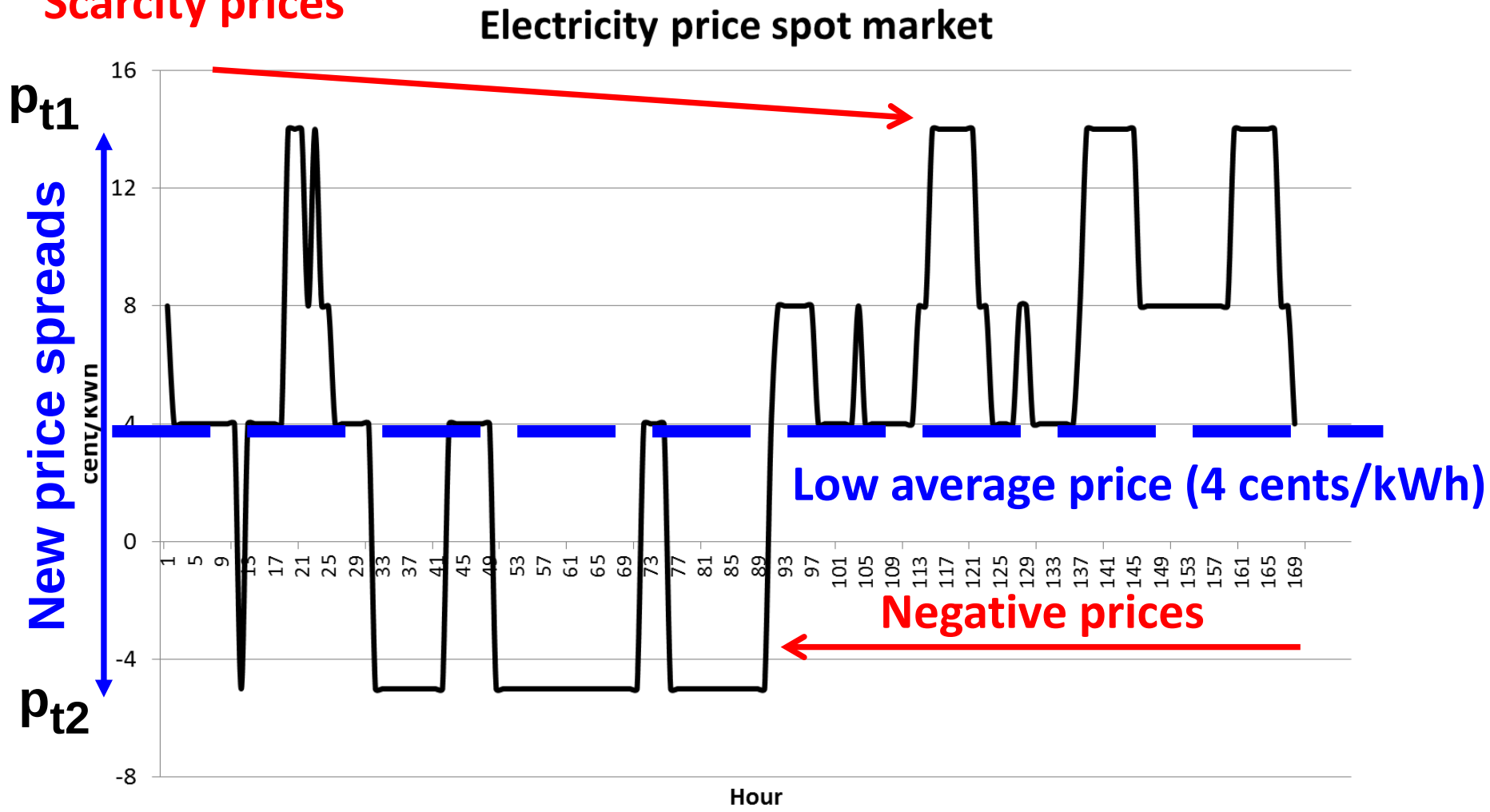
Key term of the future: Residual load (base load is “dead”)



Residual load = Load – non-flexible generation

Deviation from STMC-pricing in spot markets

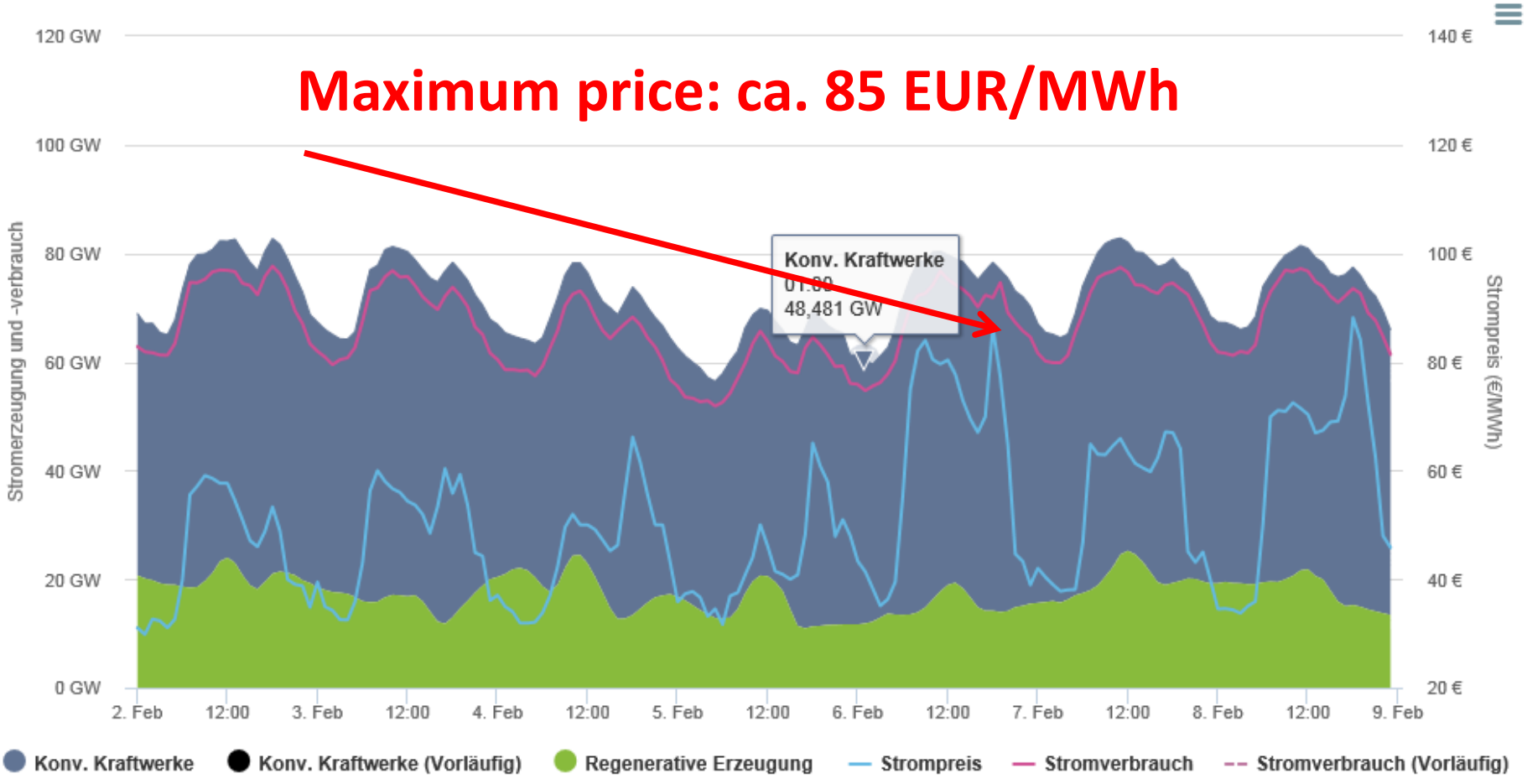
Scarcity prices



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

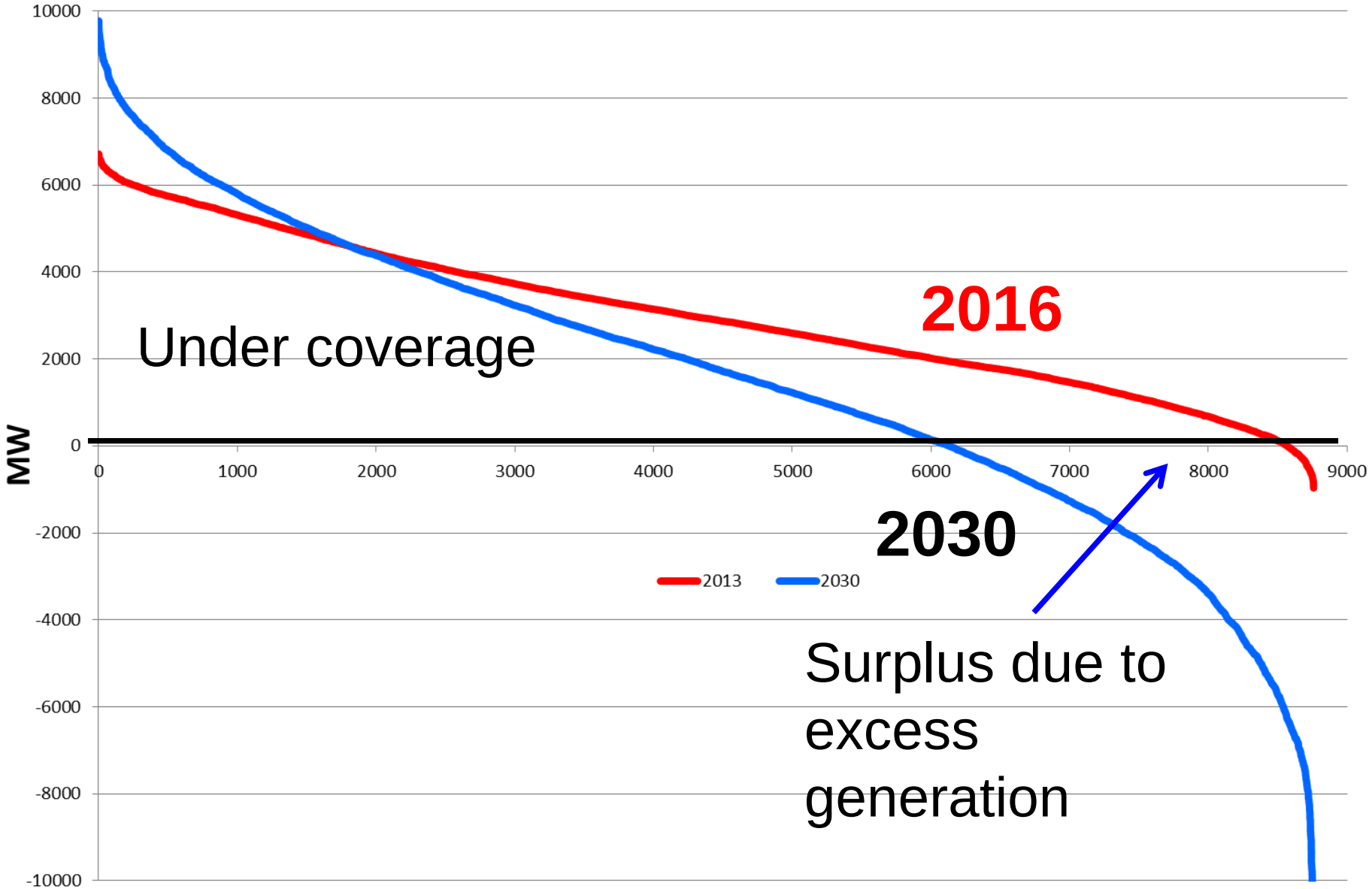
Remark: Cold - dark – Lull („Kalte Dunkelflaute“)

Maximum price: ca. 85 EUR/MWh

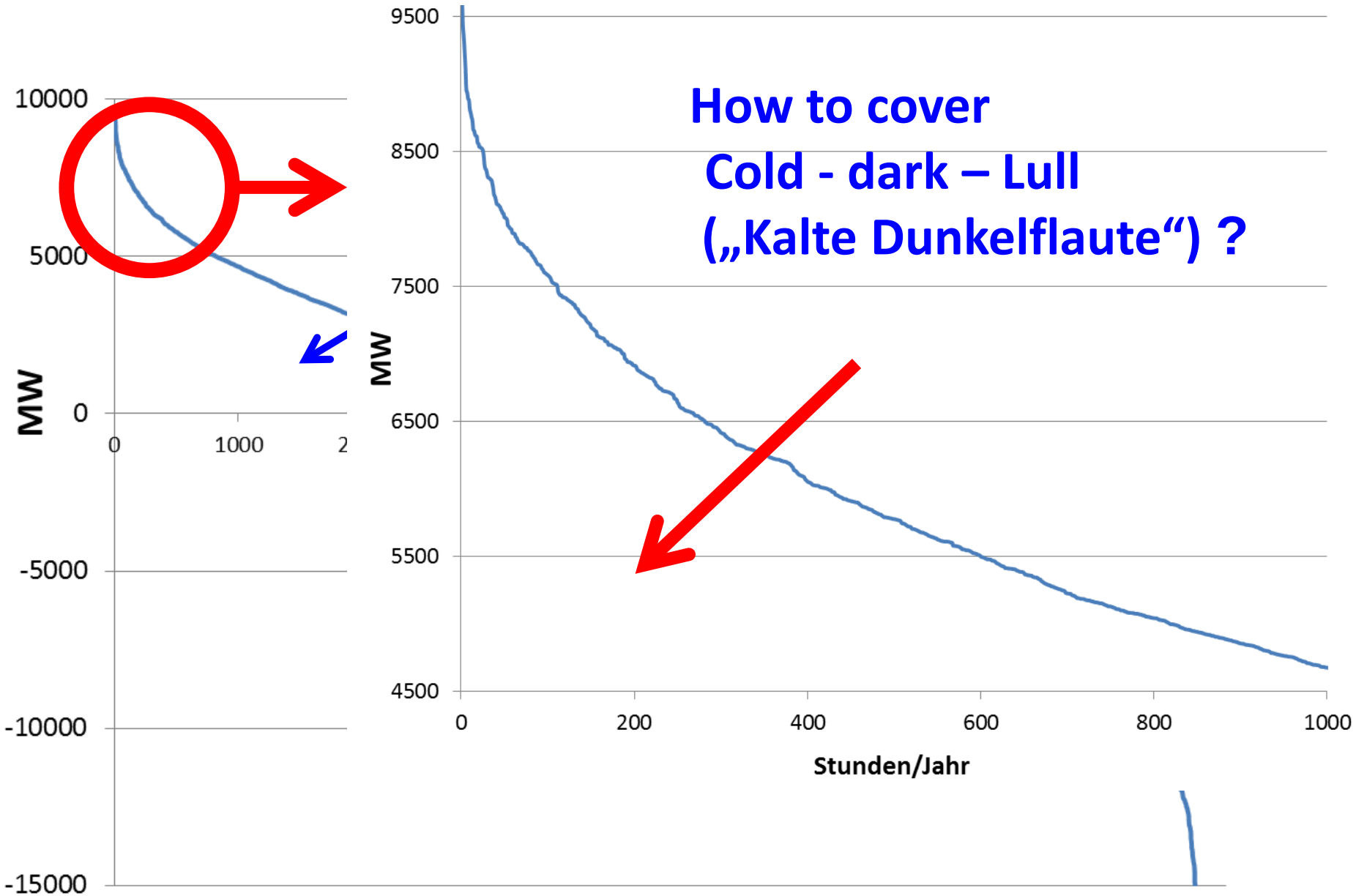


Agora Energiewende; Stand: 16.04.2017, 15:30

Classified residual load over a year



Classified residual load



4 CAPCITY PAYMENTS FLEXIBLE COVERAGE OF 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?

The core problems of regulated capacity payments

All regulatory capacity payments for power plants destort 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

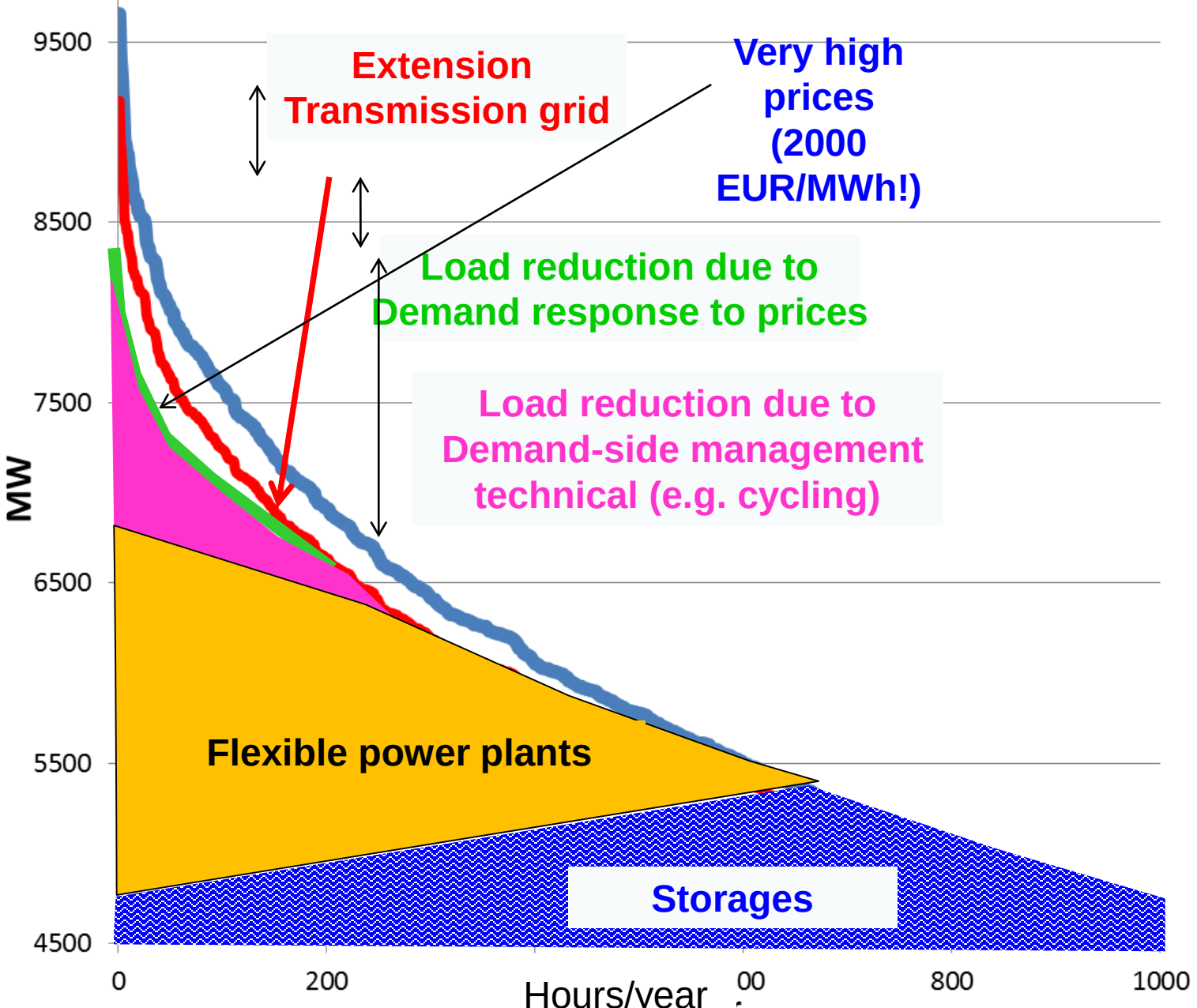
… strive to retain system resource adequacy by correct price signals without capacity payments

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!

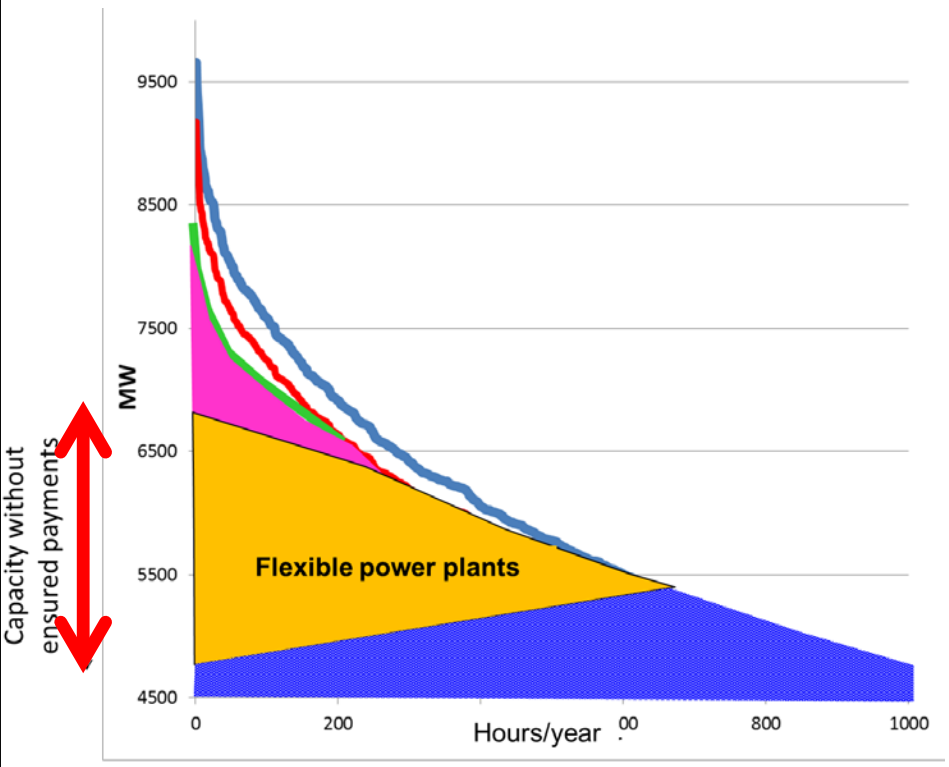
→

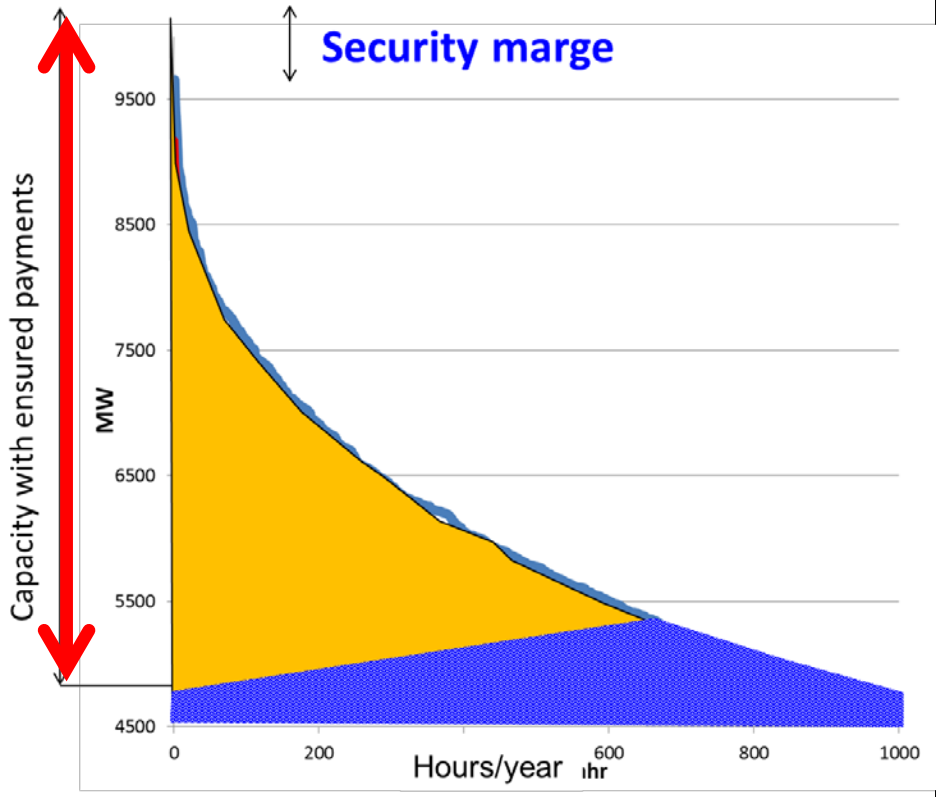
REVISED ENERGY-ONLY MARKET

Flexible coverage of residual load



Comparison

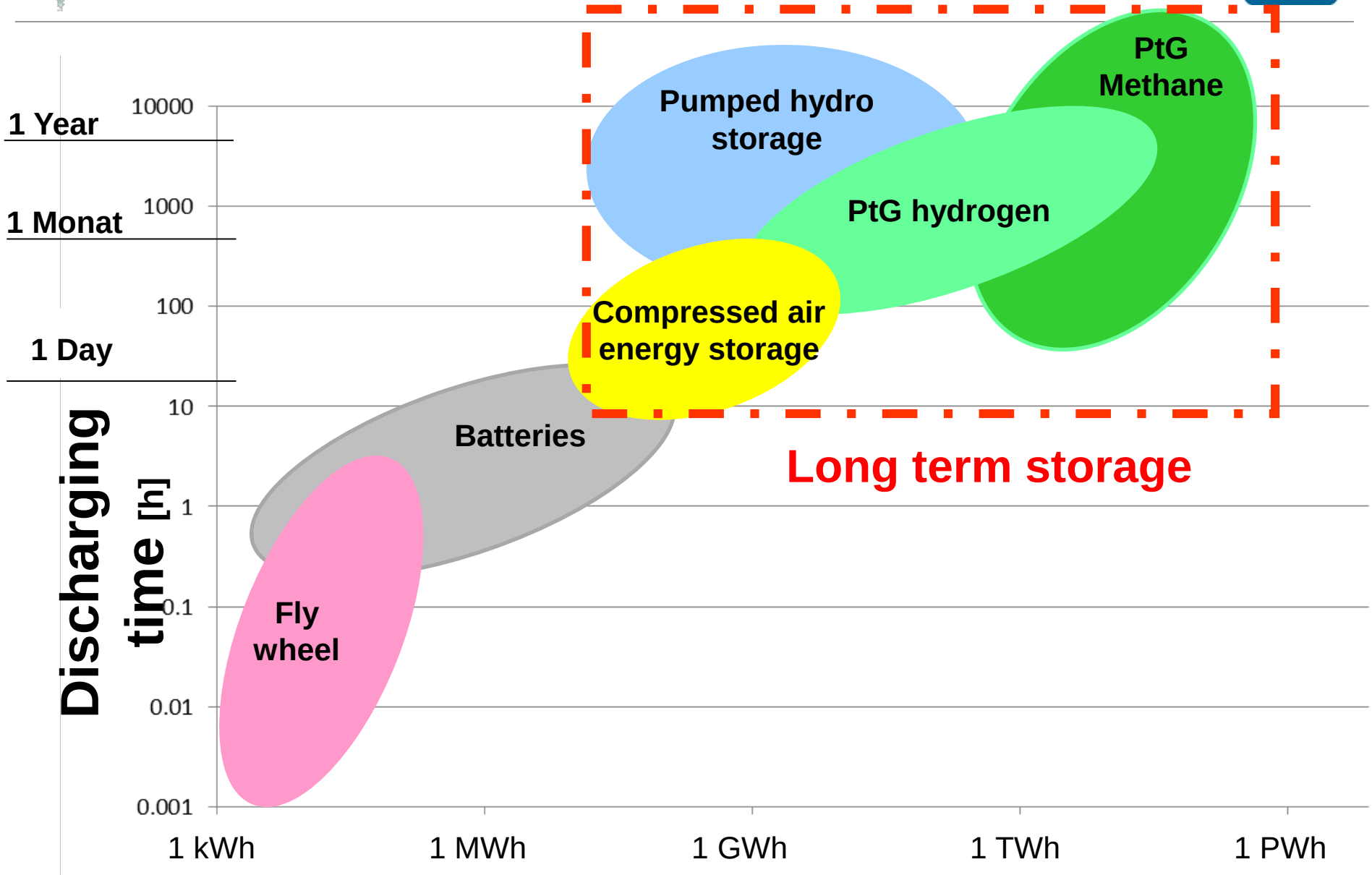

Capacity without ensured payments
MW
9500
8500
7500
6500
5500
4500
Flexible power plants
0
200
Hours/year
800
1000


Security marge
Capacity with ensured payments
MW
9500
8500
7500
6500
5500
4500
0
200
600
800
1000
Hours/year

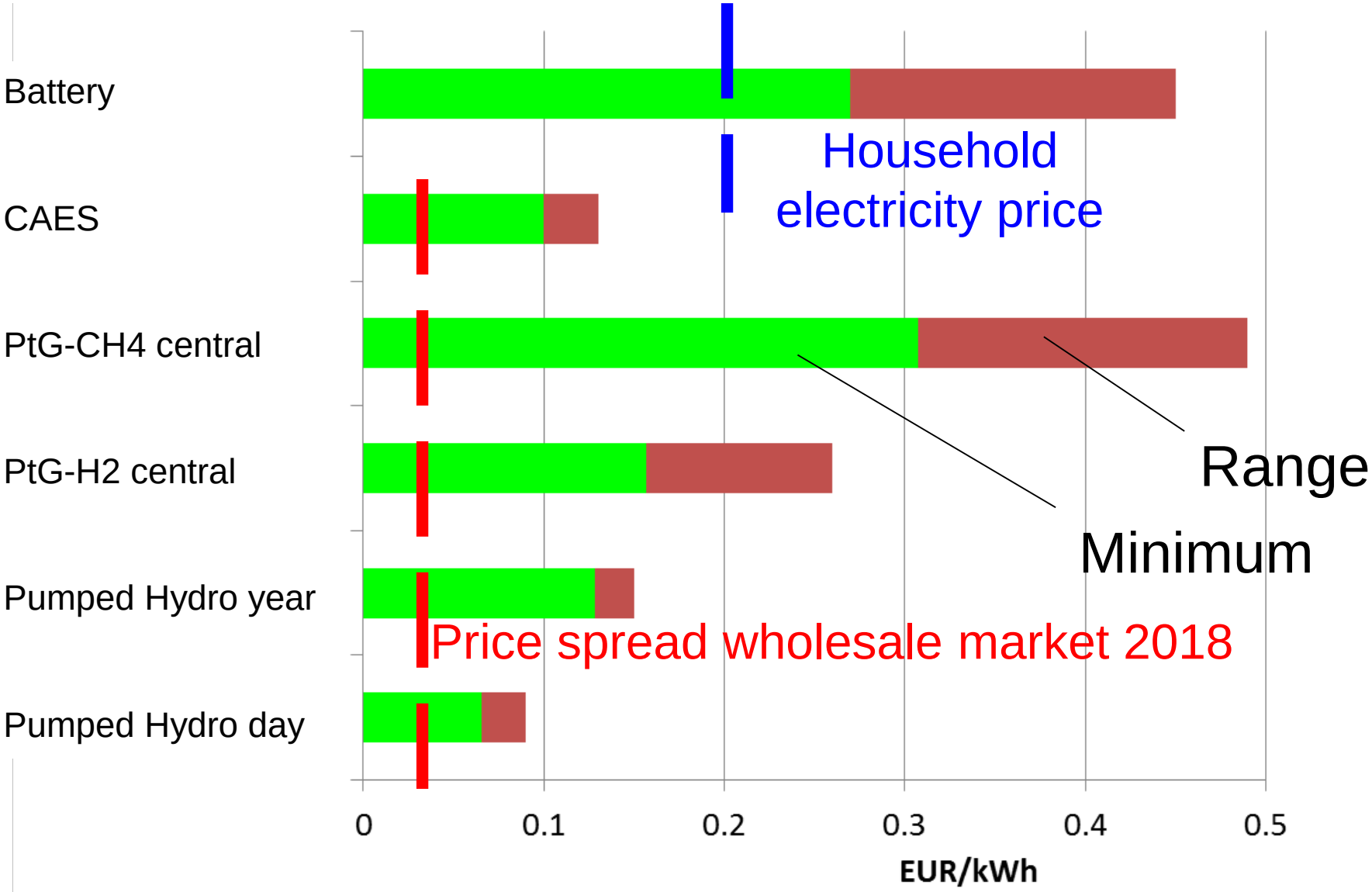
5 Storing every peak?

Specific question: How much storage do we need?

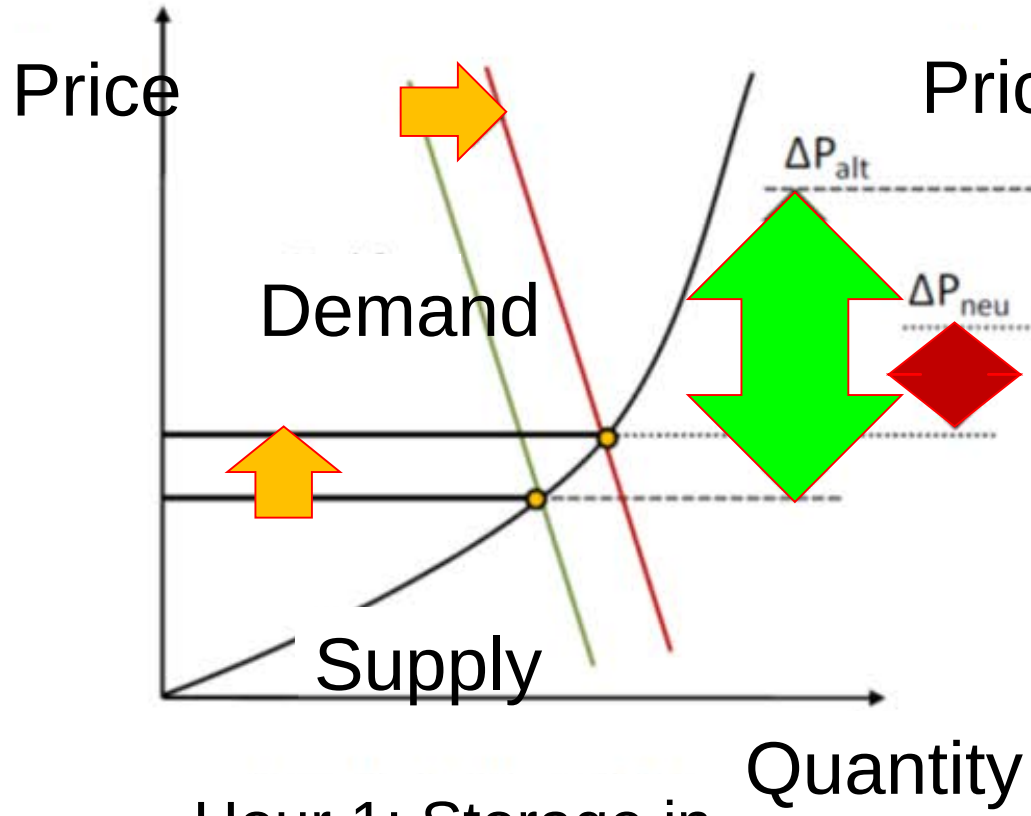
Short term vs Long term storage



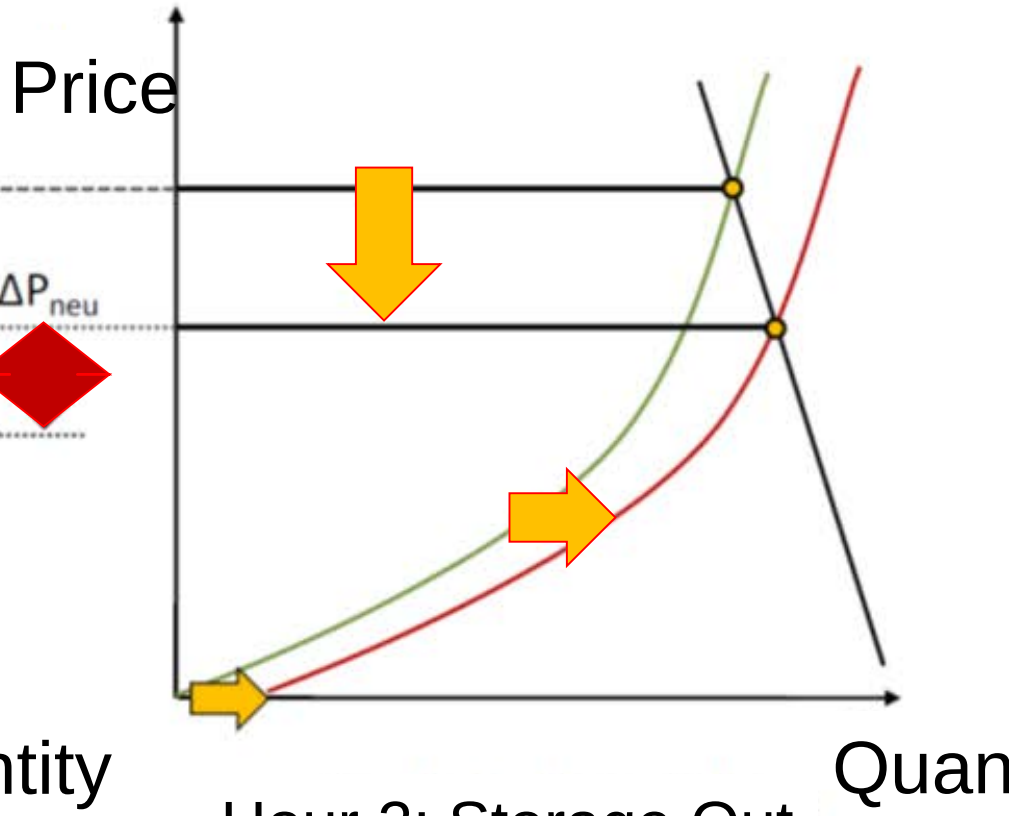
Cost of storing electricity



How storage impacts electricity market prices



Hour 1: Storage in



Hour 2: Storage Out

PRINCIPLE OF SELF CANNIBALISM IN ENERGY ECONOMICS:

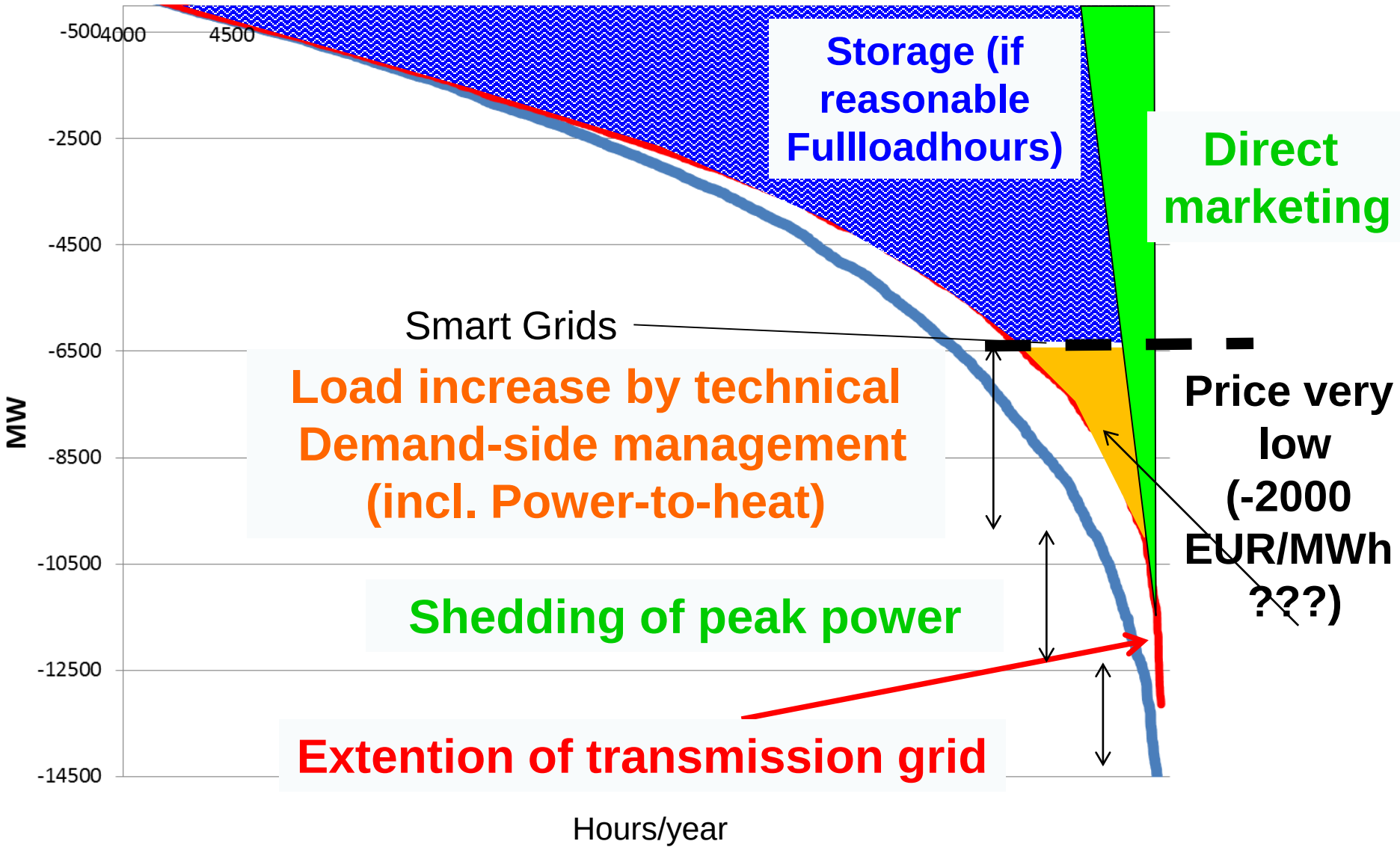
Example storage:
Every additional storage unit makes this one and every other less cost-effective!

MAJOR PROBLEMS OF ALL STORAGE:

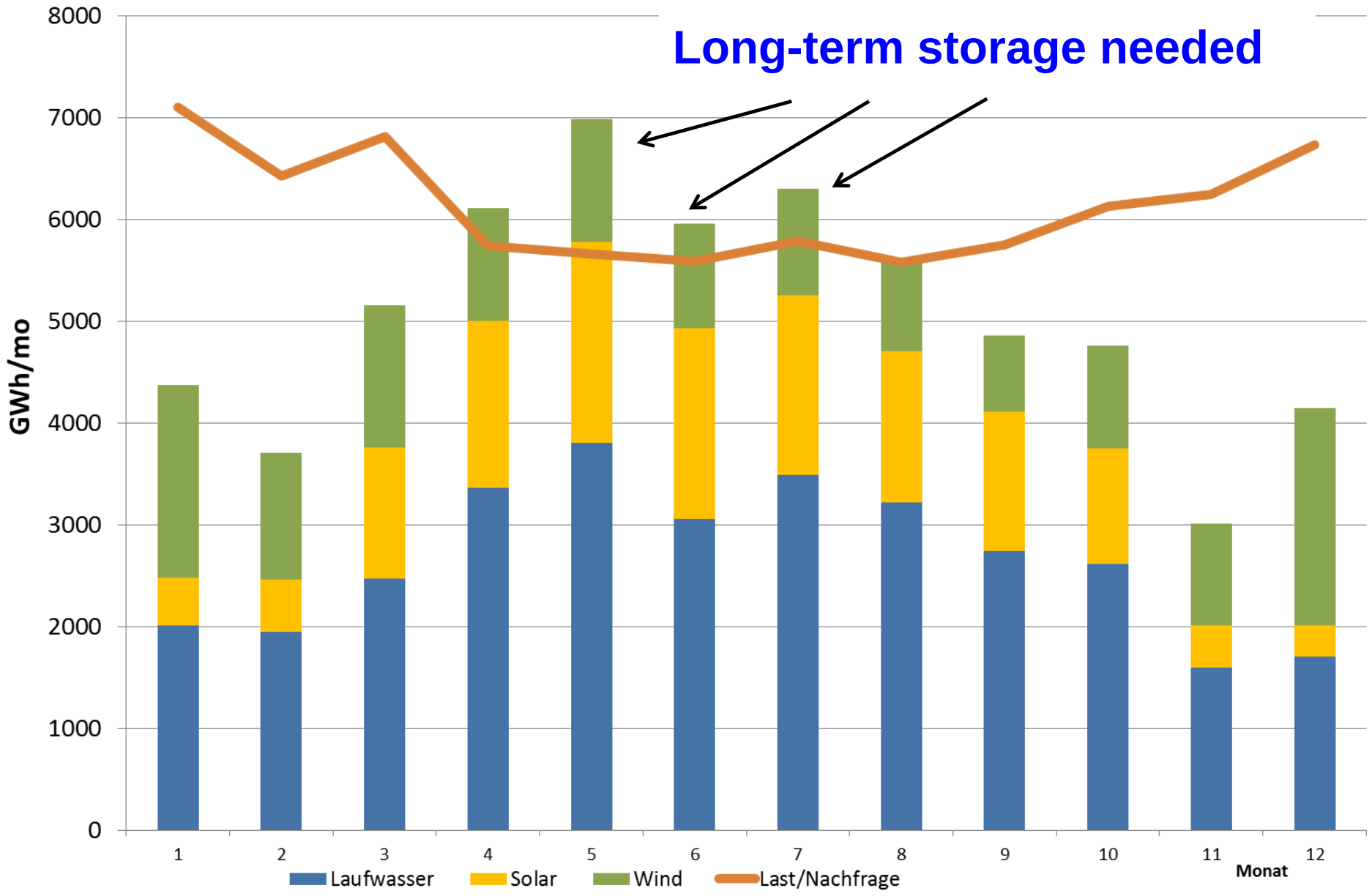
- If it is needed most urgently it is empty;
- Storage does not generate electricity
- Every additional storage unit makes this one and every other less cost-effective!

- Economic problem of all storage options: low full-load hours

6. FLEXIBLE USE OF EXCESS ELECTRICITY & SECTOR COUPLING



Demand for long-term storage



Sector coupling / Sector integration

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

Heating/Cooling

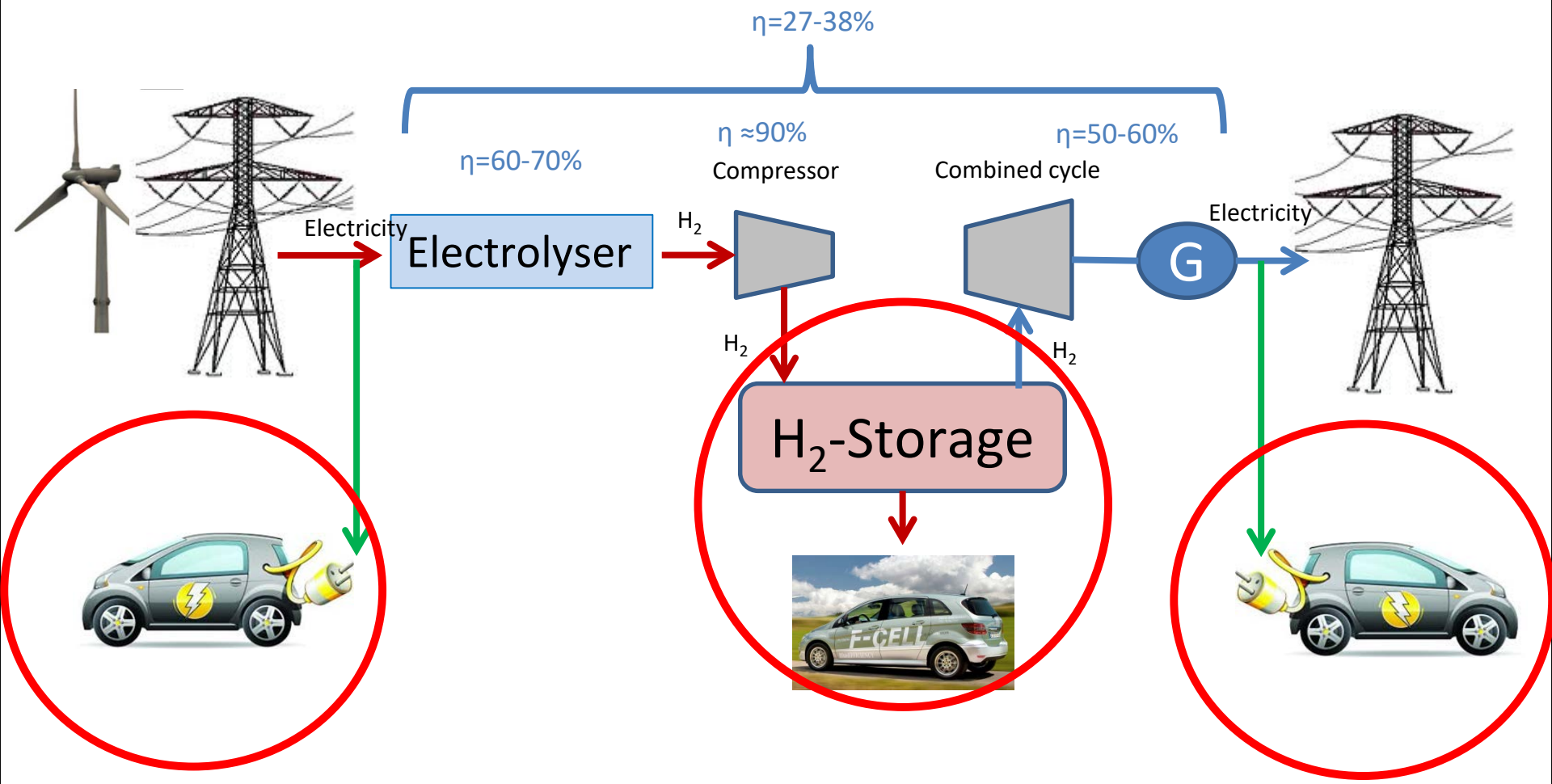
Transport

* 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

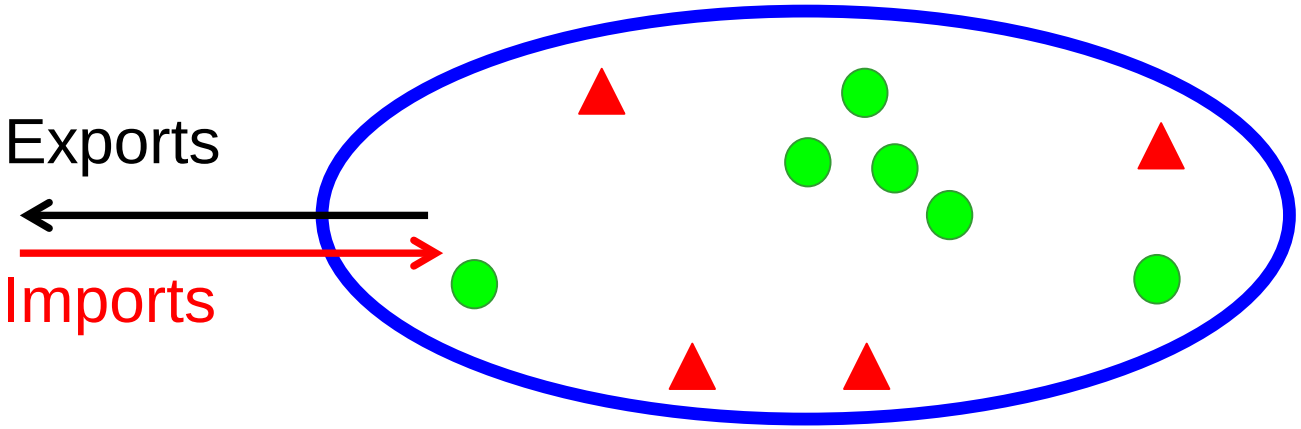
* How to fit use with time of surplus, e.g of PV for heating ?

Sector coupling hydrogen: Storage and fuel in transport?



7. THE CORE ROLE AND RESPONSIBILITY OF BALANCING GROUPS

Balancing groups



Generators

Consumers

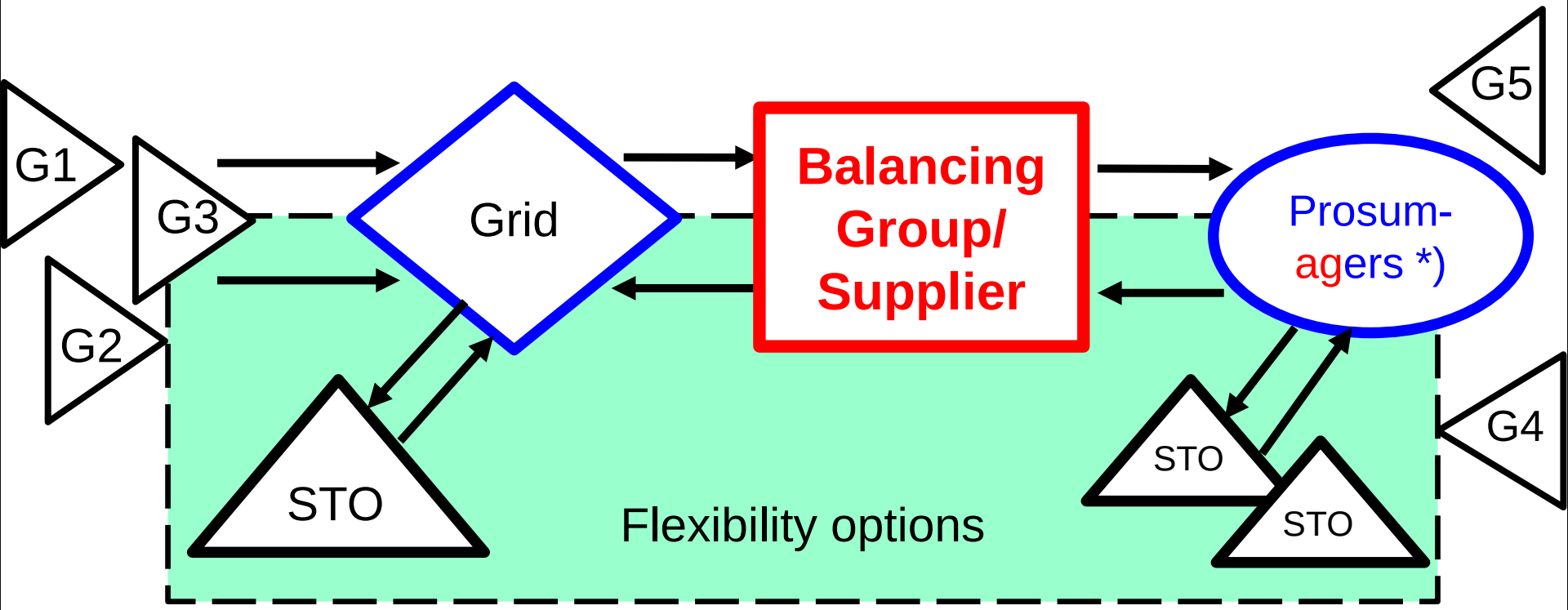
Balancing group: entity in a control area of an electricity system; it has to ensure that at every moment demand and supply is balanced

E.g. municipal utility of Salzburg, Ljubljana, Munich,

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

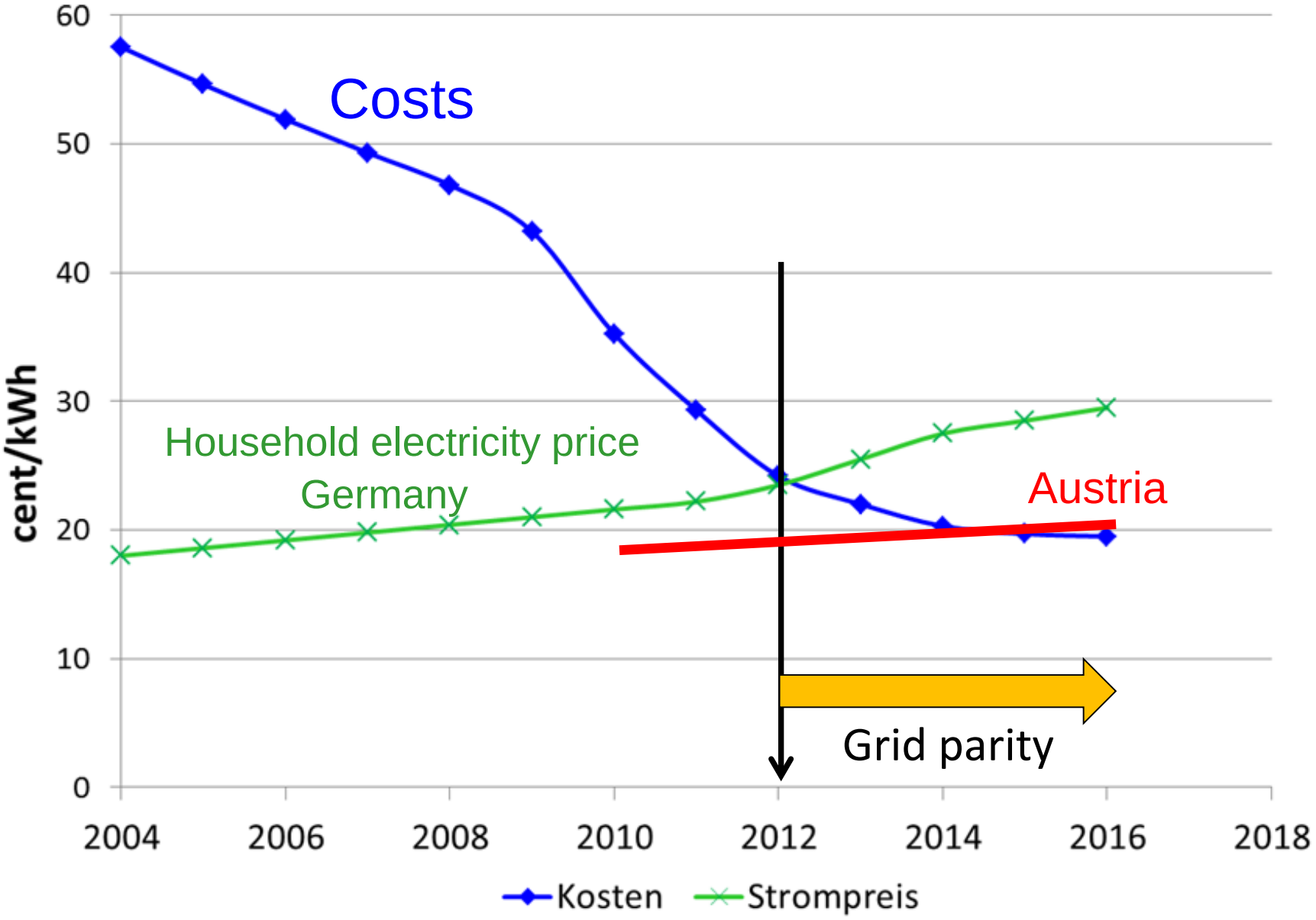


*) R. Green

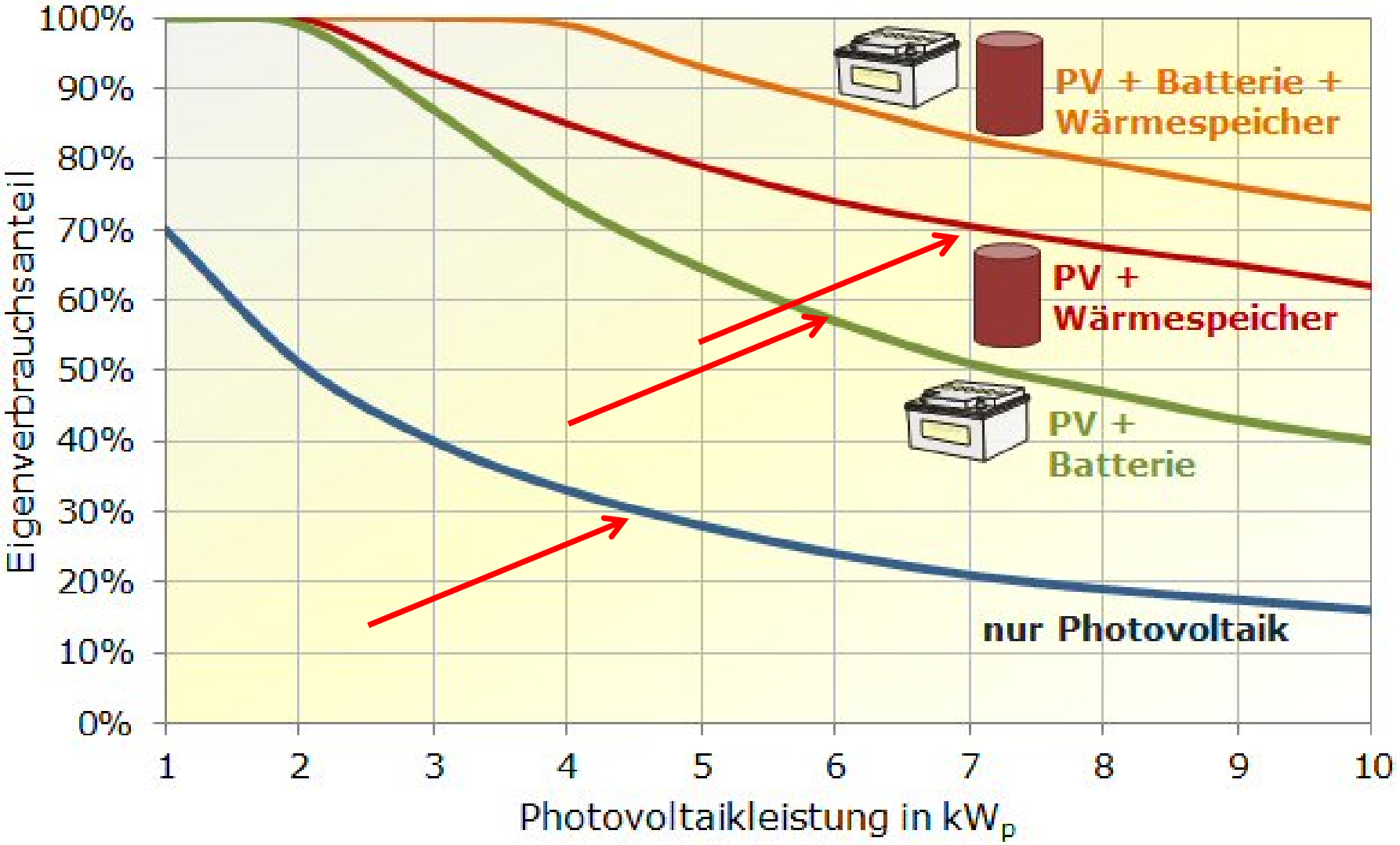
8. IS THE TIME FOR SUBSIDIZING RENEWABLES OVER ?

As long there is no price on CO2 …..

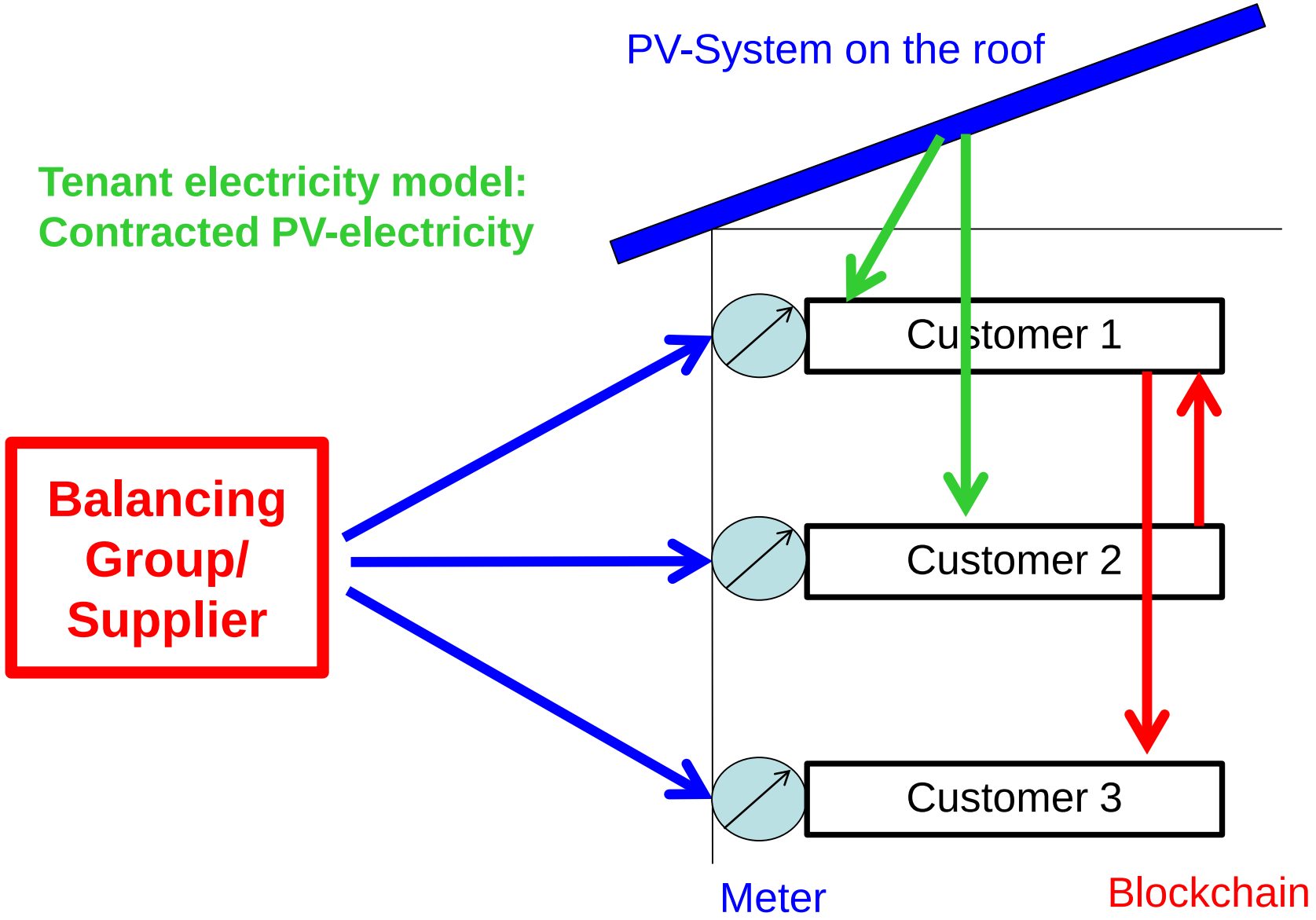
Grid parity: PV-costs and household electricity prices



Share of own consumption



Tenant electricity model and Blockchain



9. CONCLUSIONS

- 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
- Capacity payments: Any CP will distort the system towards more conv. and less RES capacity
- Increasing electricity generation from variable RES → need for new long-term storage options