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Publikationsdatenbank | ICEE2019

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ICEE 2019

16|17 May 2019

4th International Conference on Energy and Environment: bringing together Engineering and Economics

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Program - Full version available

We would like to invite you to come to the **4th International Conference on Energy & Environment: bringing together Engineering and Economics**, in Guimarães, Portugal.

The Conference will take place at the School of Engineering, University of Minho, in Guimarães on the **16 and 17 of May 2019**.

Associated Journals

Selected papers are planned to be published in scientific journals.

more

Registration

Information about registration is availabe.

Welcome | Bem Vindos!

Paula Ferreira

Chair of the 4th ICEE

It is a great pleasure to welcome you to the 4th International Conference on Energy & Environment: bringing together Engineering and Economics, ICEE, in Guimarães, Portugal, May 16 - 17, 2019.

The conference is organized by the School of Engineering, University of Minho and the School of Economics and Management, University of Porto.

ICEE brings together leading academic scientists, researchers and scholars from the energy and environment science community to

ma.pt) Programme - Full version available | Weather report: Expected Temperatures for May 16 and 17, max 20C-min 7C (info:www.ipma.pt) Programme - Full version a

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MARKET DESIGN FOR A SUSTAINABLE AND DEMOCRATIC ELECTRICITY SYSTEM

Reinhard HAAS,

Energy Economics Group,

TU Wien

Guimaraes, May 2019

CONTENT:

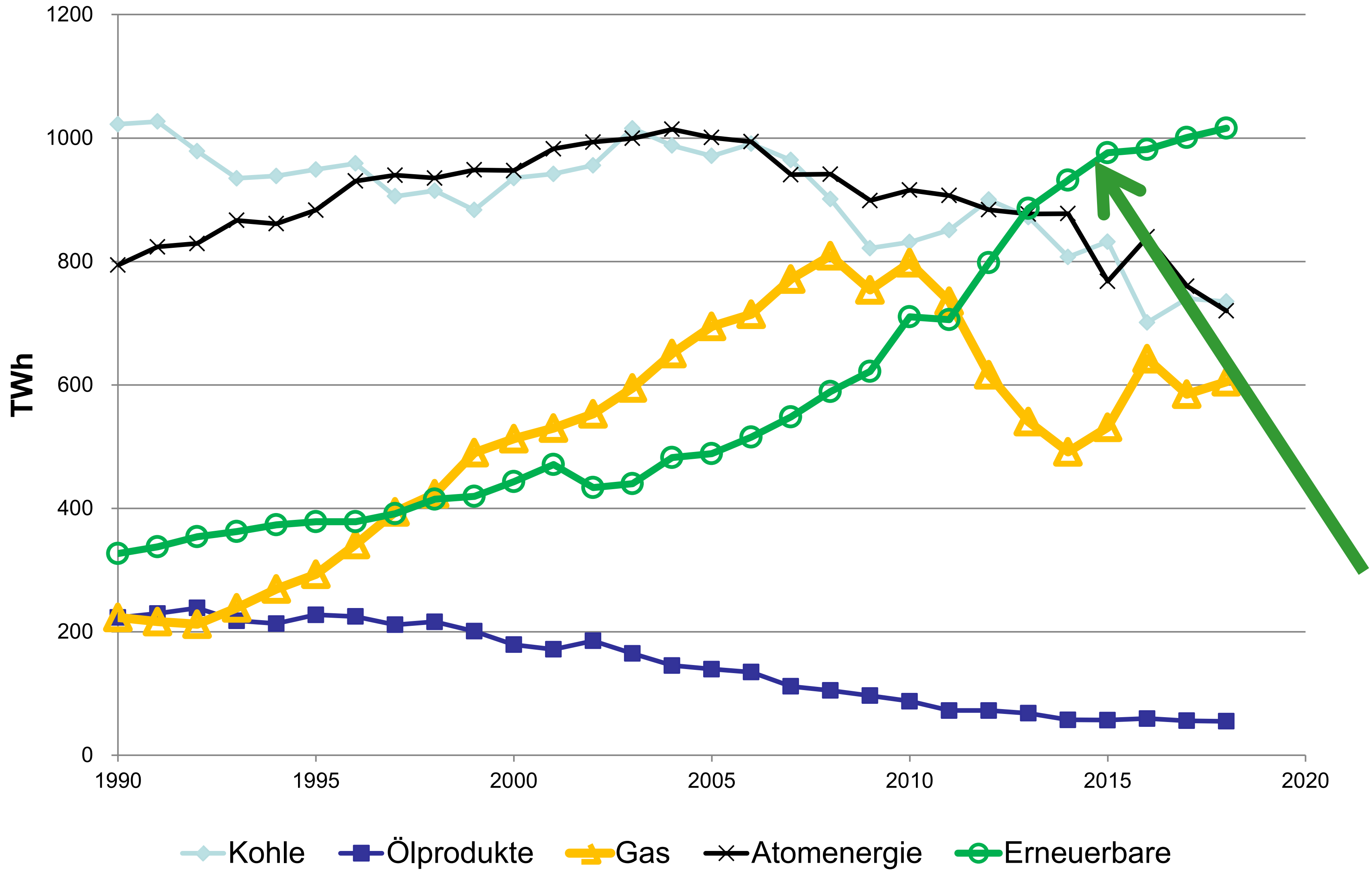
1. Introduction: Motivation
2. Method of approach
3. How variable renewables impact prices in electricity markets
4. The core problem of capacity payments
5. The role of flexibility
6. Storing every peak?
7. Subsidizing renewables?
8. Conclusions

1. INTRODUCTION

Motivation:

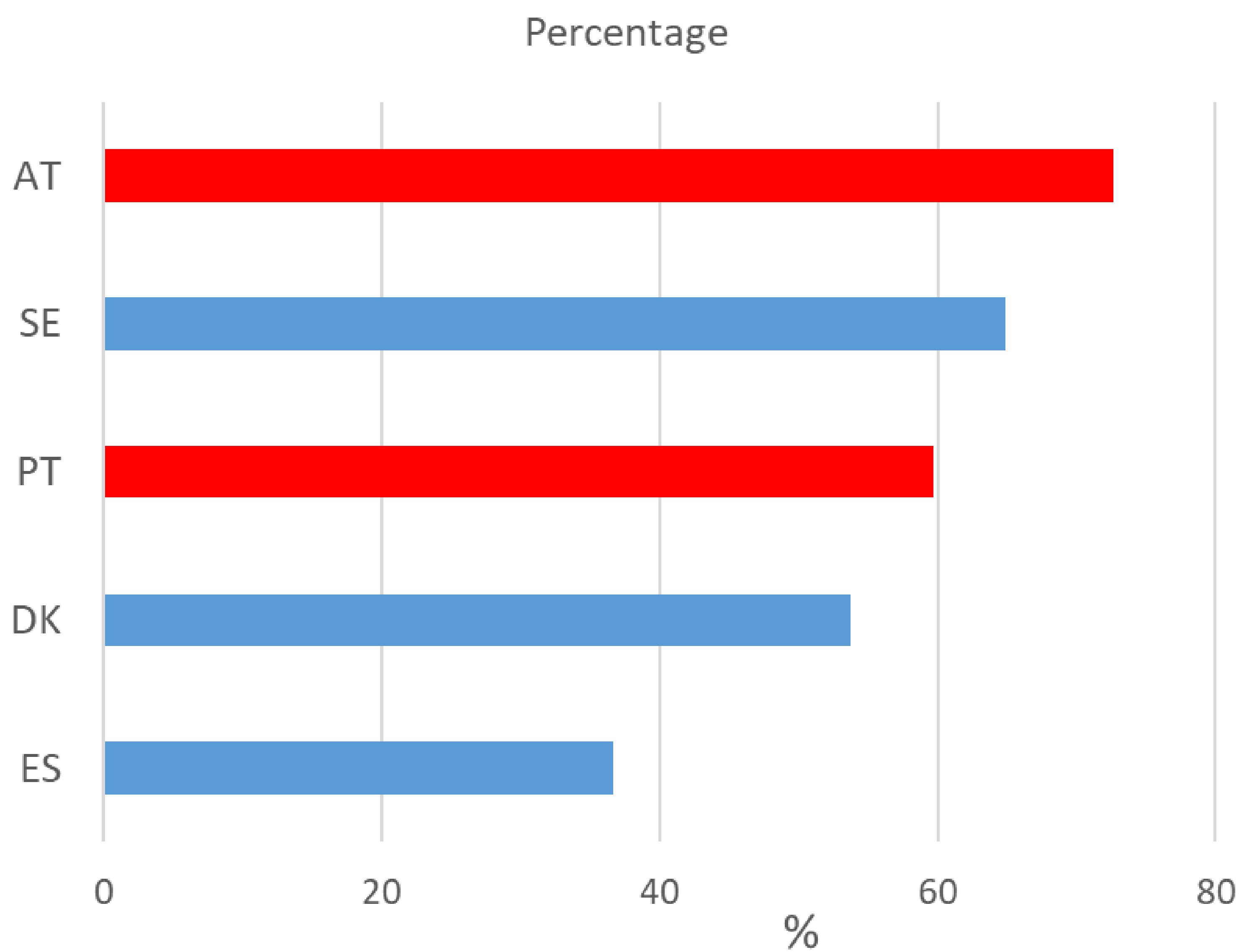
* Climate change → Paris agreements
* Targets for renewables
* Europe: The clean energy package → energy communities
* It is not possible to force variable renewables into the system
* A strong desire of some customers to participate in electricity supply

Electricity generation EU-28



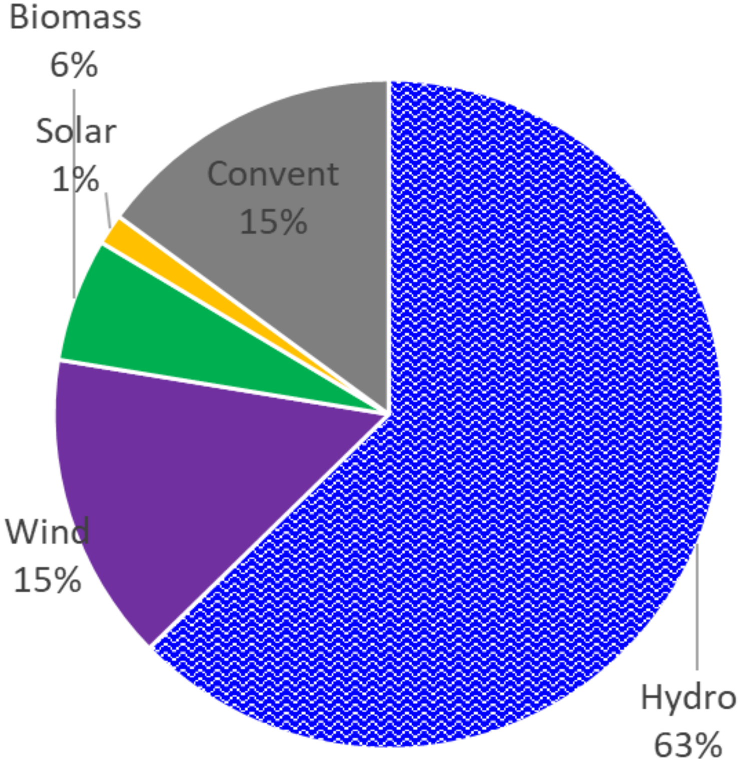
Werte für 2017 und 2018 vorläufig

Ranking: Electricity generation from RES in EU-28

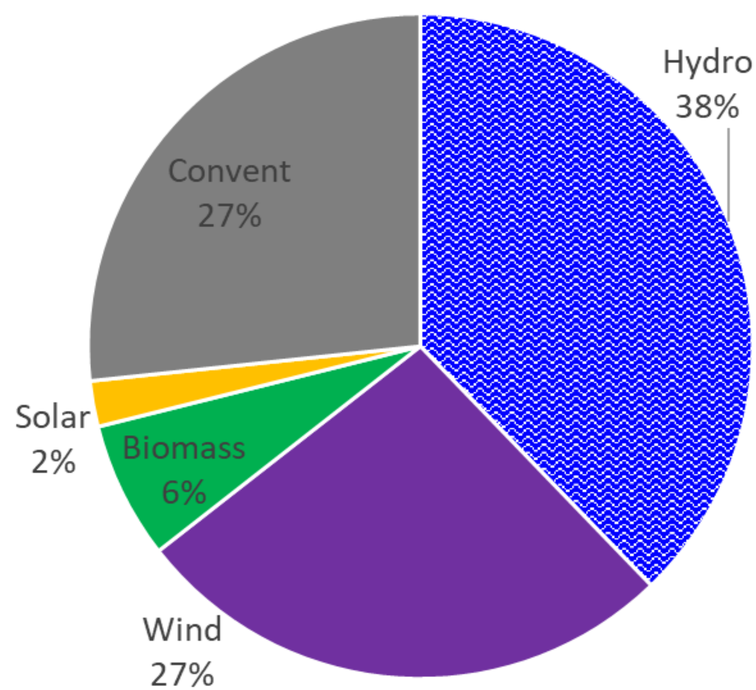


Electricity generation: Austria vs Portugal

Austria



Portugal



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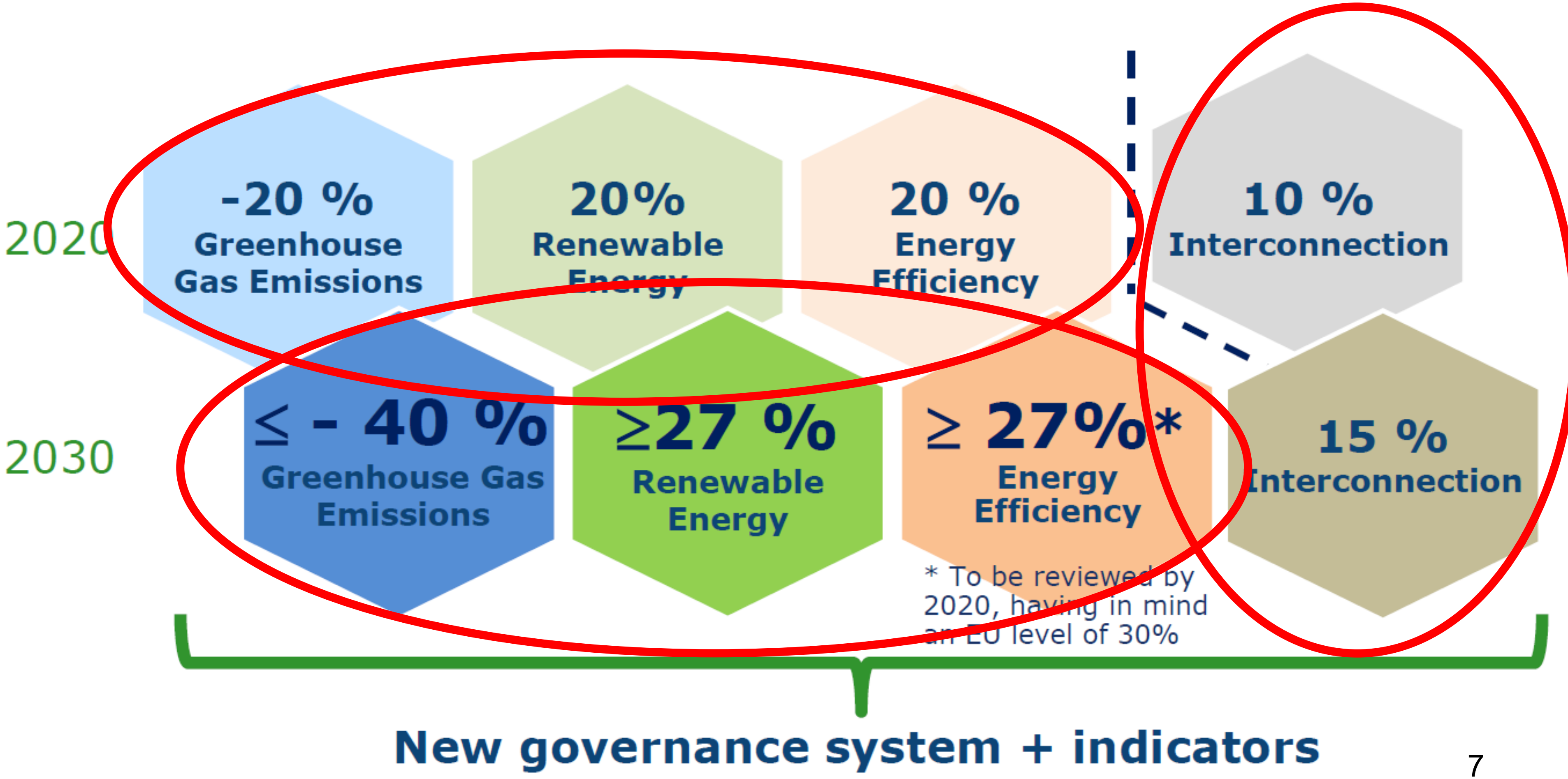
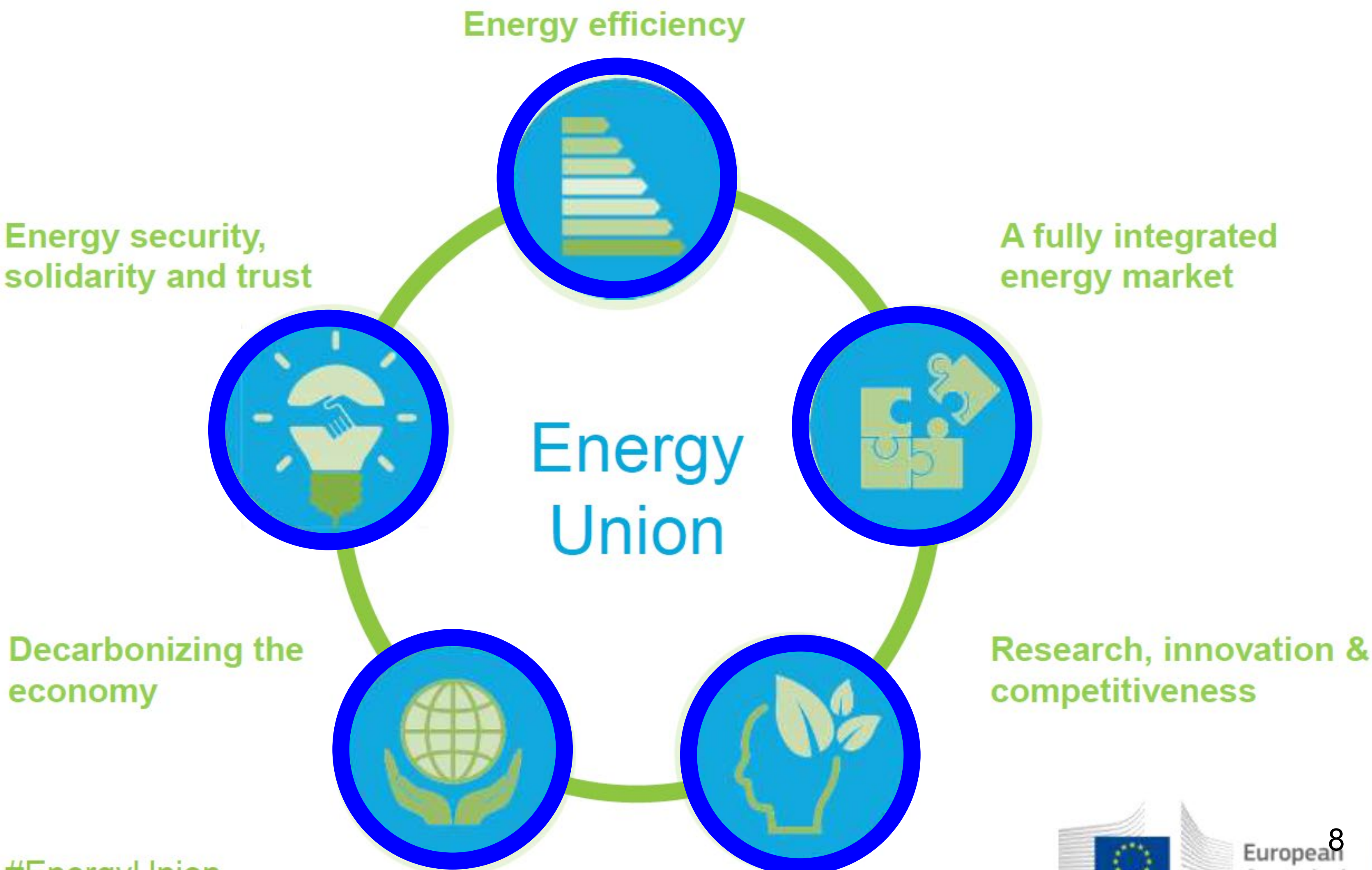
1. INTRODUCTION

TU WIEN

Strategic decision by European Council in 2014



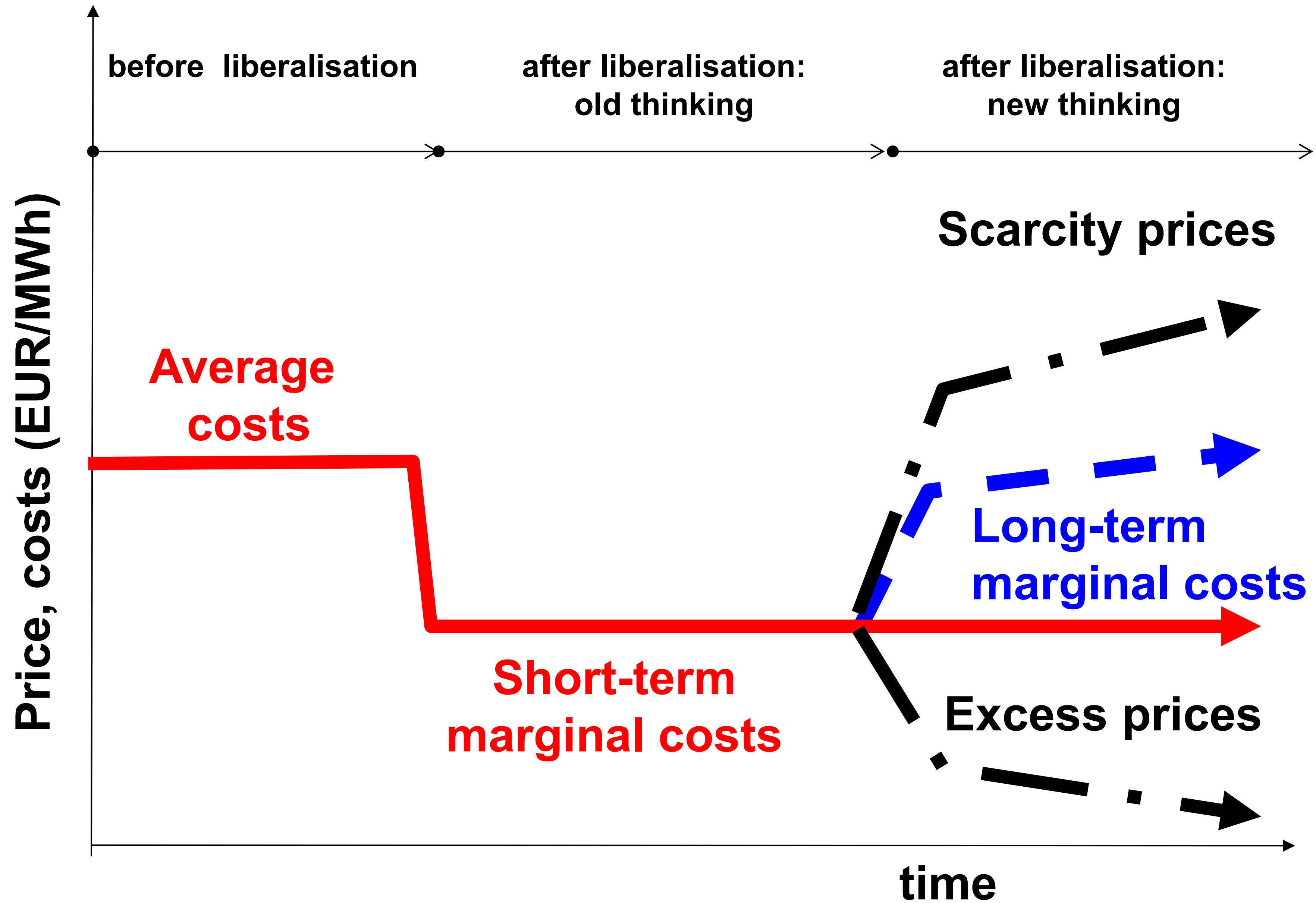
Energy Union Strategy



5 #EnergyUnion

Structure of the Package

How prices come about: Three periods of market design



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

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/elasticity in a dynamic framework for price calculation;

Day-ahead electricity markets

Expectation of

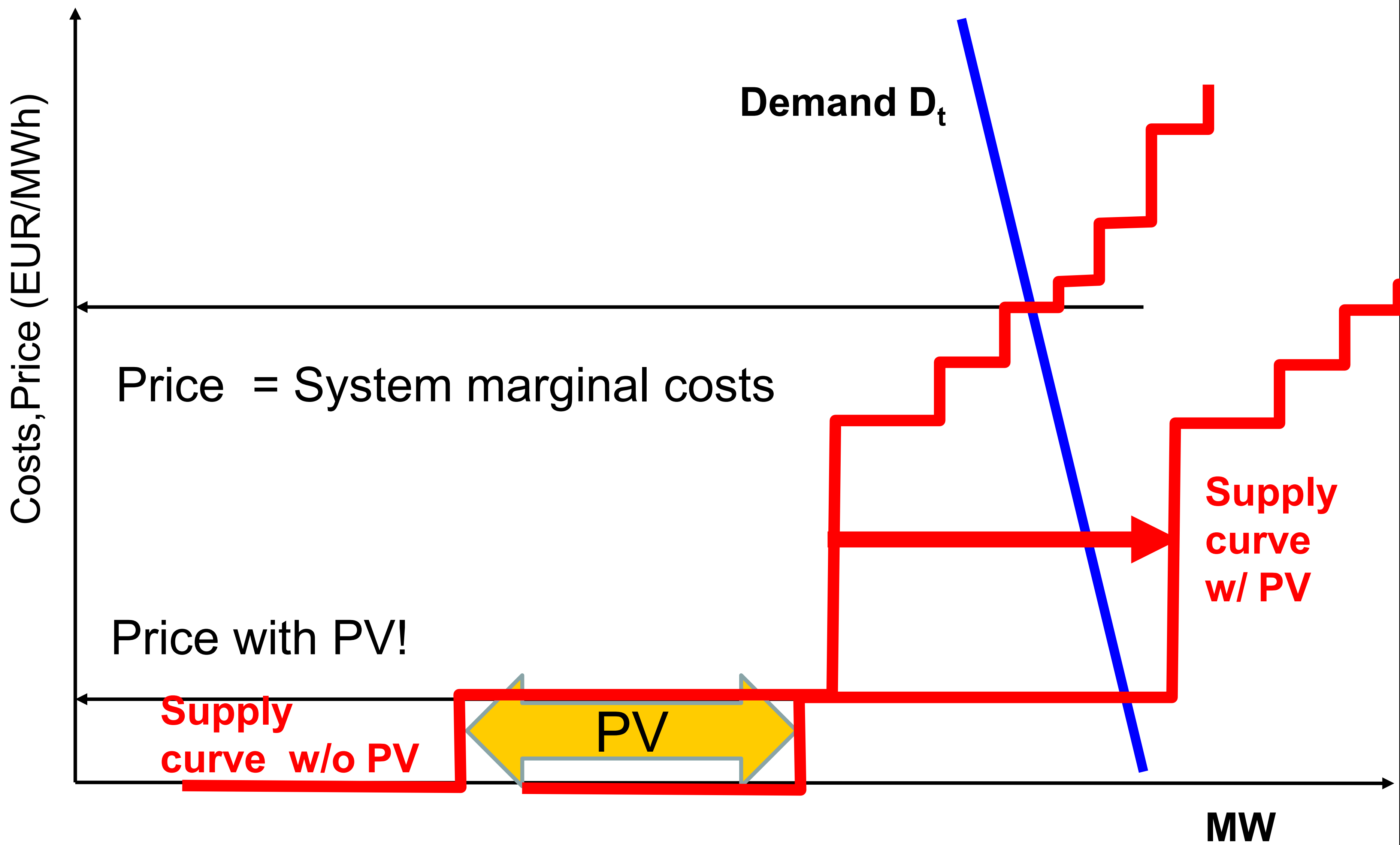
prices = <u>Short</u>-term marginal costs

(Short-term marginal costs = fuel costs)

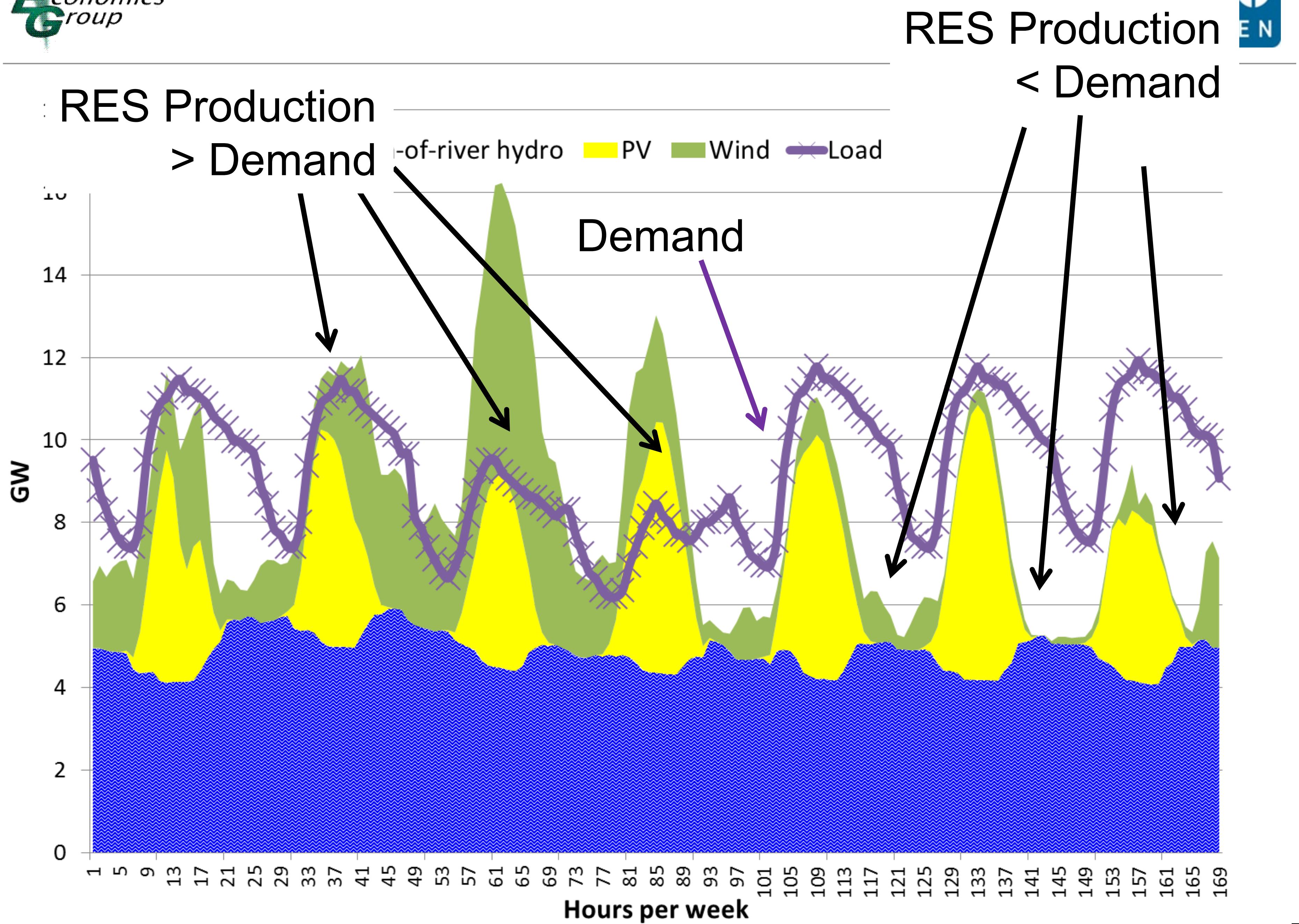
due to huge depreciated excess capacities at the beginning of liberalisation!

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

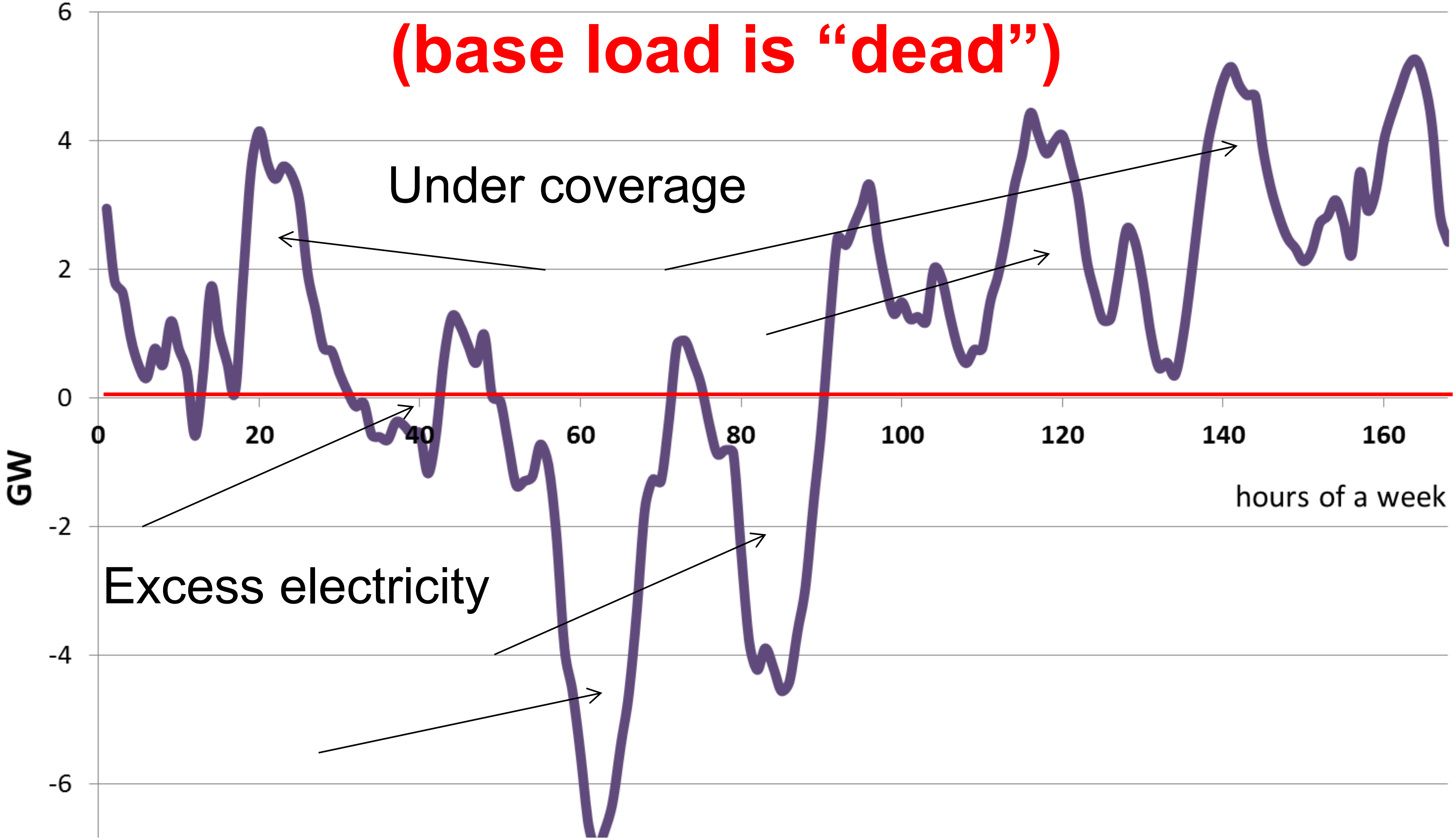
Example: prices without and with PV



Supply and Demand



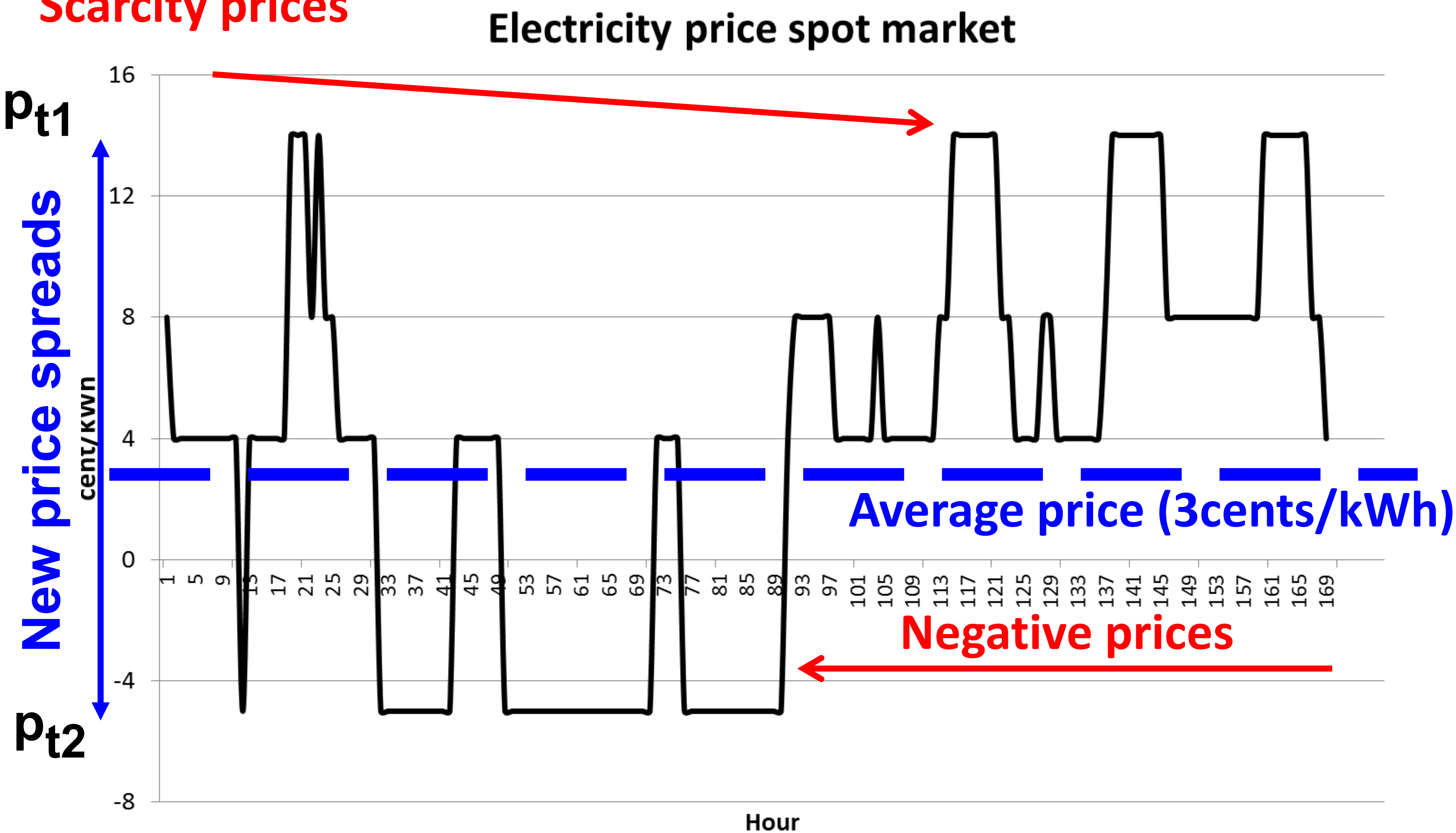
Key term of the future: Residual load (base load is “dead”)



Residual load = Load – non-flexible generation

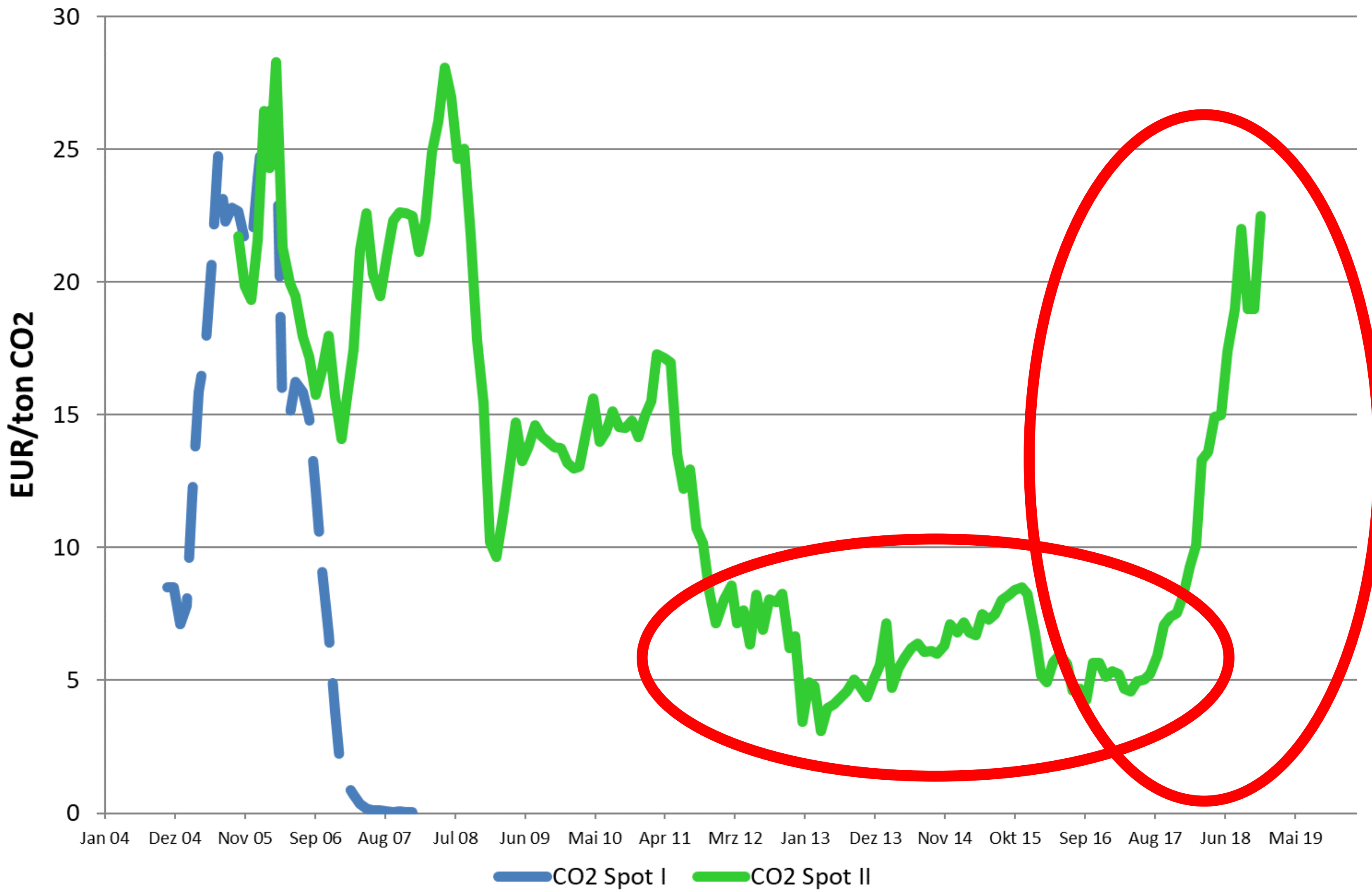
Deviation from STMC-pricing in spot markets

Scarcity prices

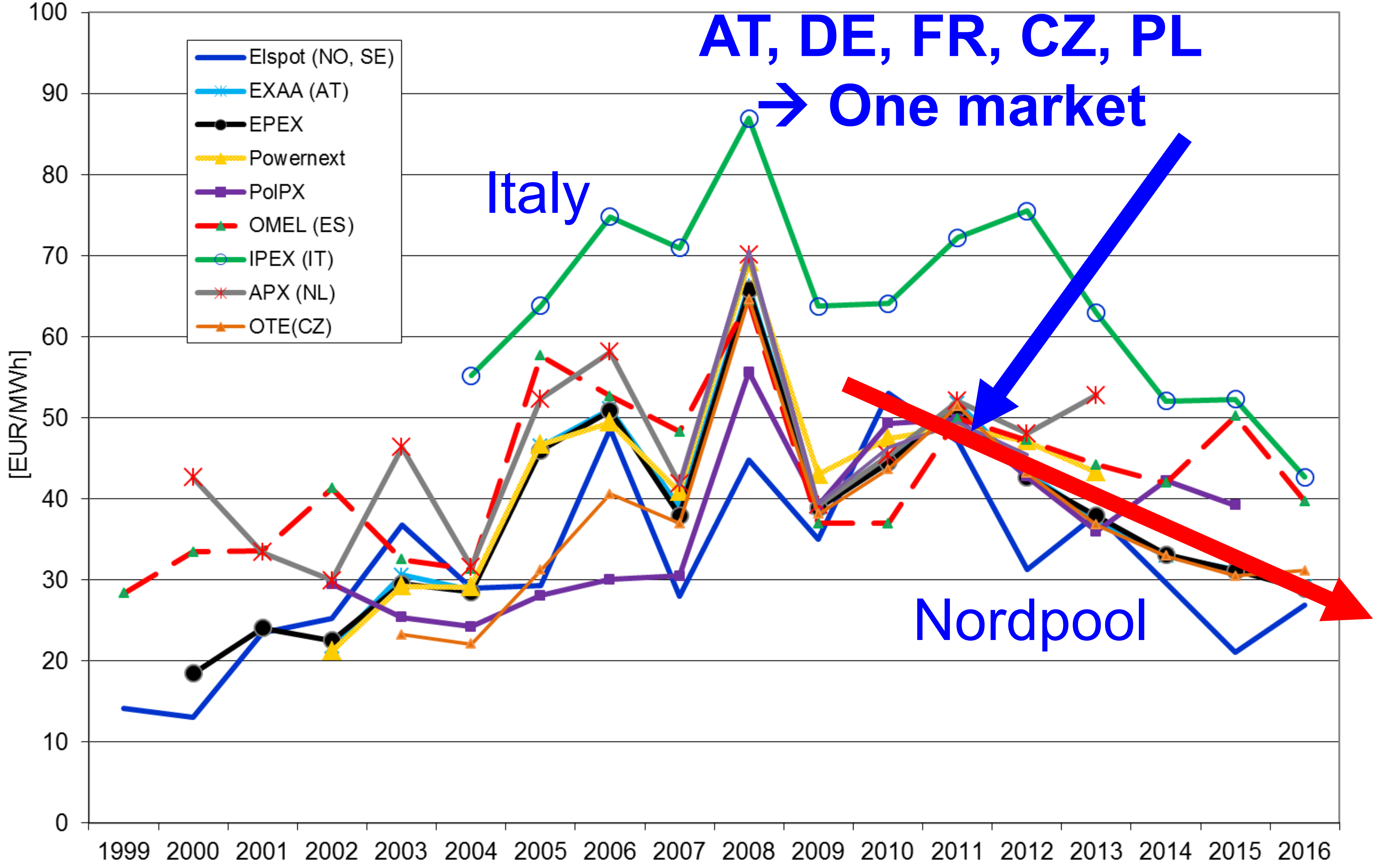


→ These price spreads provide incentives for new flexible solutions!!!!

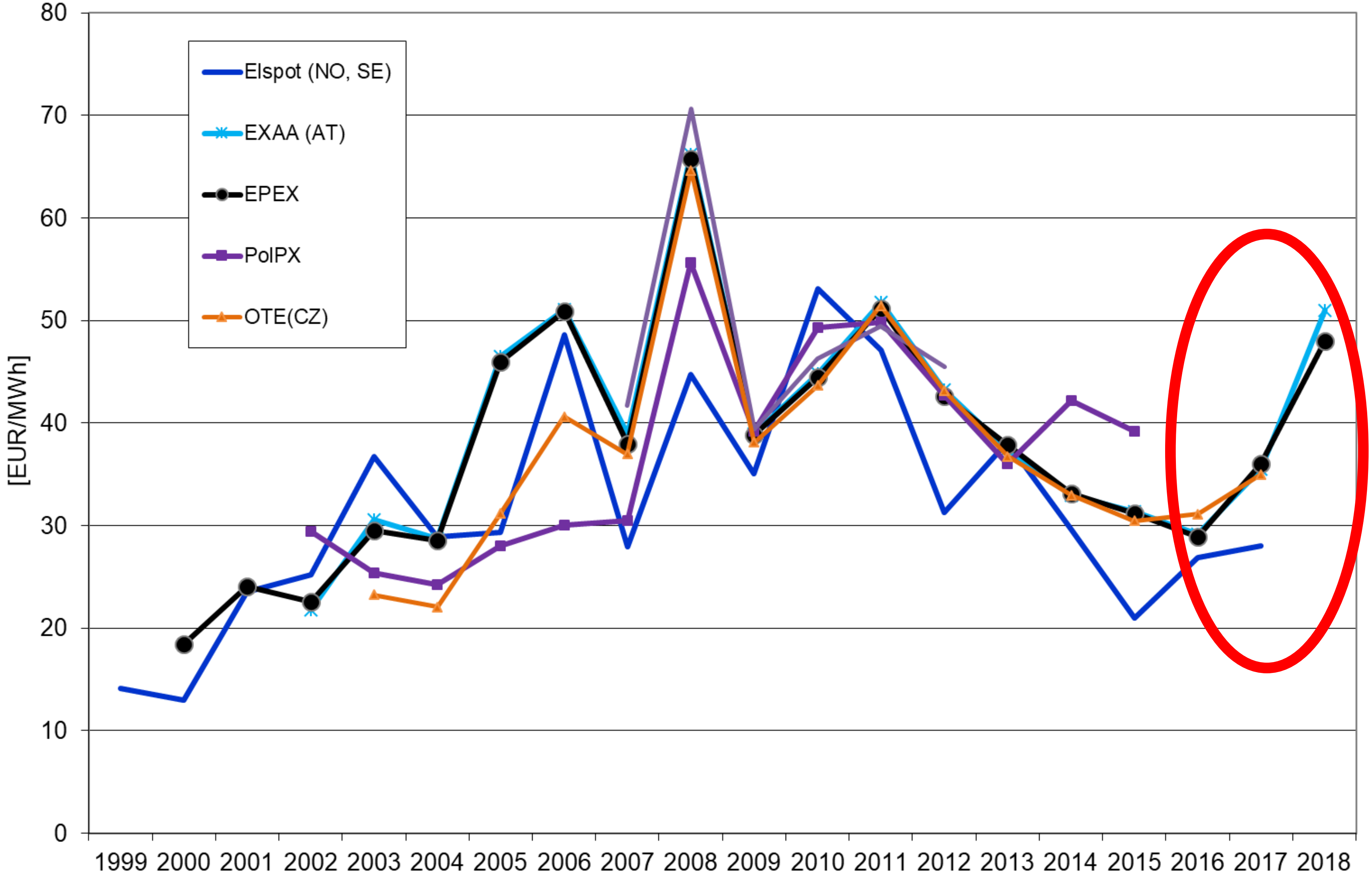
The CO2-Price



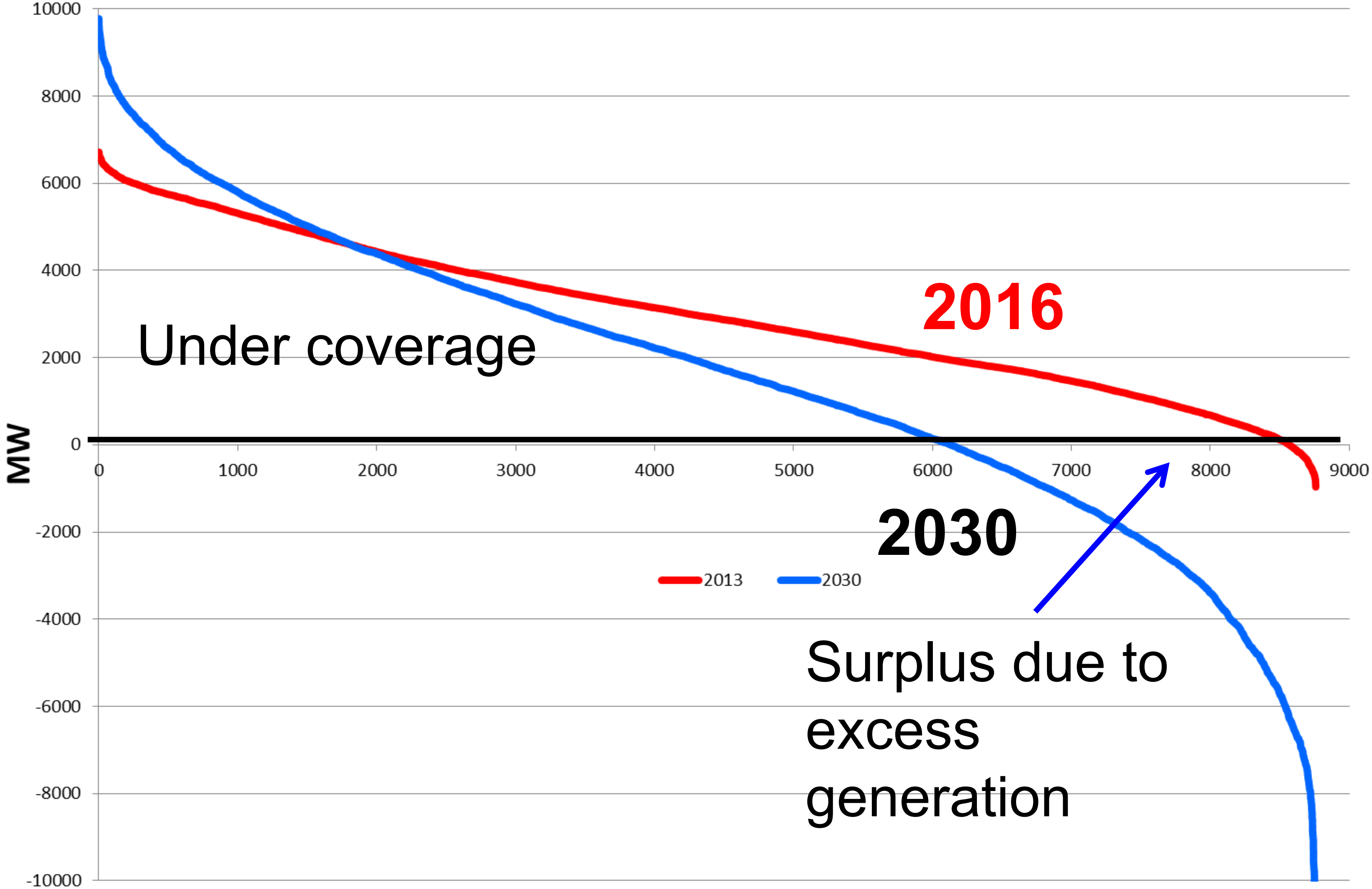
Development of electricity prices in Europe up to 2016 (1)



Development of electricity prices in Europe up to 2018 (2)



Classified residual load over a year



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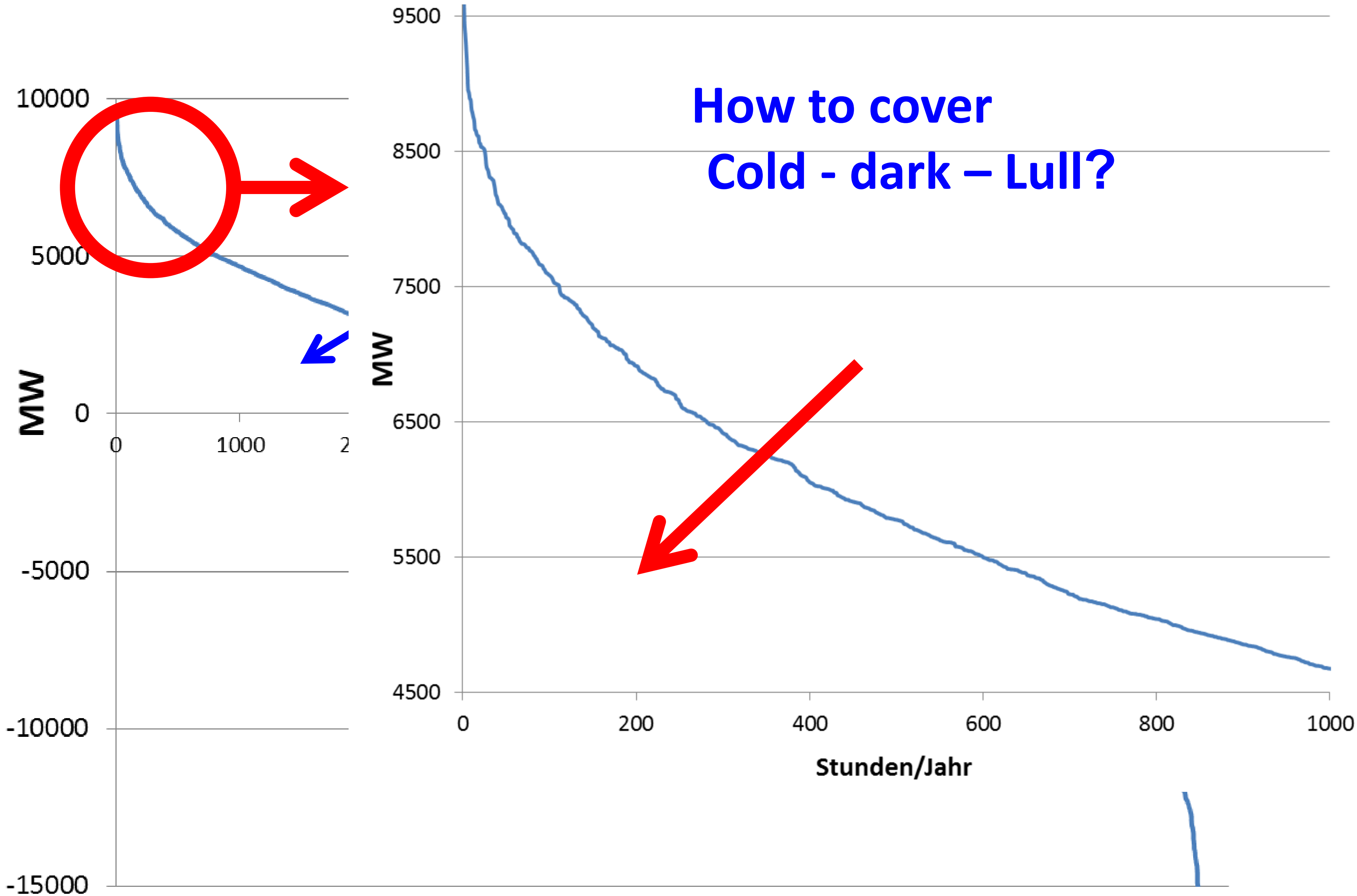
Classified residual load



There are two extreme positions:

By a regulated capacity payment 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

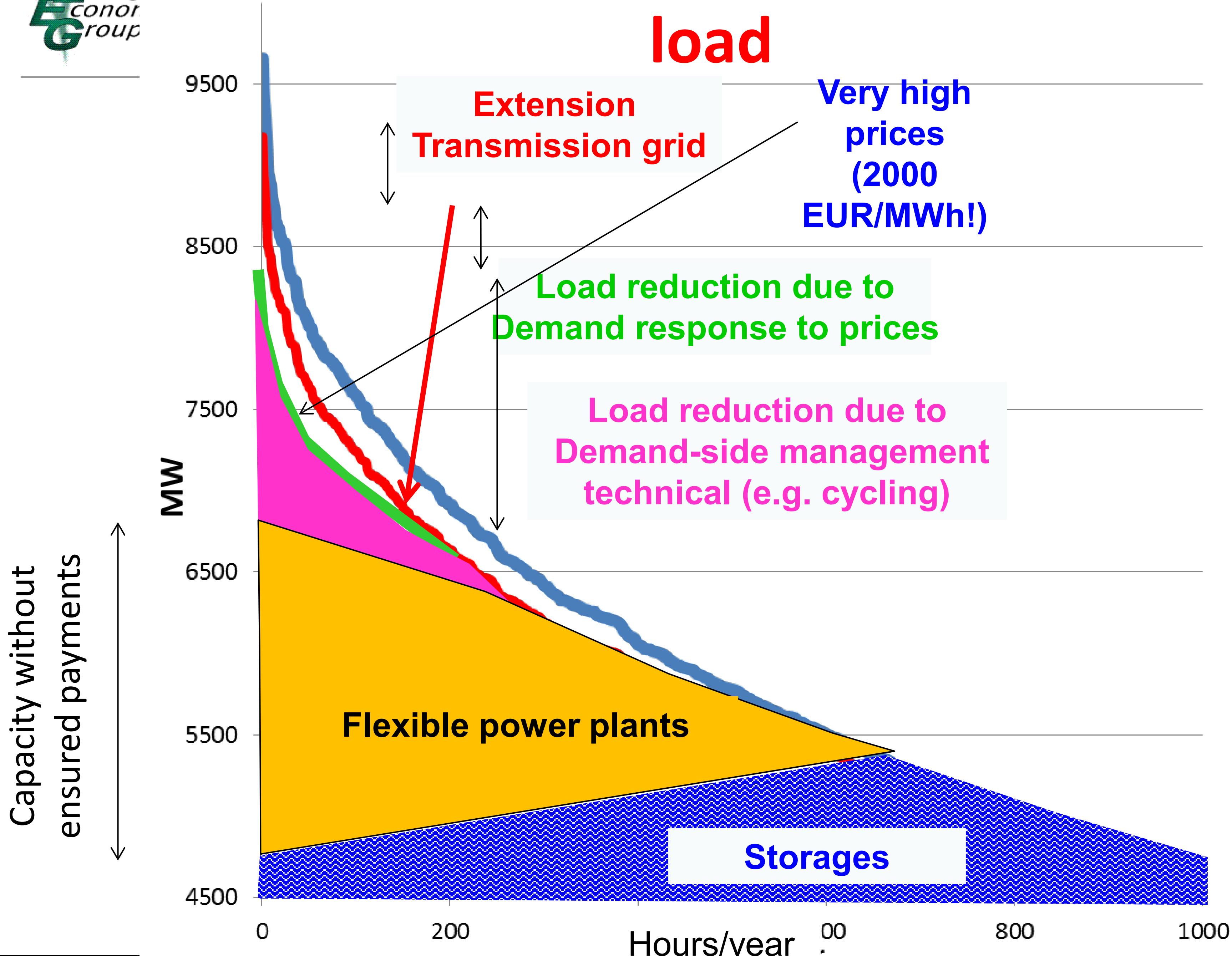
All regulatory capacity payments for power plants destort the EOM and lead to wrong price signals for all other options

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

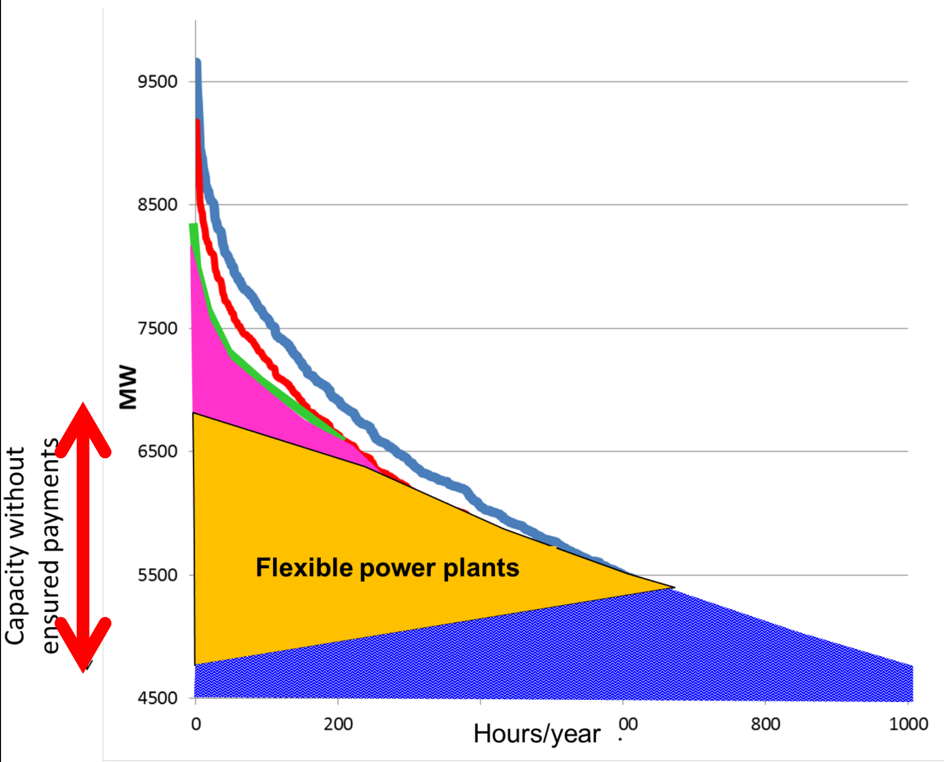
The higher the excess capacities, the lower is the share of RES

strive to retain system resource adequacy by correct price signals

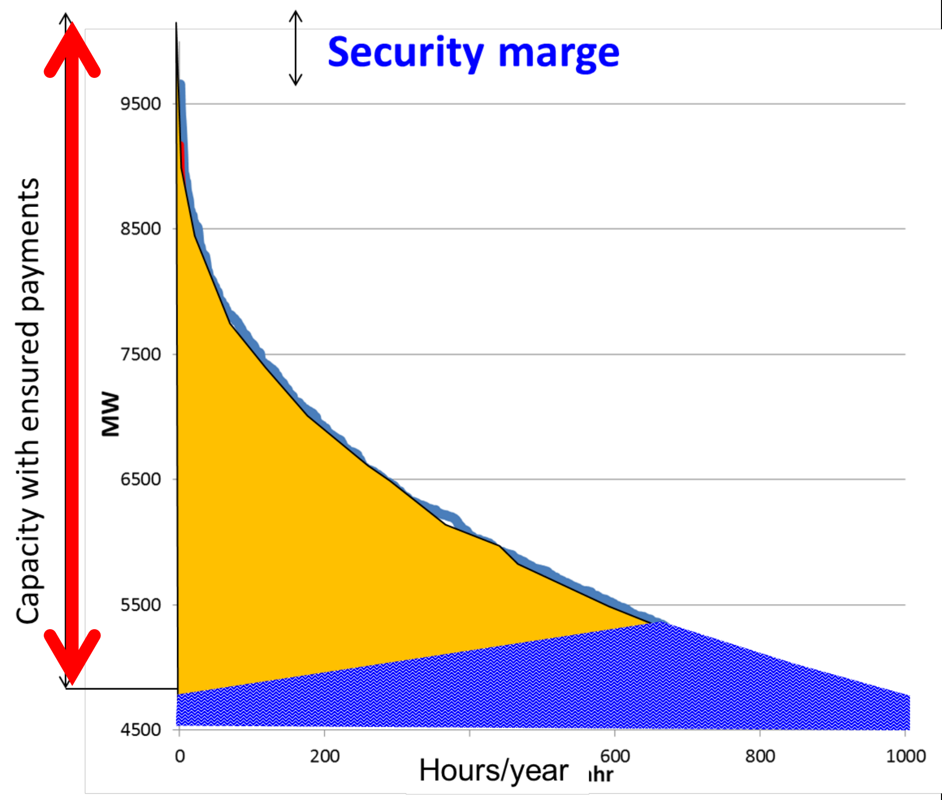
5 Flexible coverage of residual load



Comparison

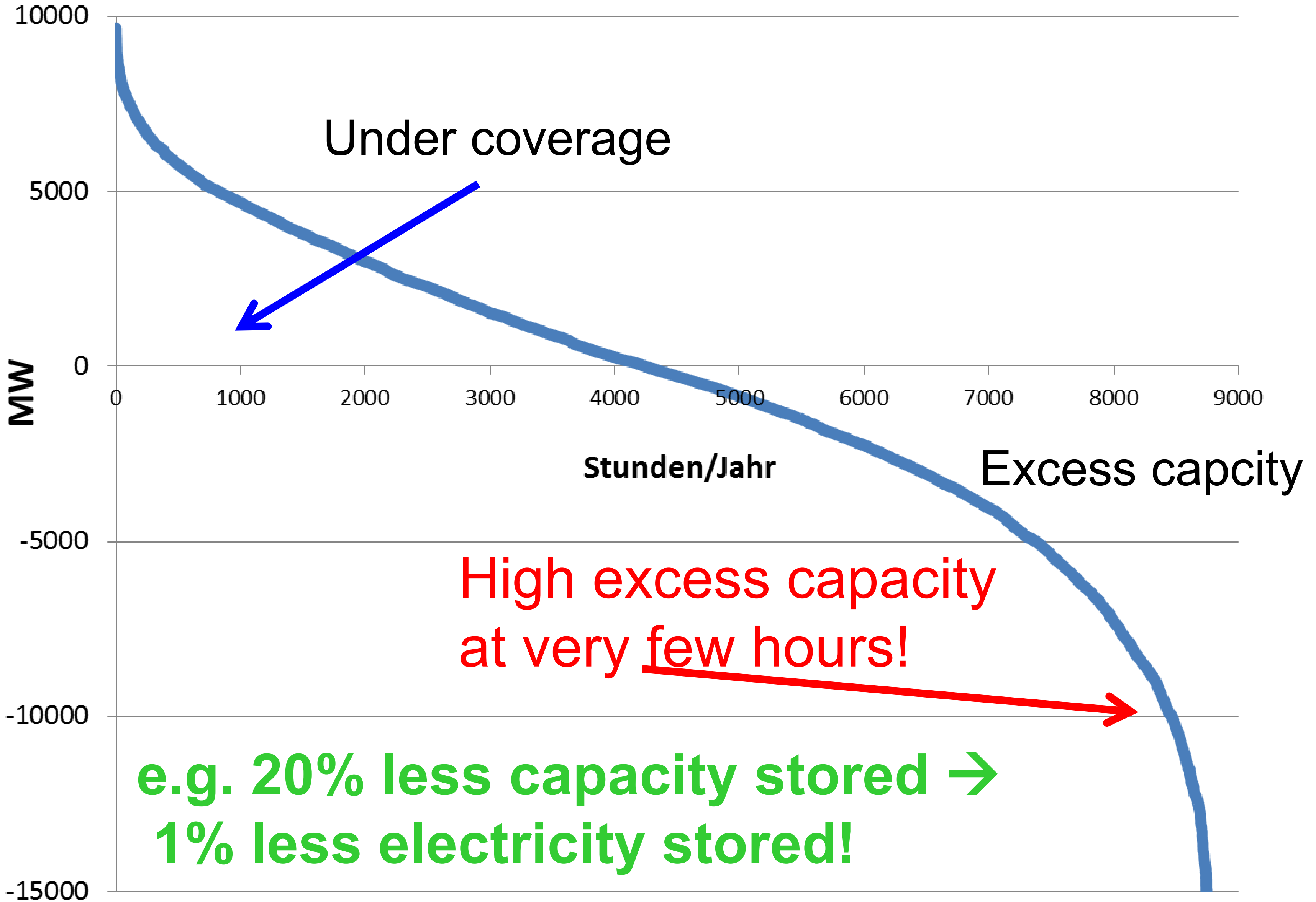


Capacity without ensured payments
MW
9500
8500
7500
6500
5500
4500
Flexible power plants
0
200
800
1000
Hours/year



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

6. Storing every peak?



The costs of storage

$$C = \frac{\frac{IC \cdot \alpha + C_{OM}}{T} + C_E}{\eta_{STO}} \quad [\frac{EUR}{kWh}]$$

C … Storage costs (EUR per kWh)

C_E … Energy costs (EUR per kWh)

C_{OM} … O&M costs (cent per kWh)

IC … Investment costs (EUR/kW)

α … Capital Recovery factor

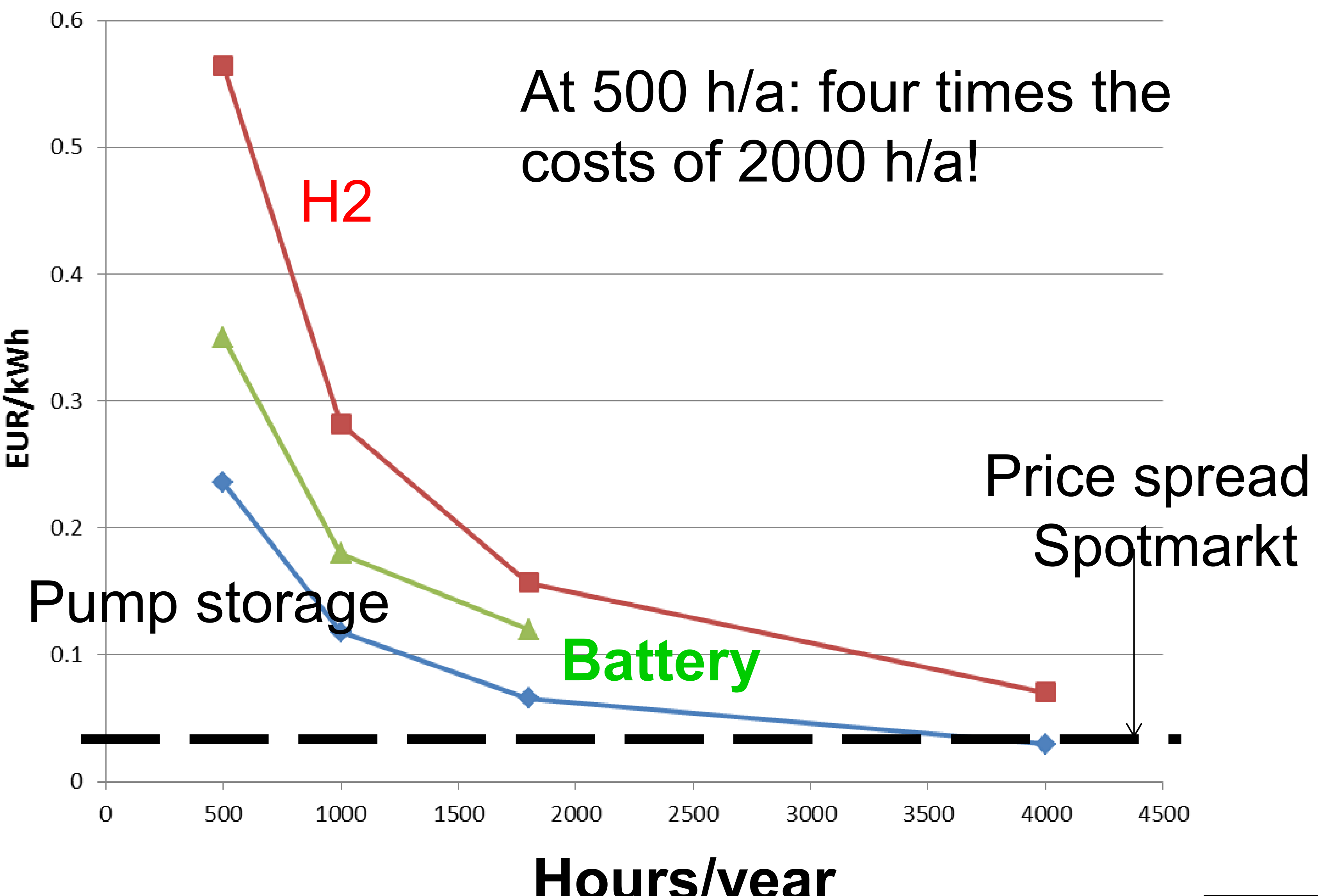
T … Fullloadhours (hours per year)

η_{SP} … Efficiency of storage

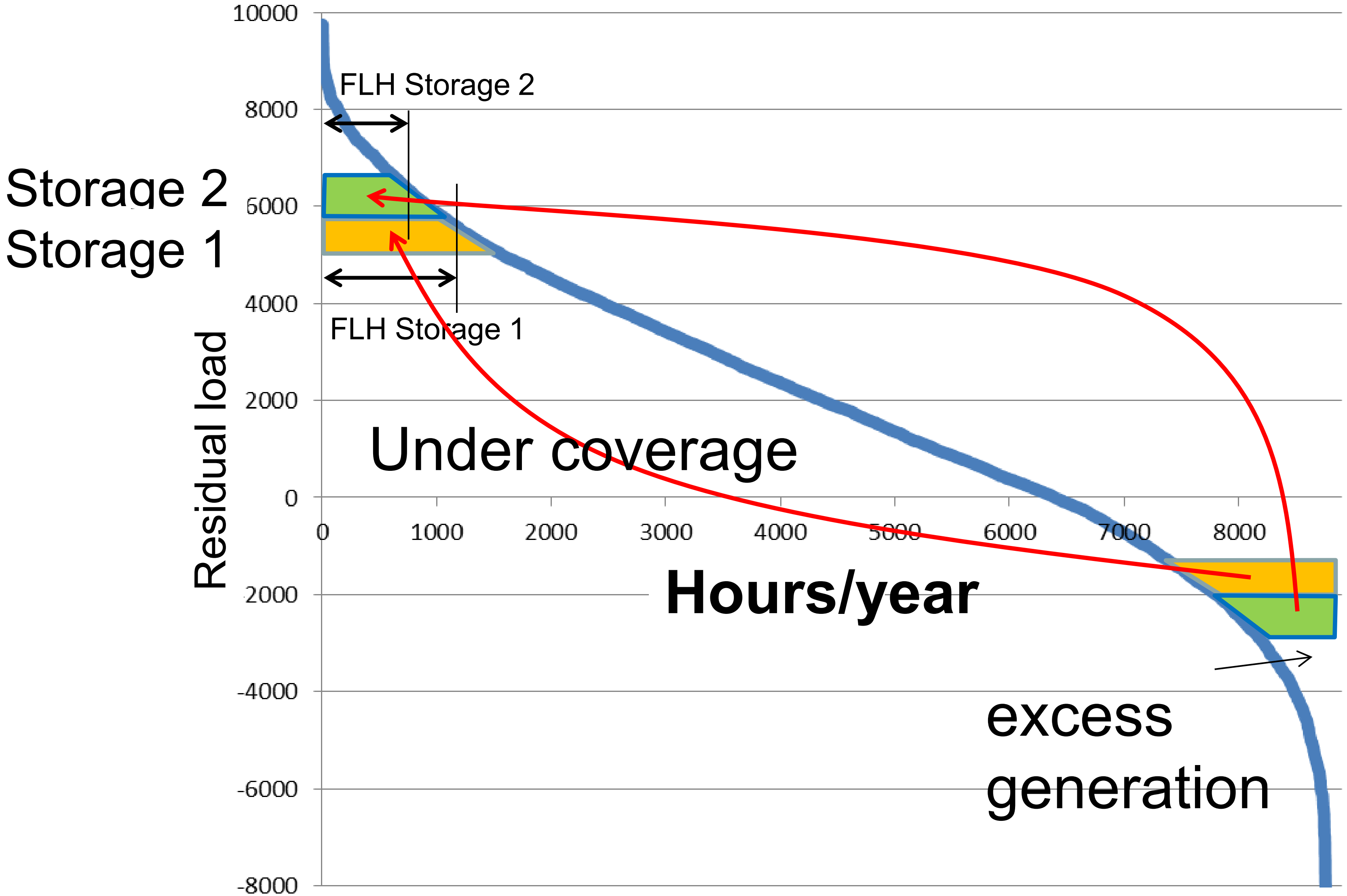
Key factors:

- **T (Fullloadhours)!**
- **C_E (electricity price)**

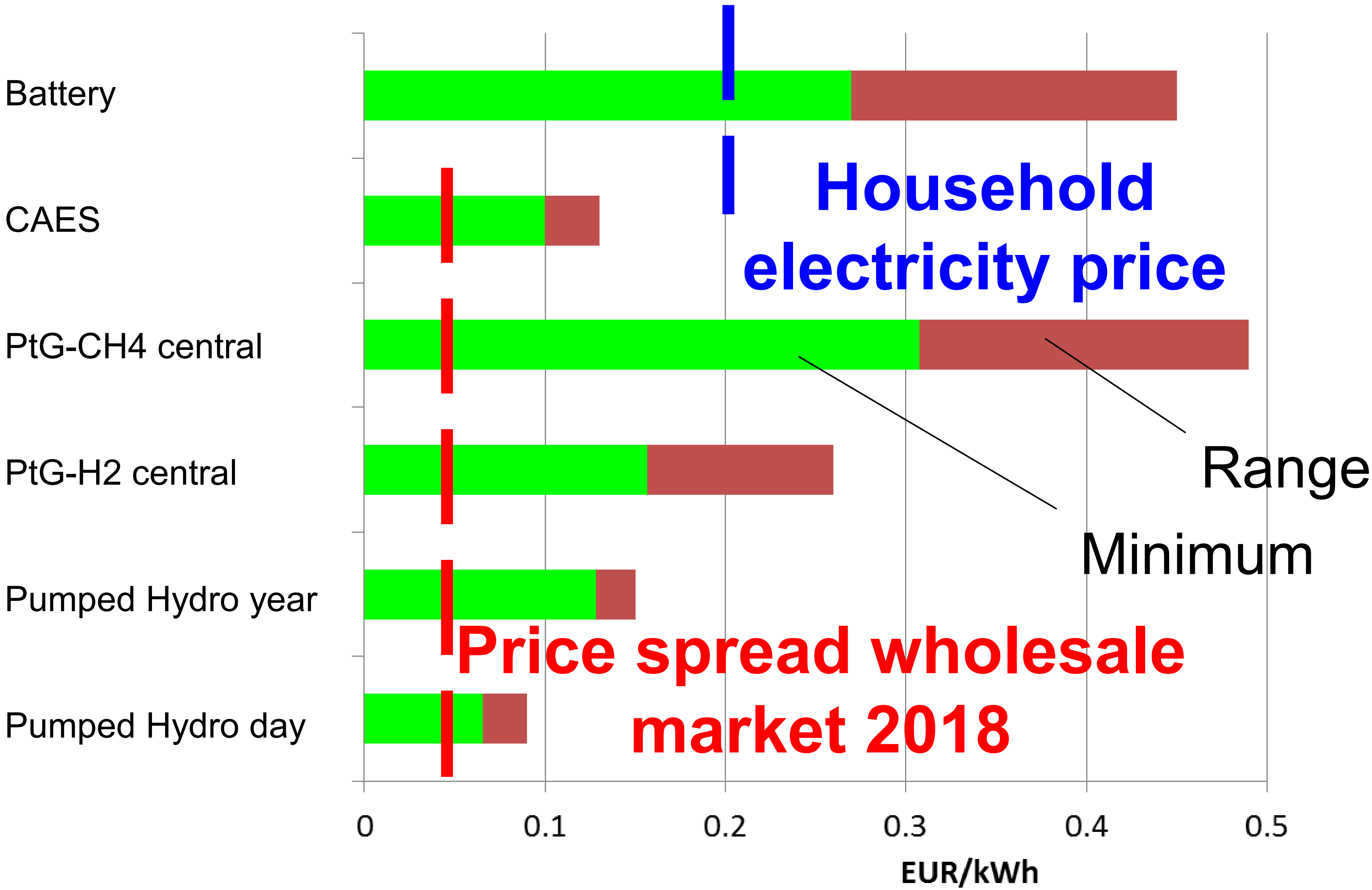
Impact of fullloadhours



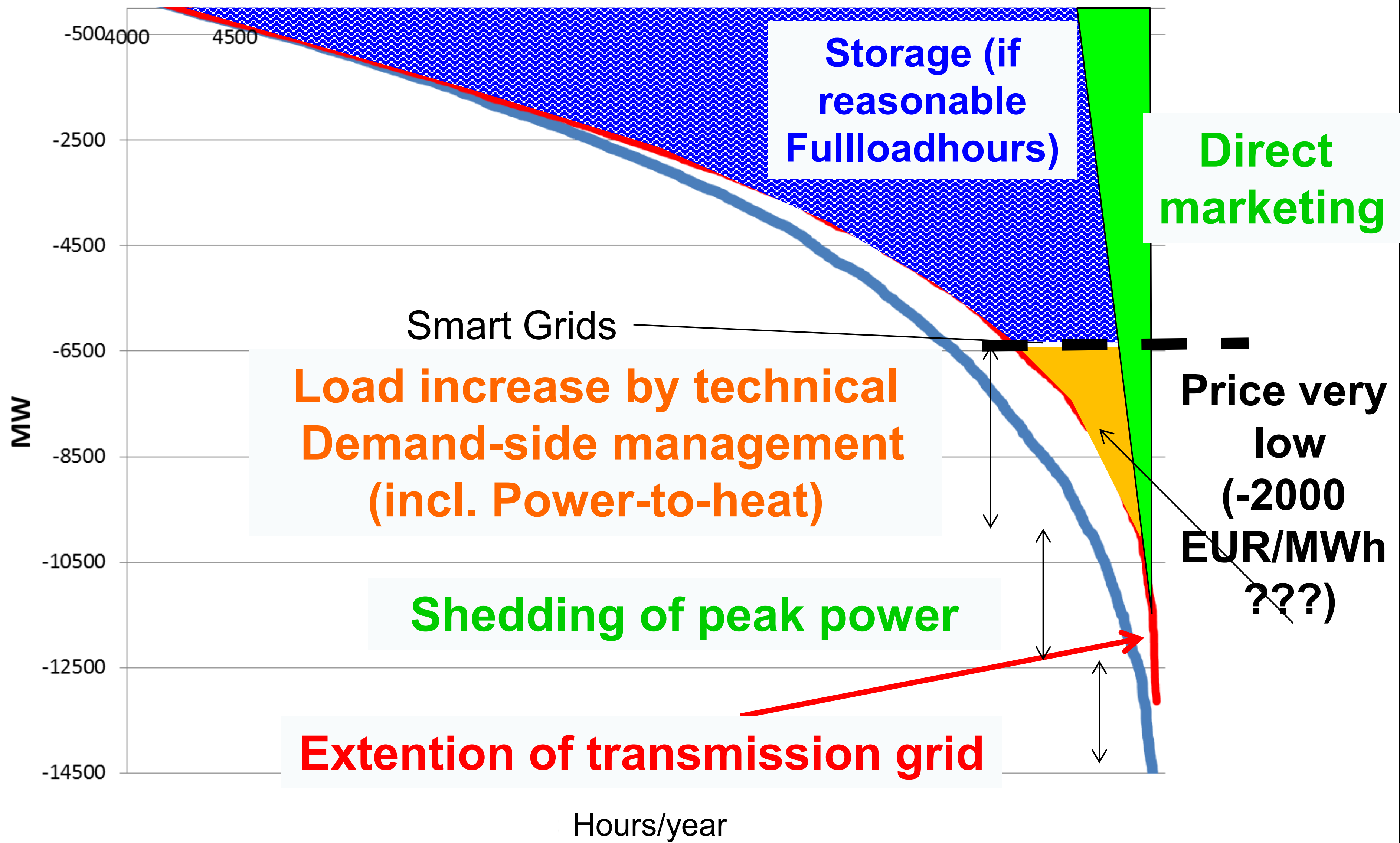
Decreasing full-load hours of storages



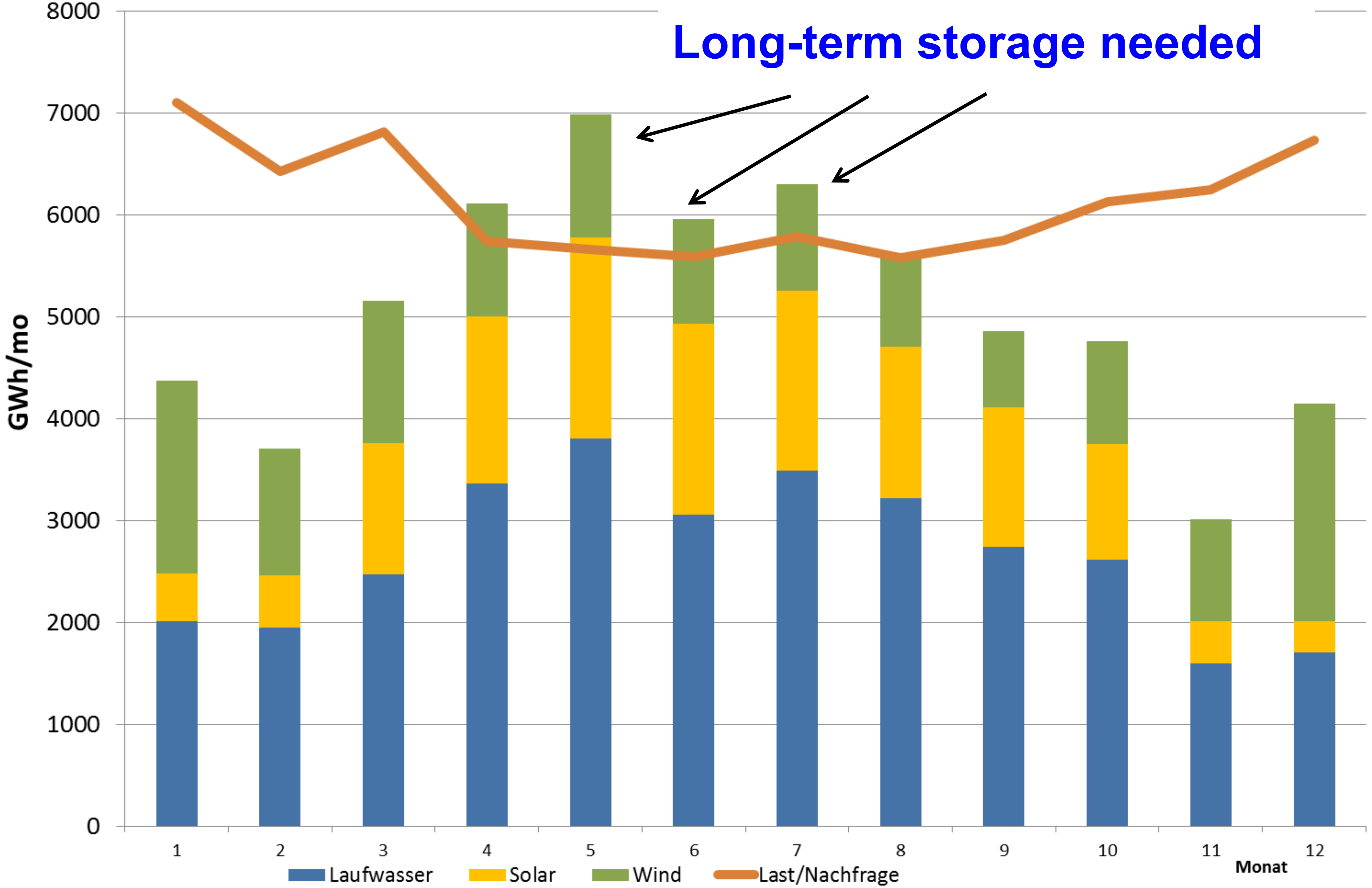
Range of storage costs 2018



Flexible use of excess electricity



Demand for long-term storage



Sector coupling / Sector integration

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

Heating/Cooling

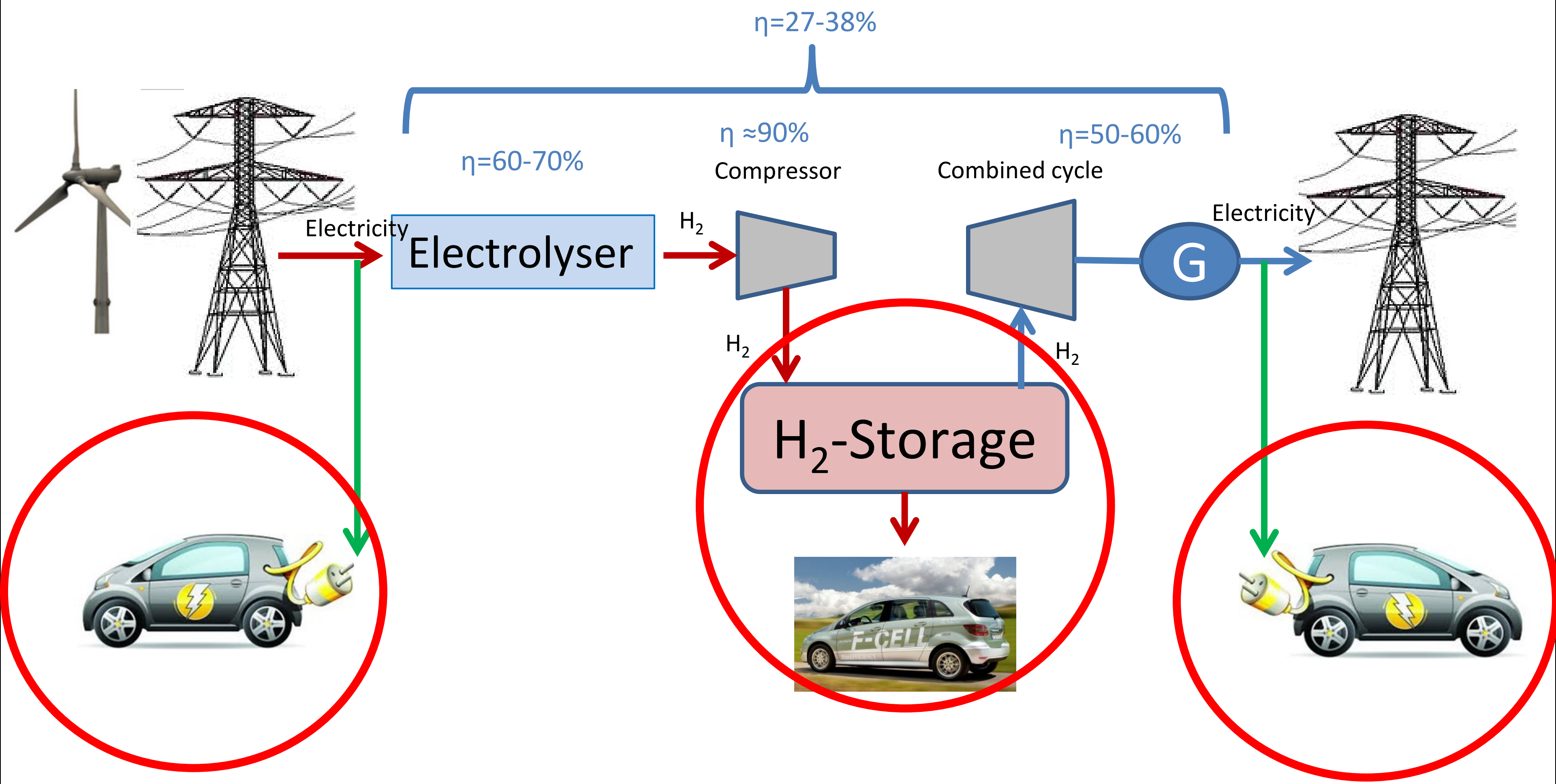
Transport

* 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 ?

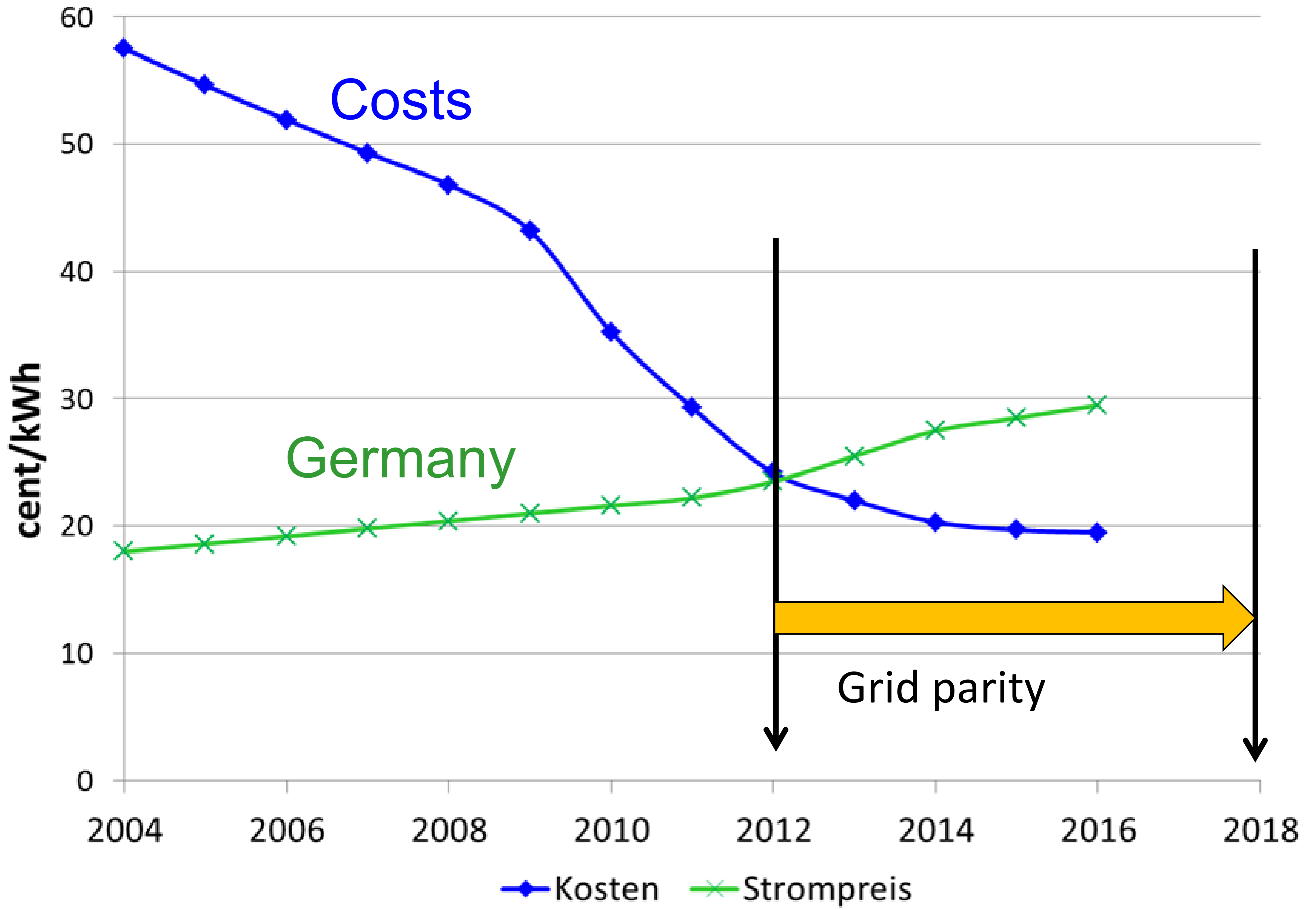
Sector coupling hydrogen: Storage and fuel in transport?



7. IS THE TIME FOR SUBSIDIZING RENEWABLES OVER ?

As long there is no price on CO_2 …..

Grid parity: PV-costs and household electricity prices



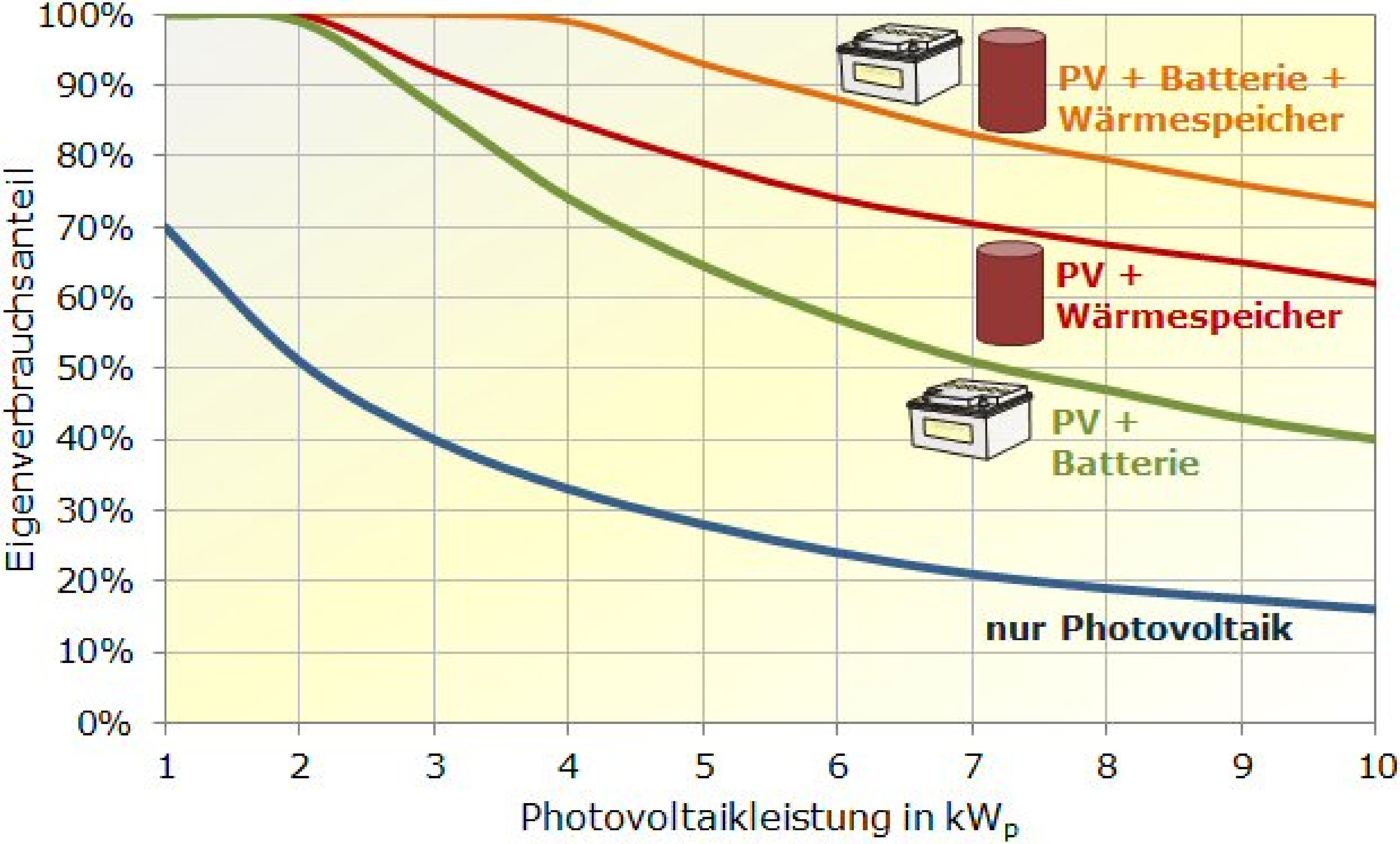
Assessment of Grid Parity

$$\underbrace{E_{Own} * P_{HH} + E_{Feed\text{-}in} * P_{feed\text{-}in}}_{\text{Savings/revenues}} > \underbrace{\text{Annuity}}_{\text{Costs}}$$

Grid parity term

Subsidy still necessary?

Share of own consumption



Bidding Zero for off-shore wind

Tender for wind farms to be constructed between 2021 and 2025:

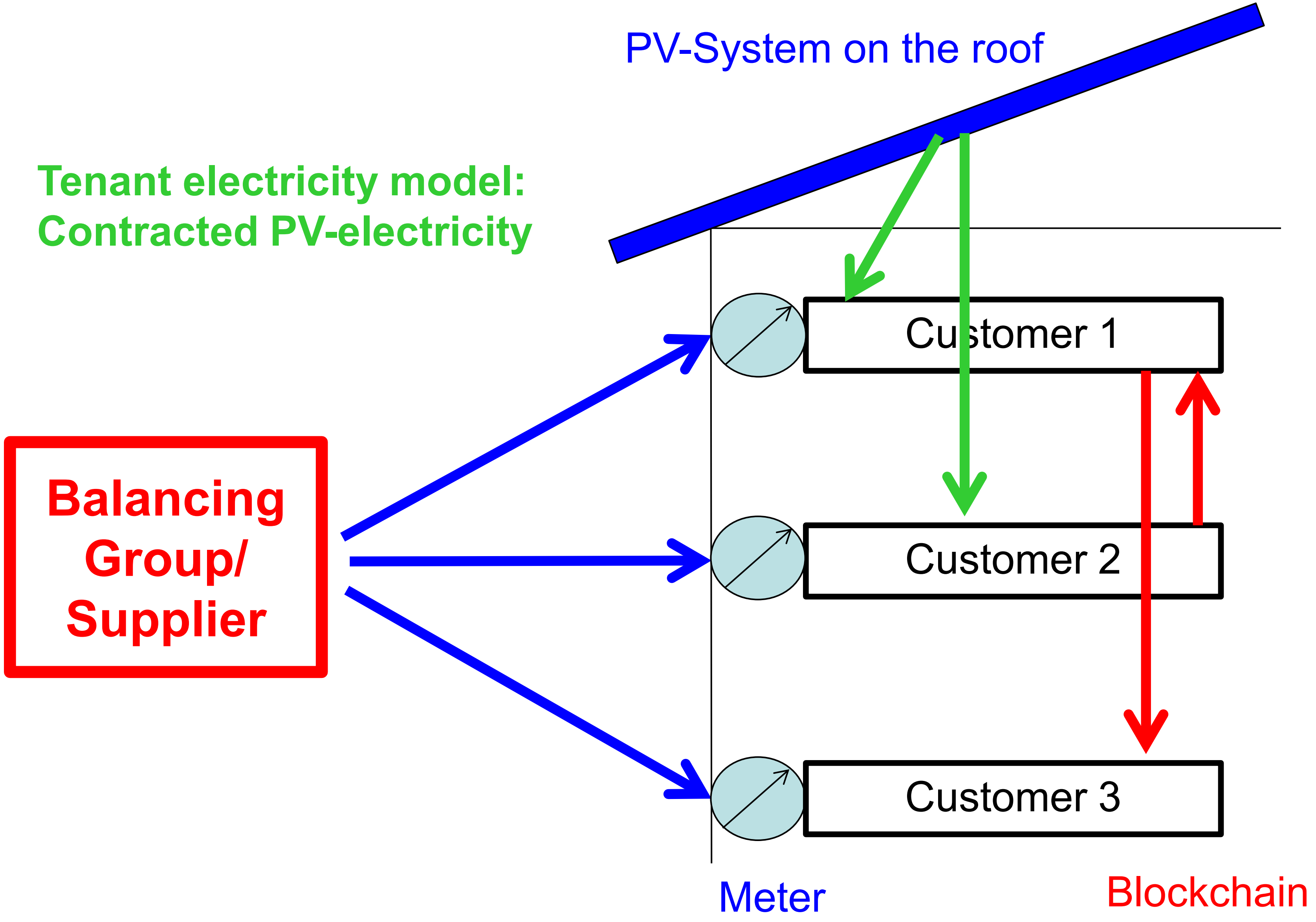
Project	MW	ct/kWh
EnBW He Dreiht GmbH	900	0.0
DONG Energy Borkum Riffgrund West II GmbH	240	0.0
Dong Energy Northern Energy OWP West GmbH	240	0.0
Dong Energy Gode Wind 03 GmbH	110	6.0*
Weighted average	**1,490**	**0.44**

Source: Innogy

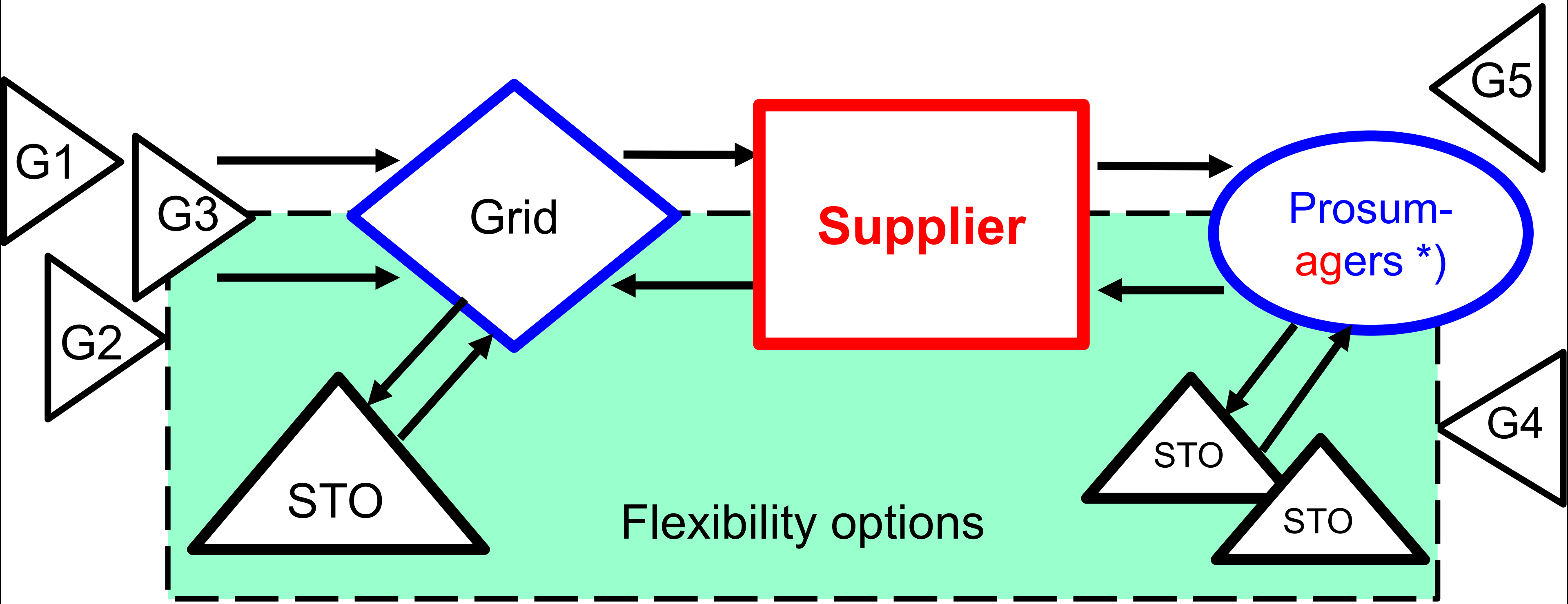
Bets on:

- **Increasing electricity prices**
- **Decreasing technology costs**
- **Sector coupling works**

Tenant electricity model and Blockchain



New Thinking: Making the electricity system more democratic



*) R. Green

8. CONCLUSIONS

- Sustainable electric. system → integration of a broad technology portfolio & demand-side options!
- No quick fix, no one size fits all solutions
- Larger market areas favourable
- Very important: correct price signals (incl. CO2)
- most urgent: exhaust full creativity for flexibility of all market participants incl. decentralised systems (PV …)
- Capacity payments: Any CP will distort the system towards more conv. and less RES capacity
- New key players: Suppliers and prosumagers