New concepts for integrating larger shares of variable renewables into the electricity system

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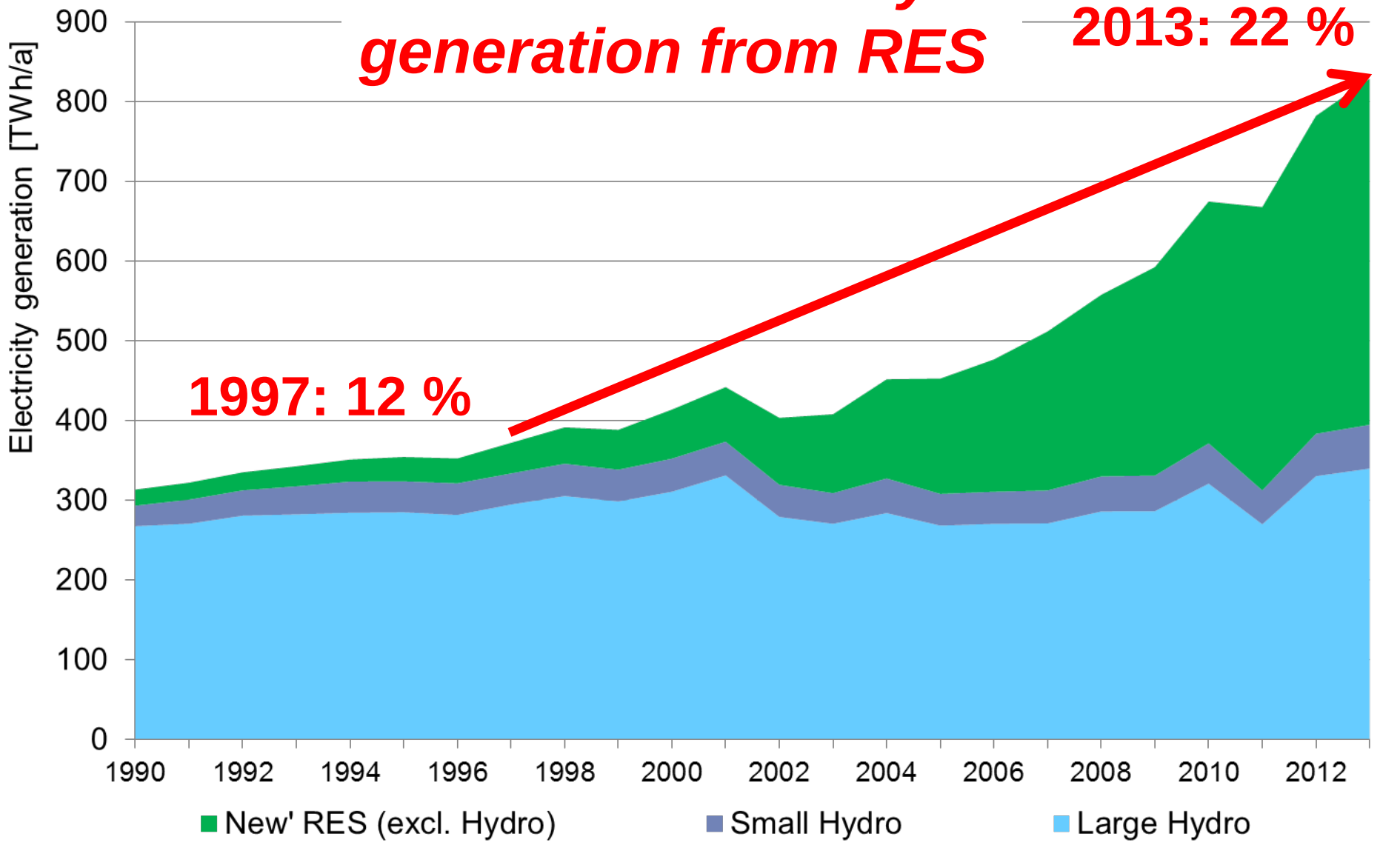
2. How intermittent renewables impact prices in electricity markets
3. Residual load
4. How much storage?
5. Market integration of RES
6. Conclusions

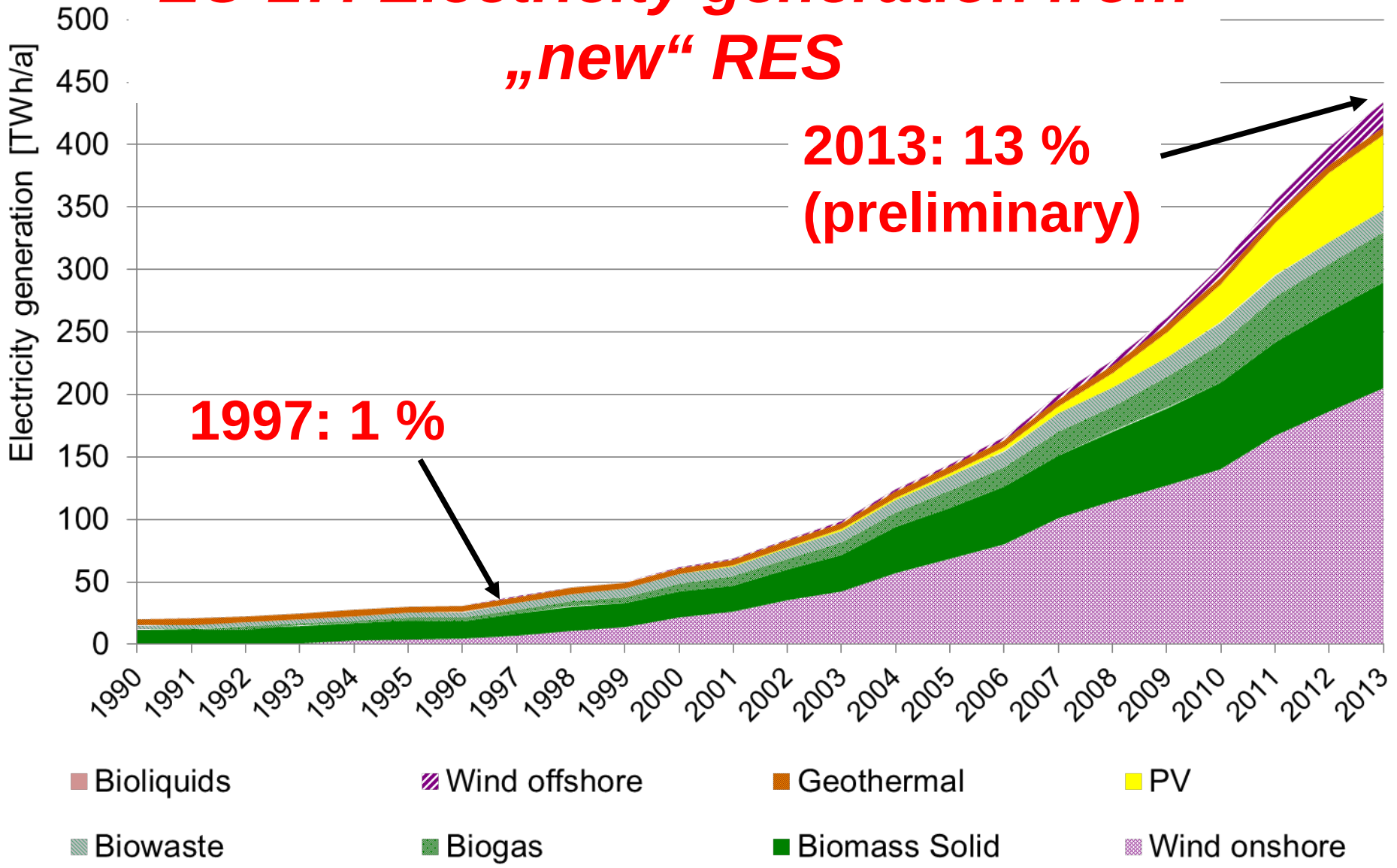
1. INTRODUCTION

EU-27: Electricity generation from RES



1. INTRODUCTION

EU-27: Electricity generation from „new“ RES



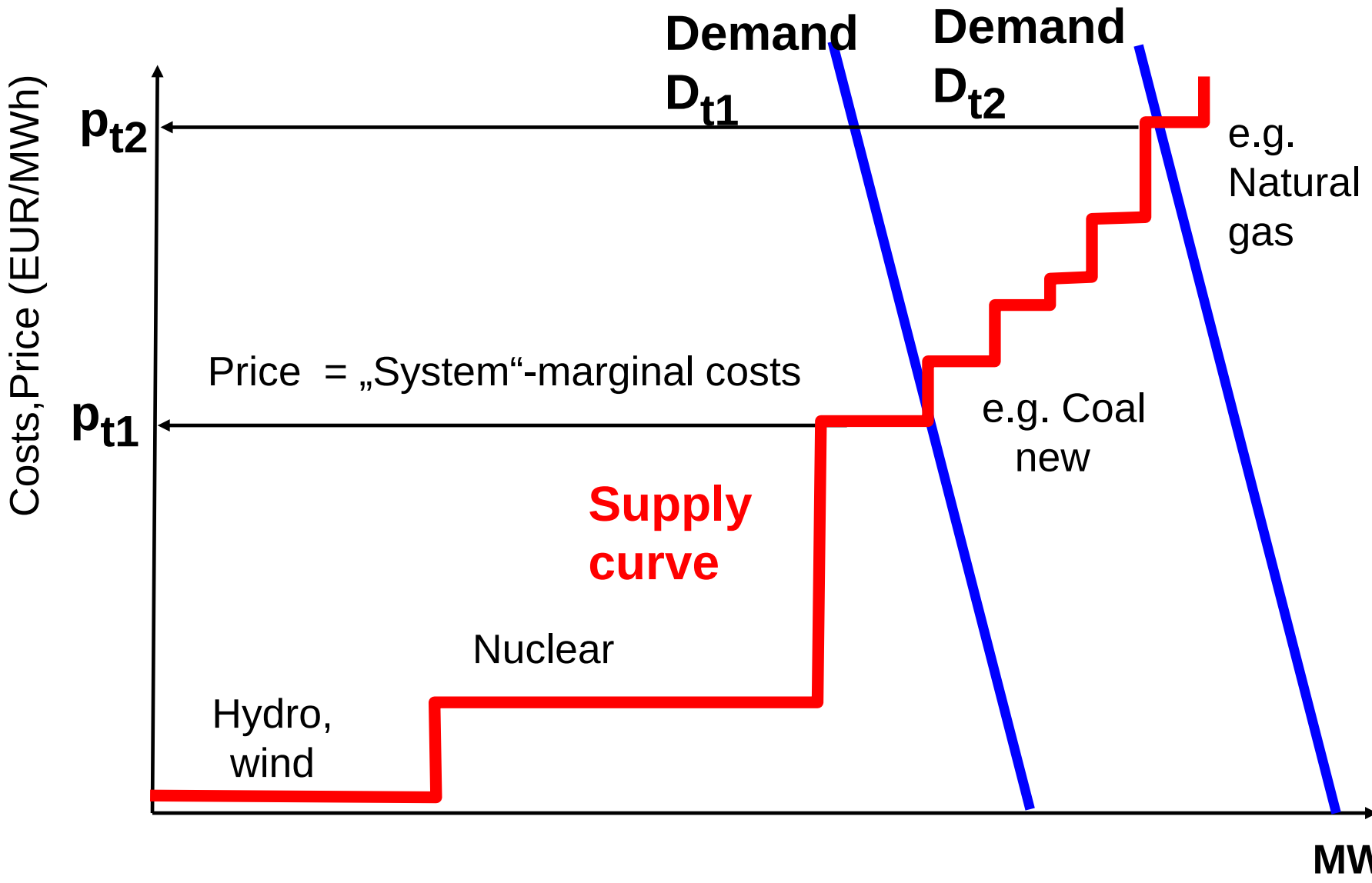
1. INTRODUCTION

Further targets of the EU: 27% to 30% total RES by 2030

Major motivation:
Reduce GHG emissions;

Increase supply security

COMPETITION: PRICES = MARGINAL COSTS



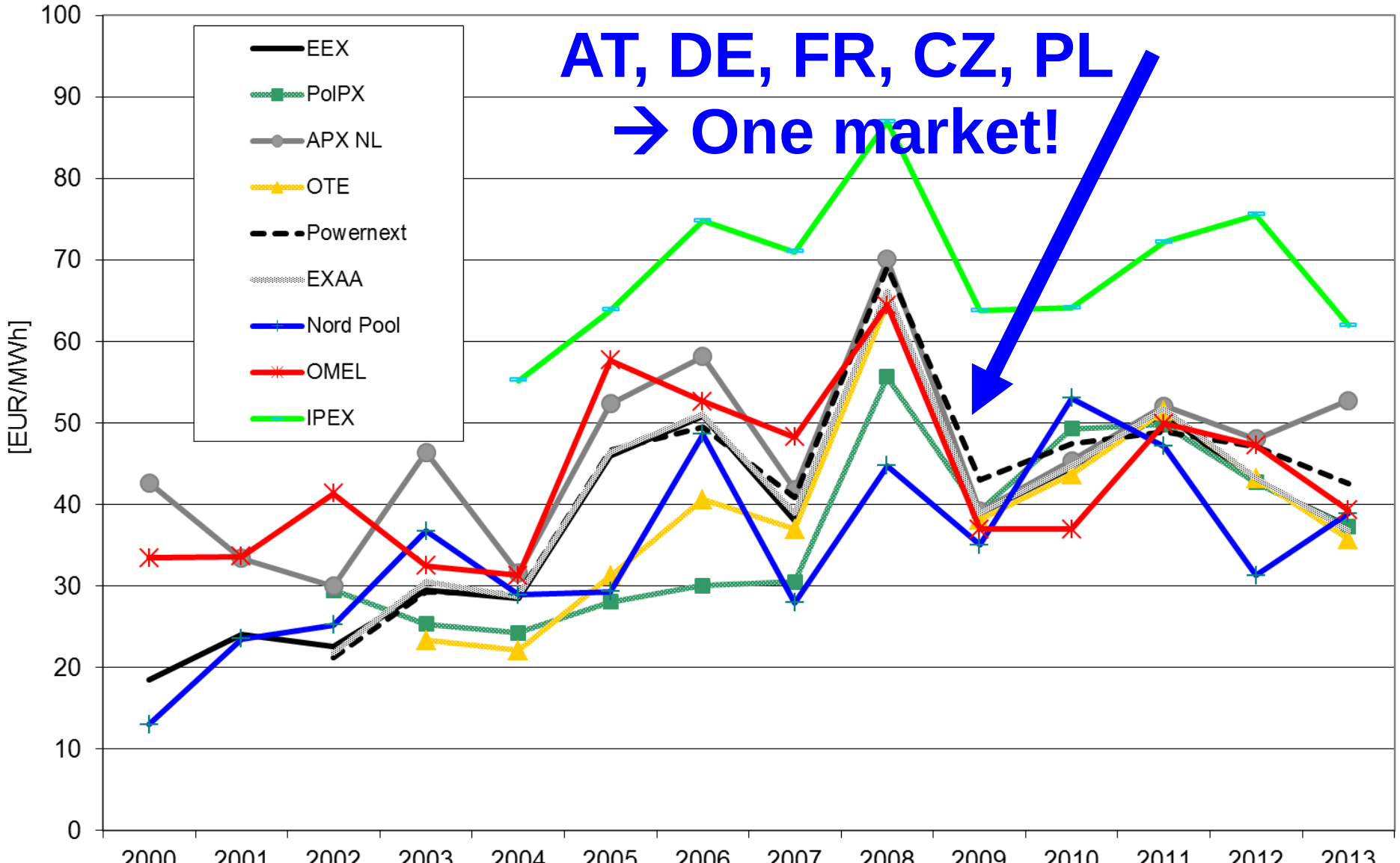
Expectation of:

prices = Short-term marginal costs:

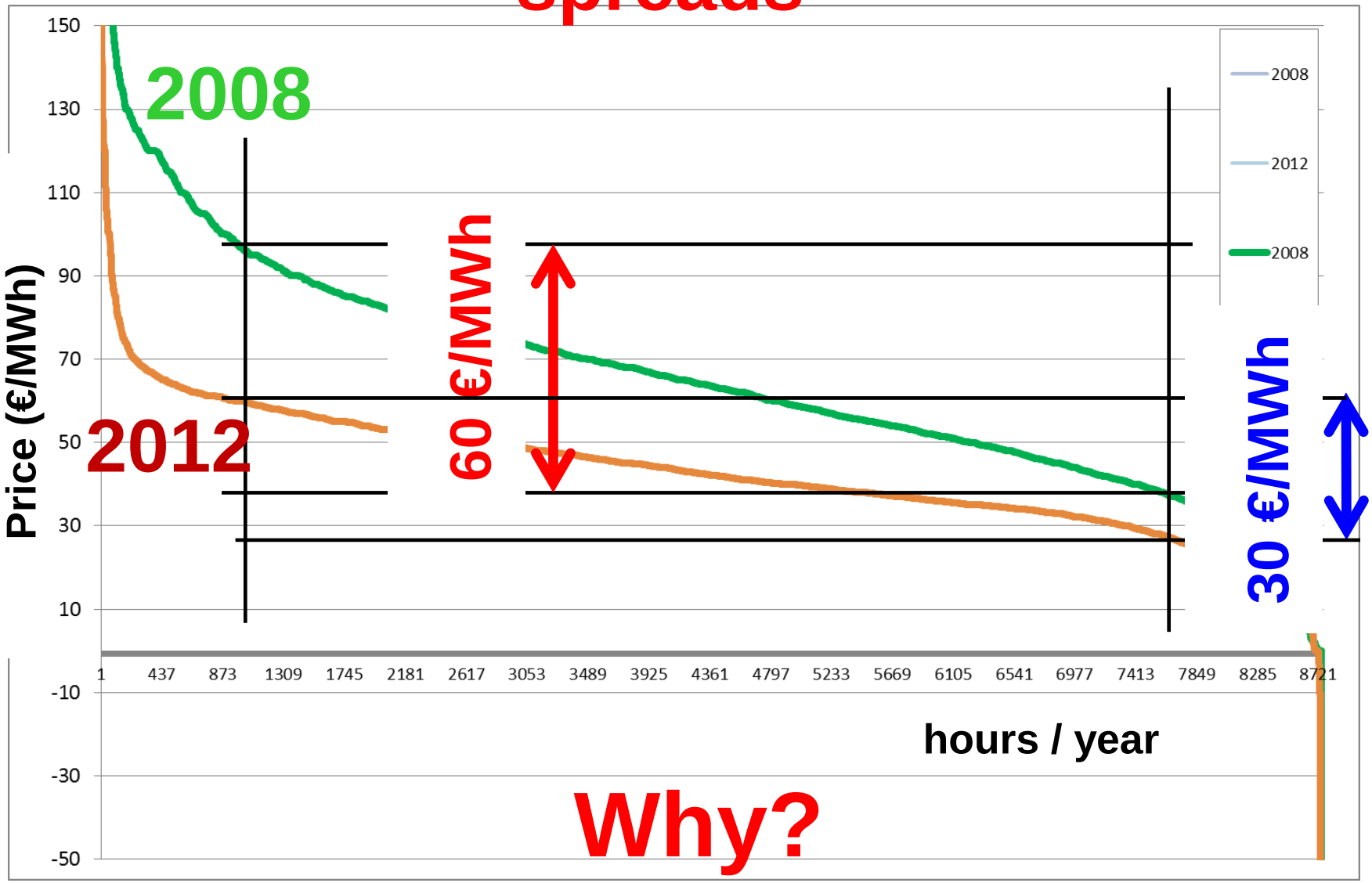
(Short-term marginal costs = fuel costs)

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

DEVELOPMENTS AT SPOT MARKETS



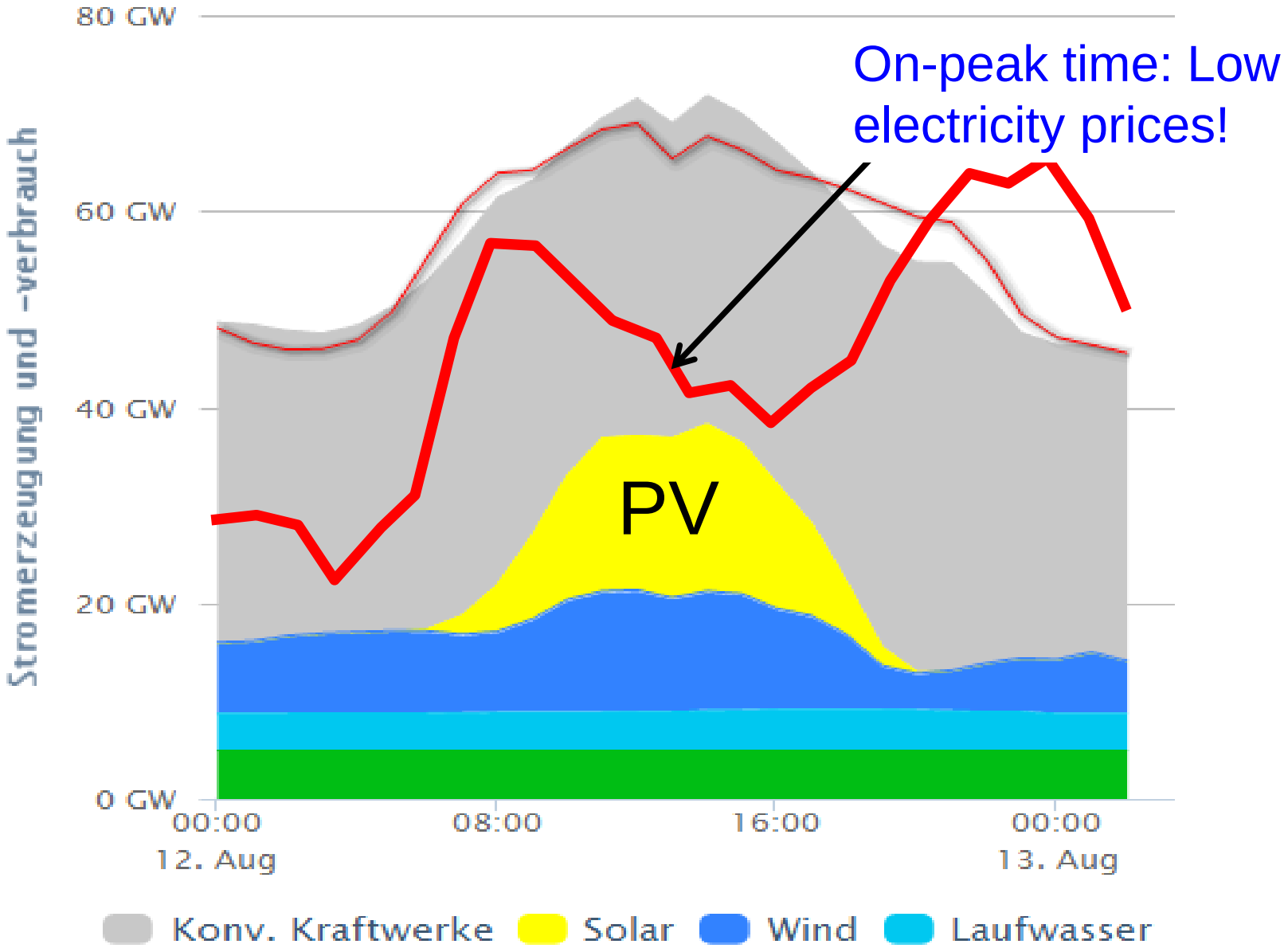
Development of price spreads



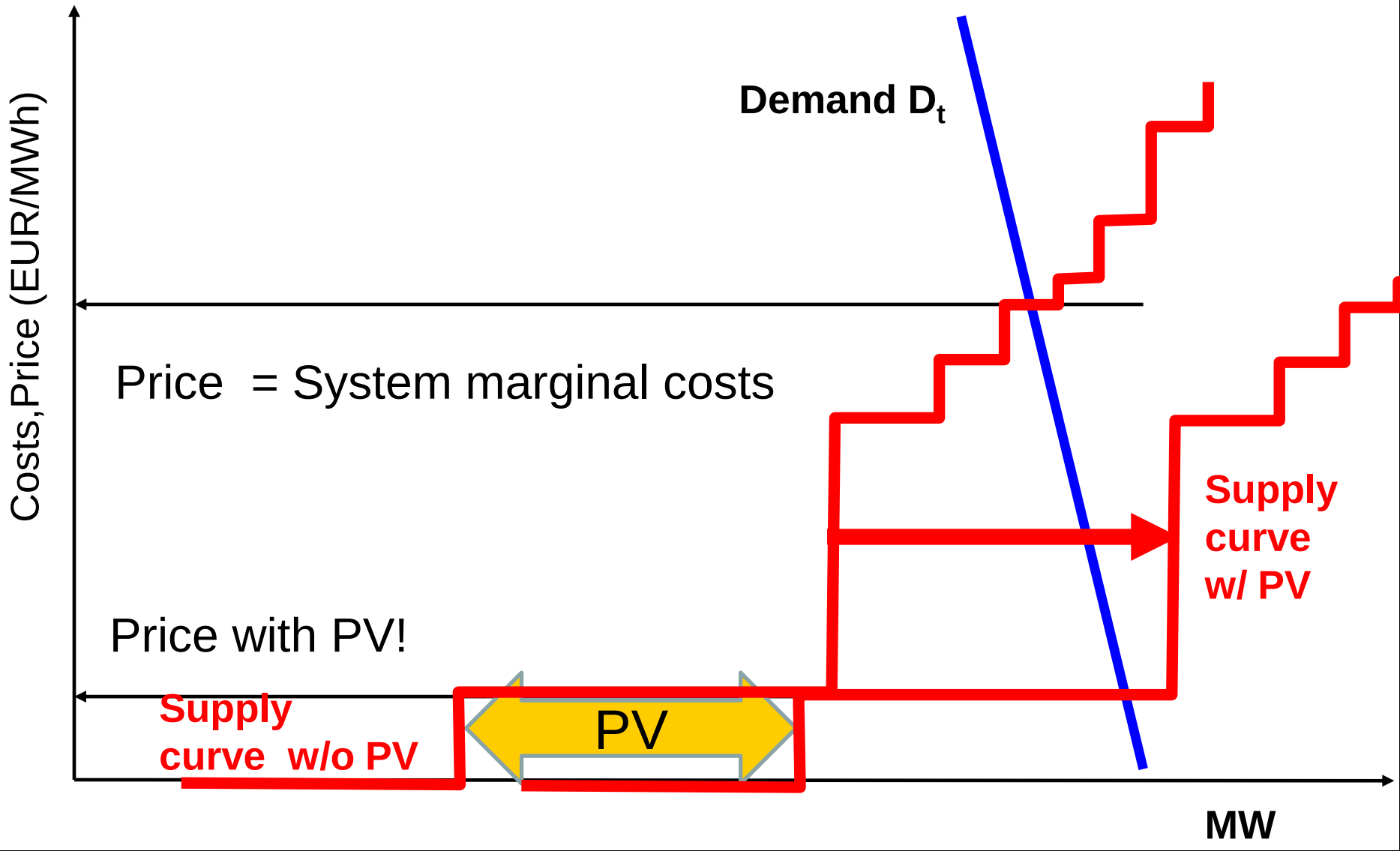
Why?

2 HOW INTERMITTENT RENEWABLES IMPACT PRICES IN ELECTRICITY MARKETS

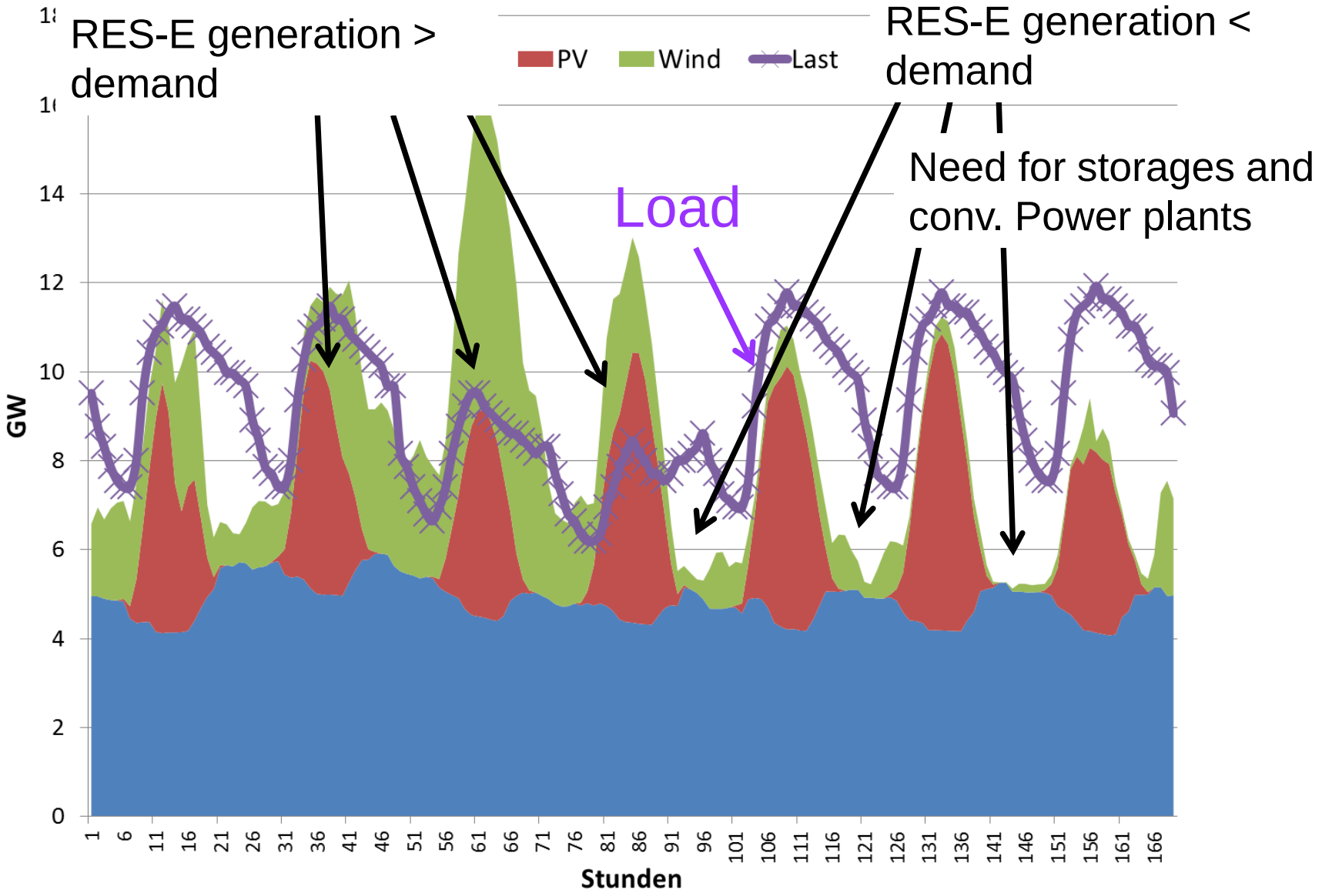
How PV affected the electricity market price at EEX on 12th August



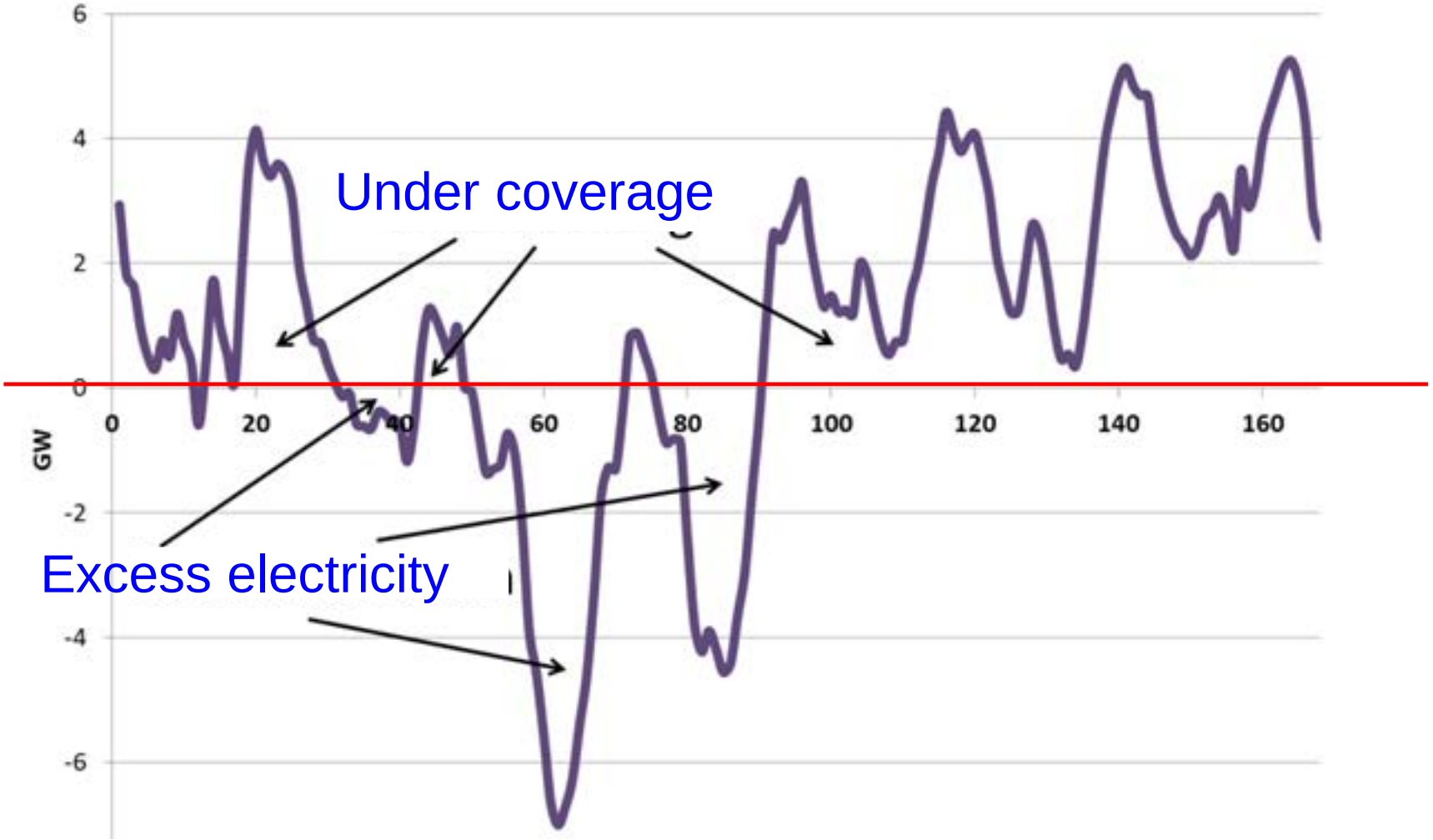
PRICES WITHOUT AND WITH PV



Large market shares of intermittent RES

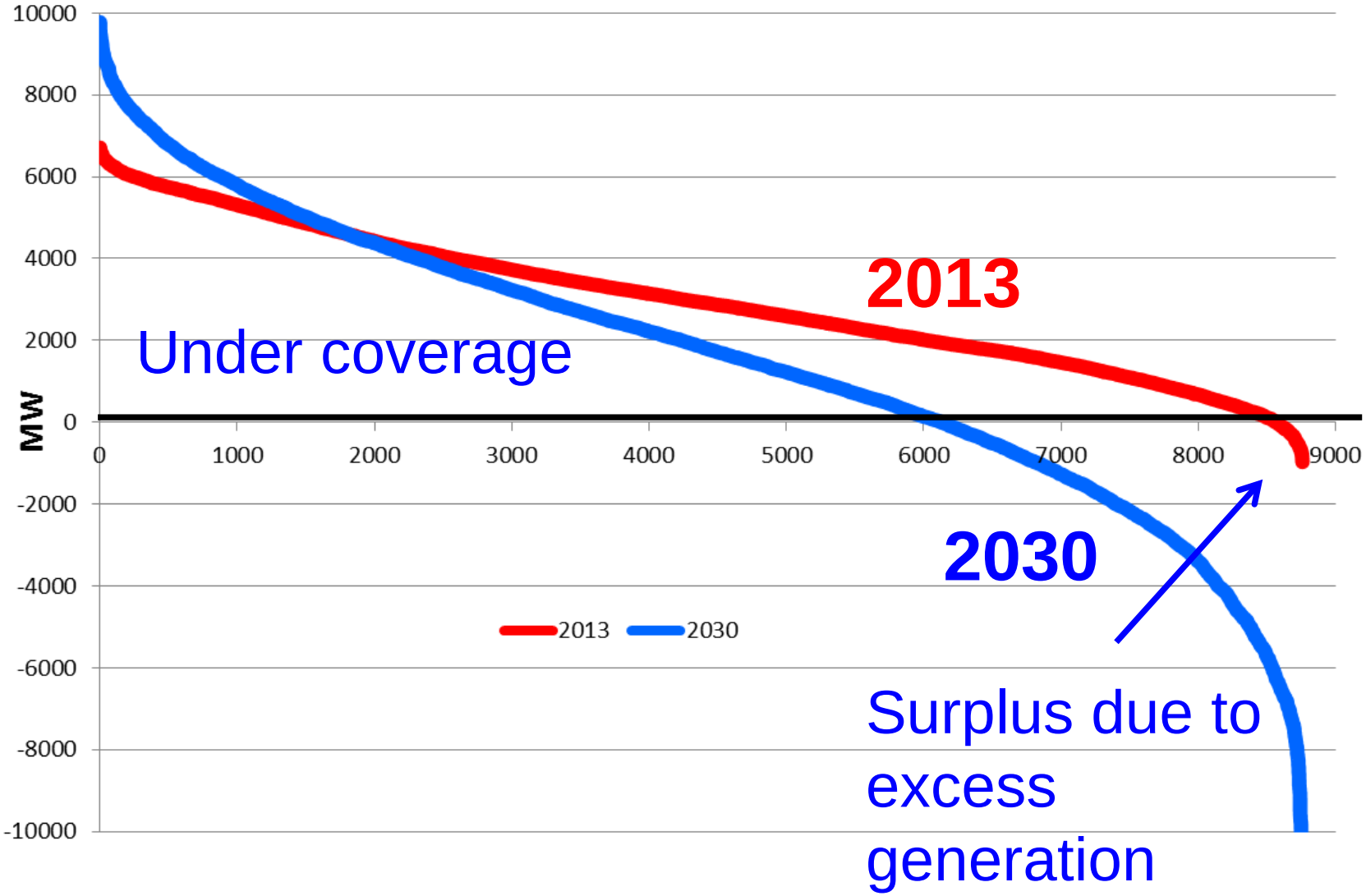


3. How to cover Residual load

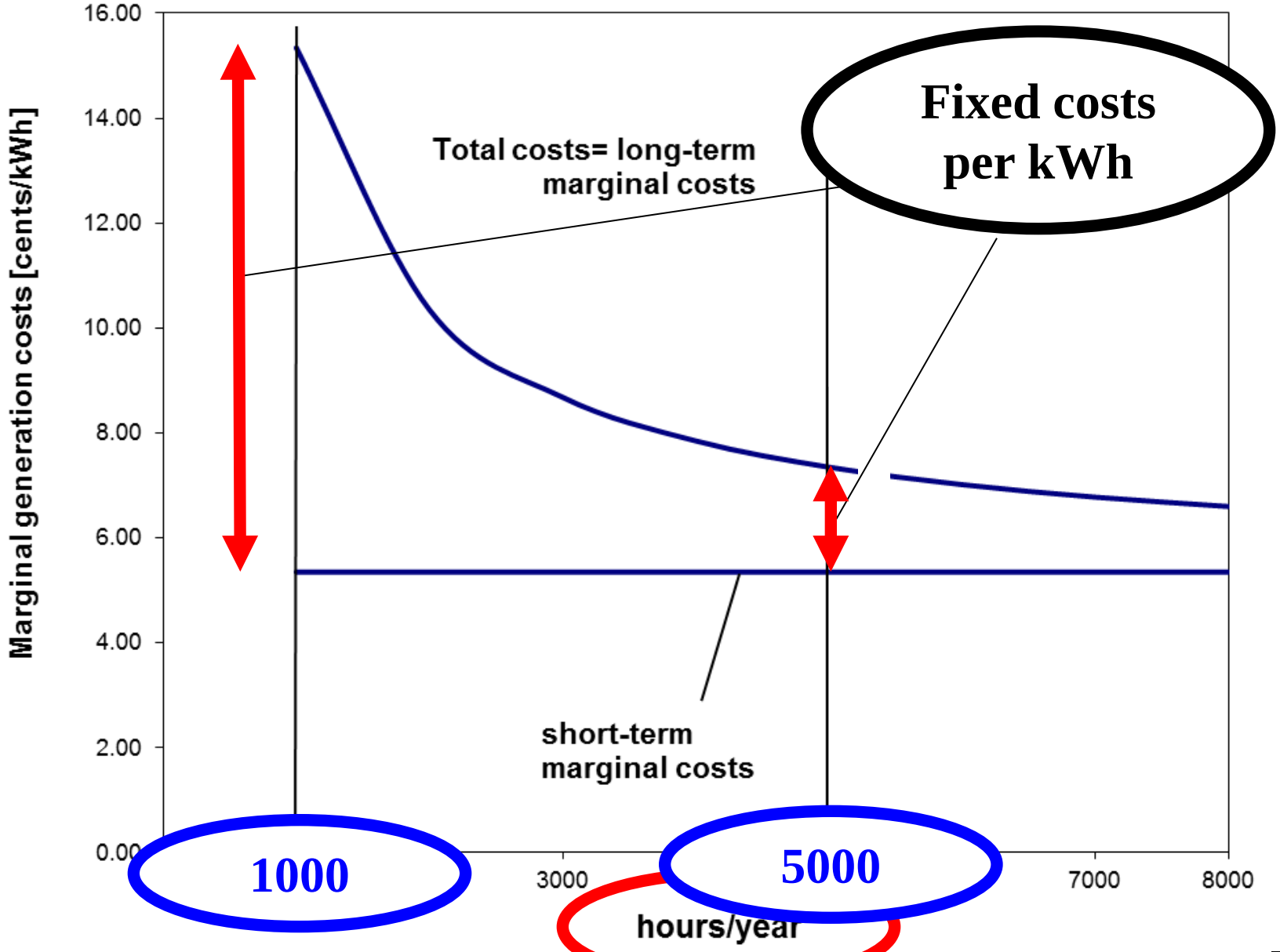


Residual load = Load – non-flexible generation

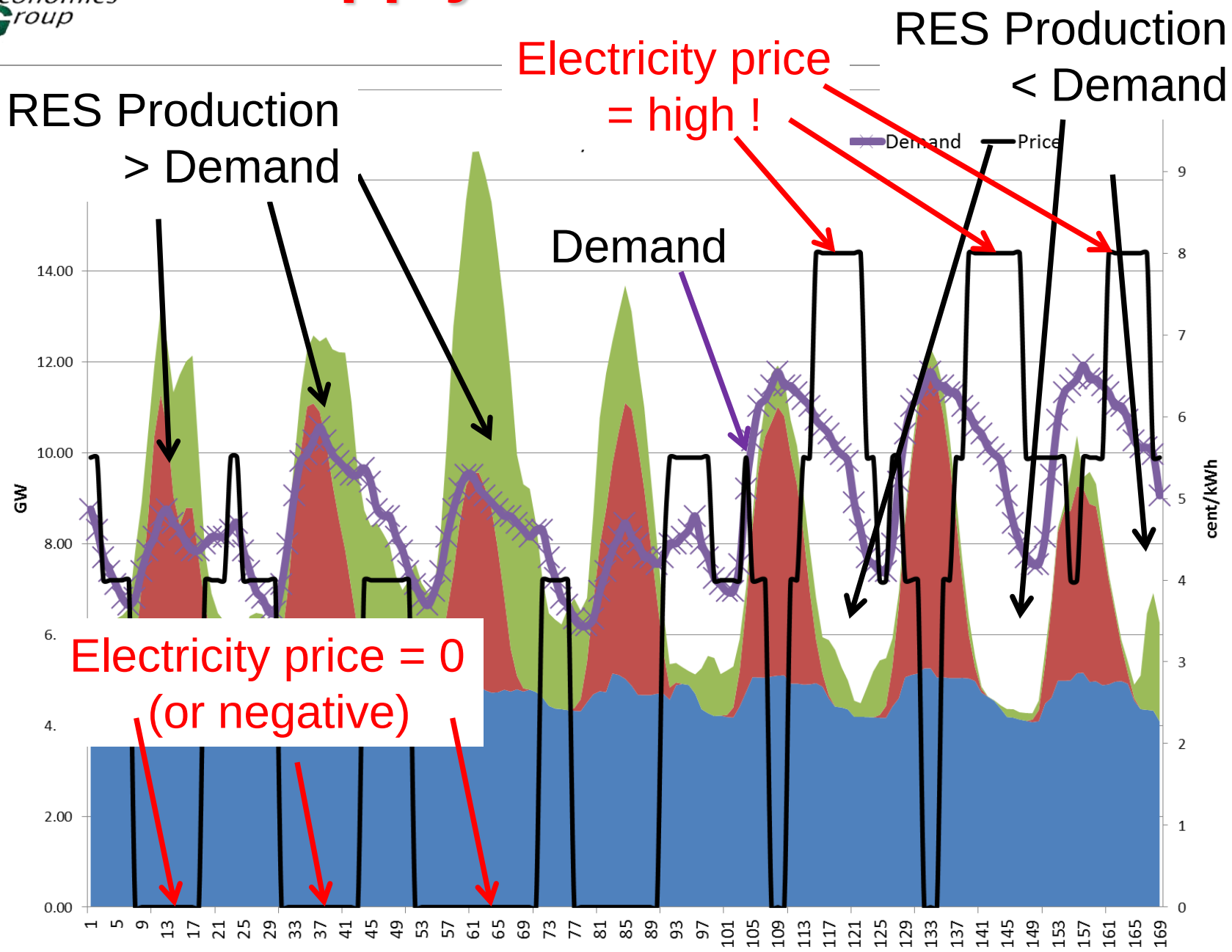
Classified residual load



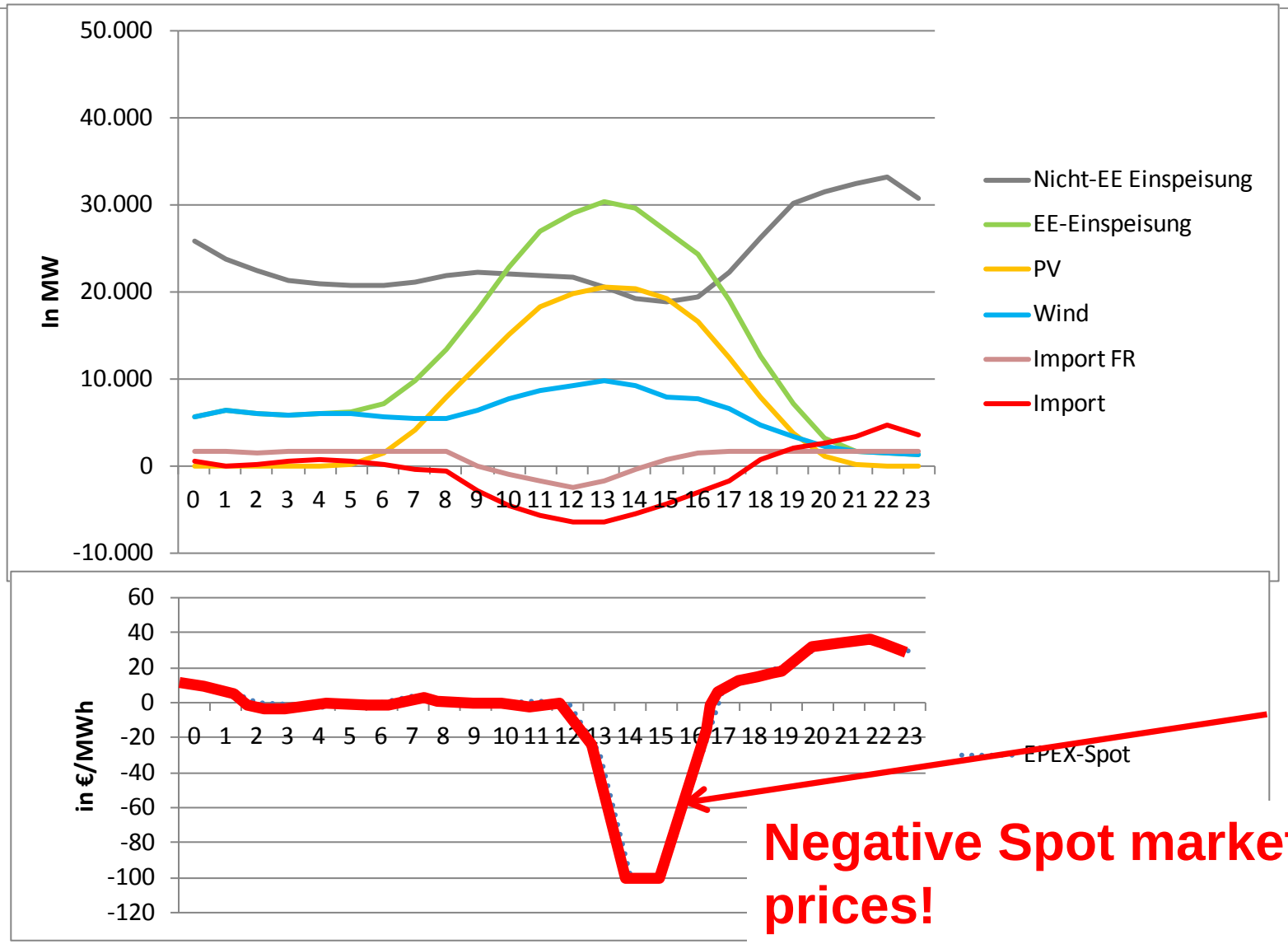
Generation costs CCGT



Supply and Demand



The end of the merit order



Negative Spot market prices!

Consequence: The old price pattern

Price = short-term marginal costs

cannot be retained!

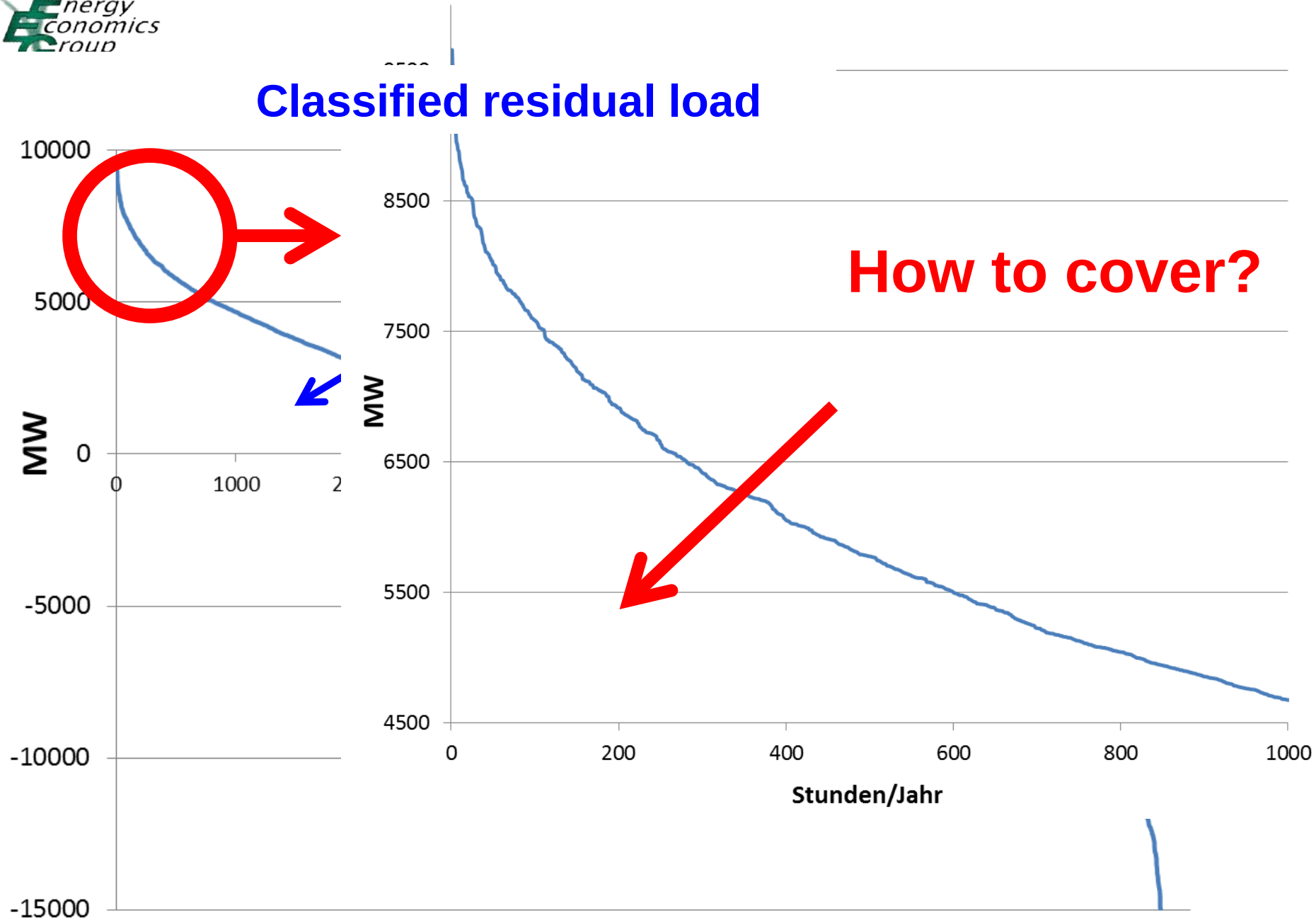
MOST IMPORTANT:
CORRECT PRICE SIGNALS!!!!

This would make it attractive for (some) power plant operators to stay in the market

→

REVISED ENERGY-ONLY MARKET

Classified residual load



By a regulated capacity „market“ ?

or

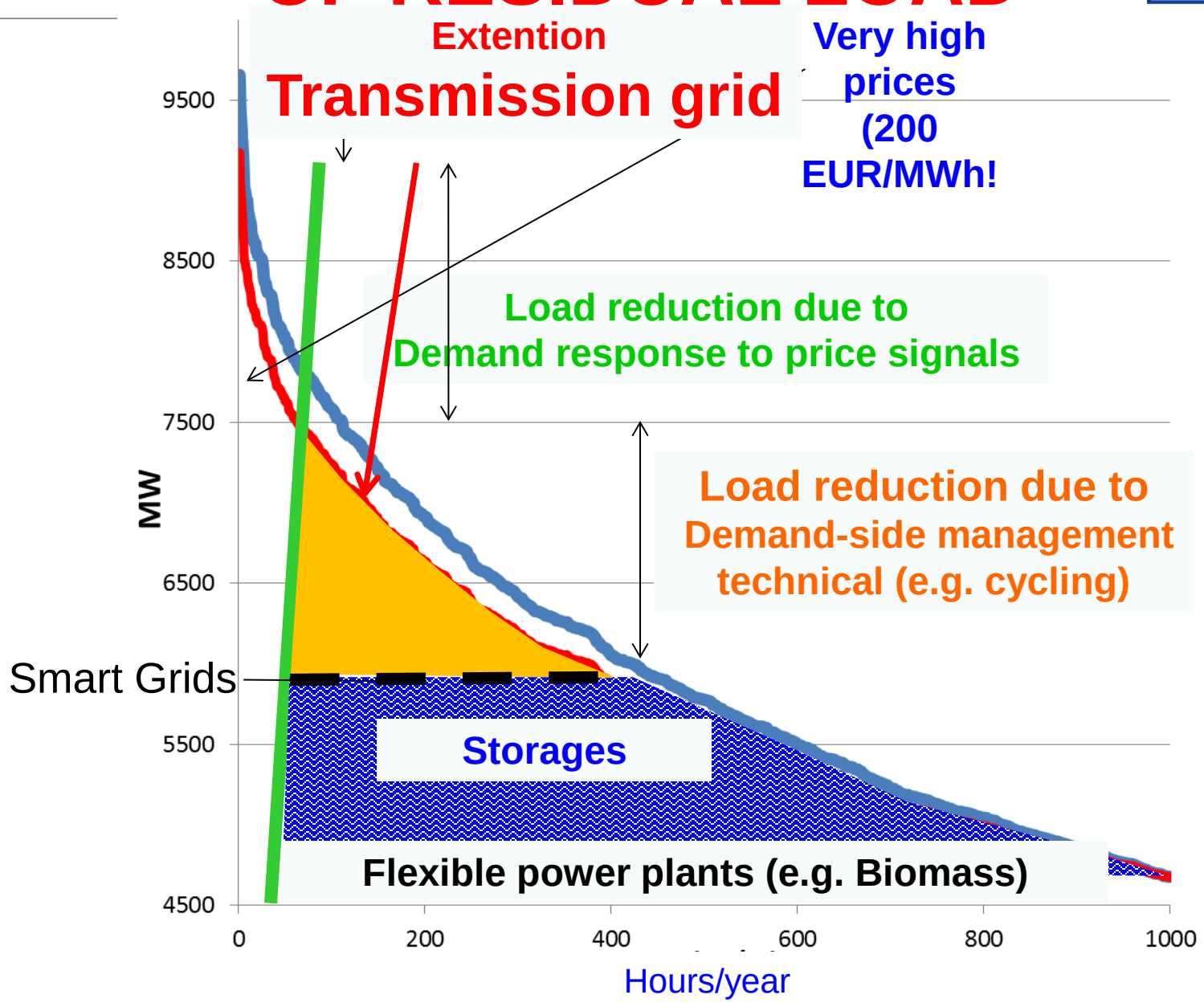
By competition between supply-side and demand-side technologies (incl. storages and grid)?

Regulated capacity payments:

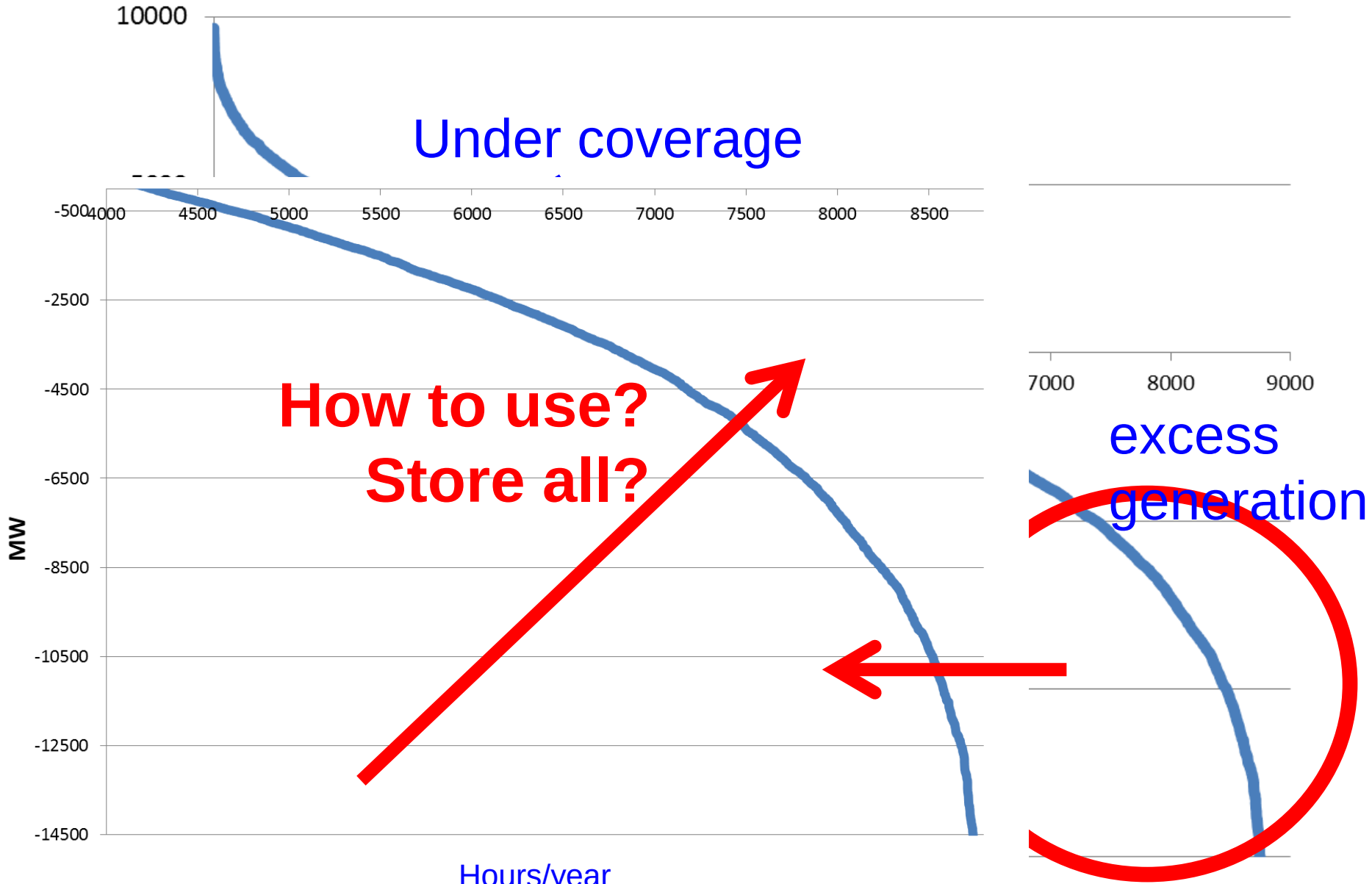
- One of the last attempts of the old (former) large advocats of fossil and nuclear to stay in the market;

- Centralized Capacity Payments will be the death of all ideas of competition and head back to a strictly planned economy

FLEXIBLE COVERAGE OF RESIDUAL LOAD

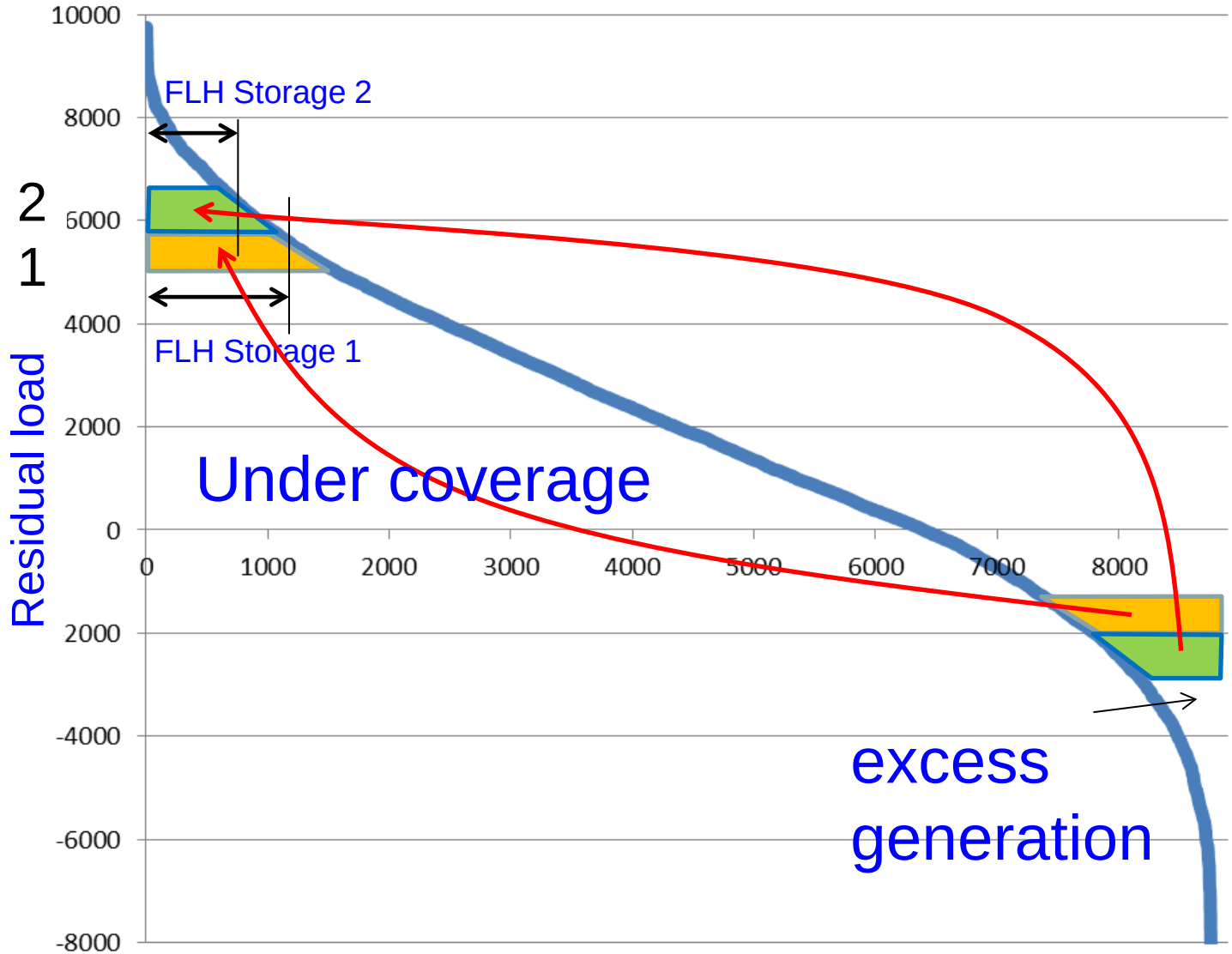


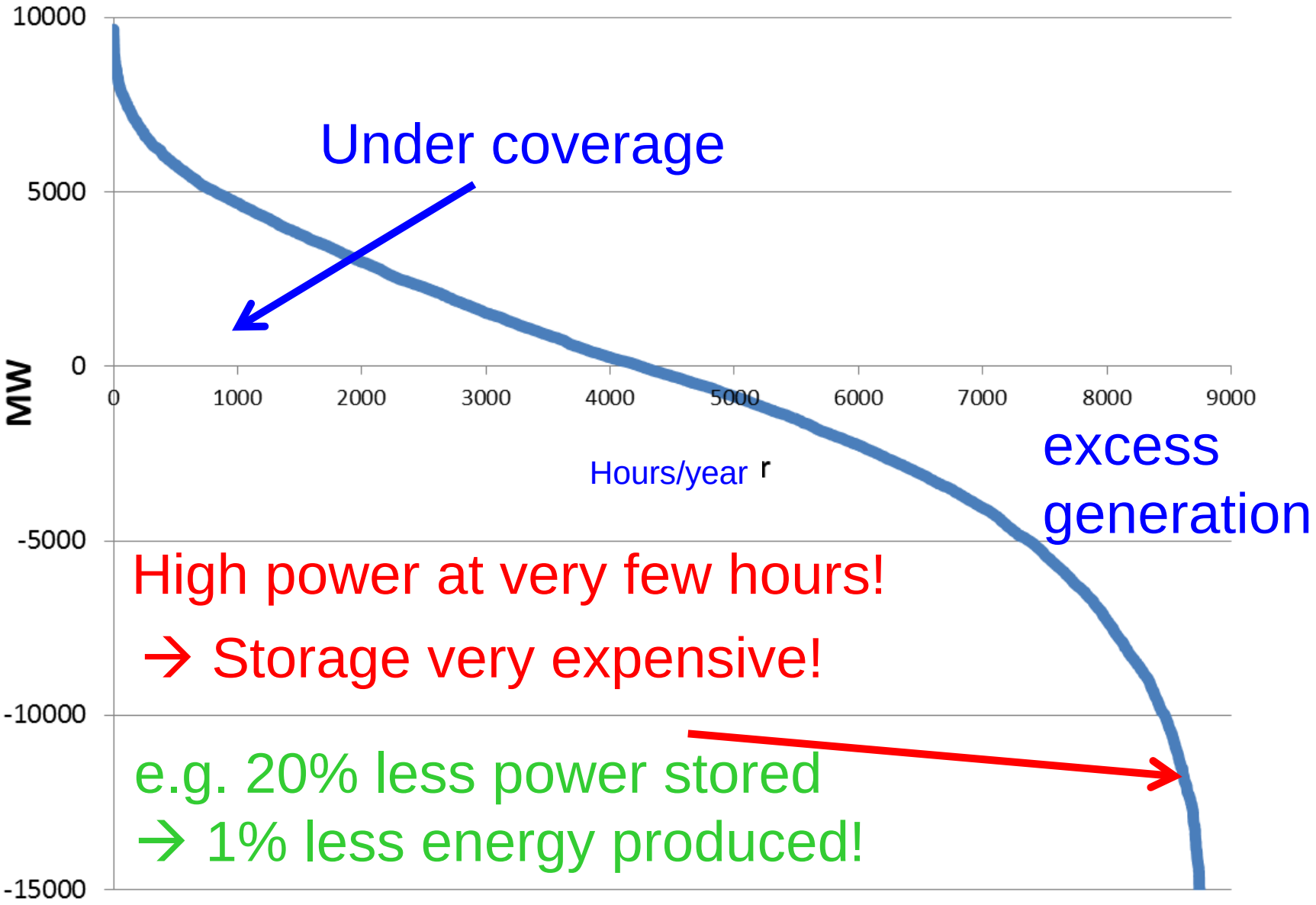
4. HOW MUCH STORAGE DO WE NEED?



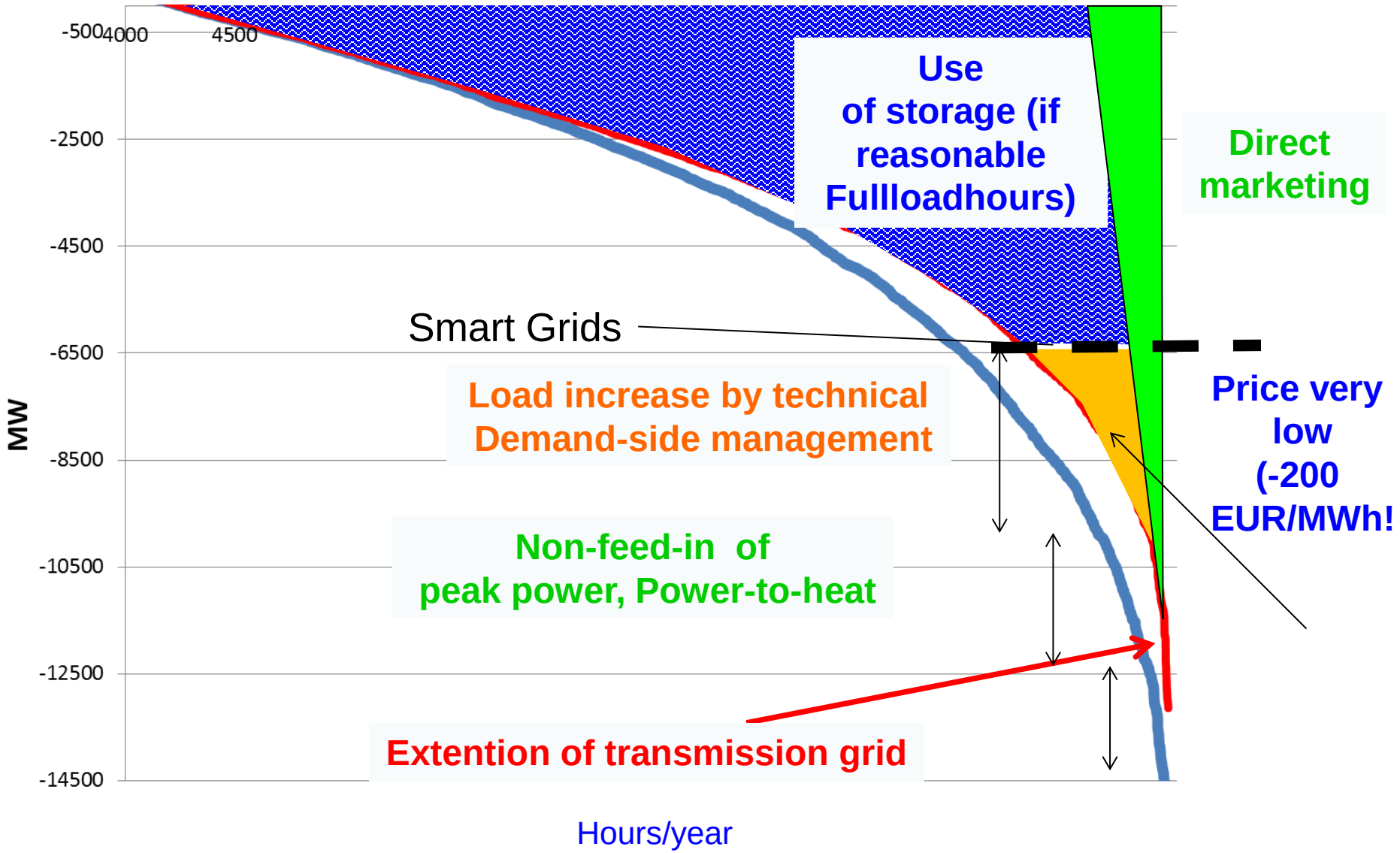
Self cannibalism of storages

Storage 2
Storage 1




10000
5000
0
-5000
-10000
-15000
MW
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Hours/year
Under coverage
excess generation
High power at very few hours!
→ Storage very expensive!
e.g. 20% less power stored
→ 1% less energy produced!

FLEXIBLE USE OF EXCESS ELECTRICITY



5. MARKET INTEGRATION

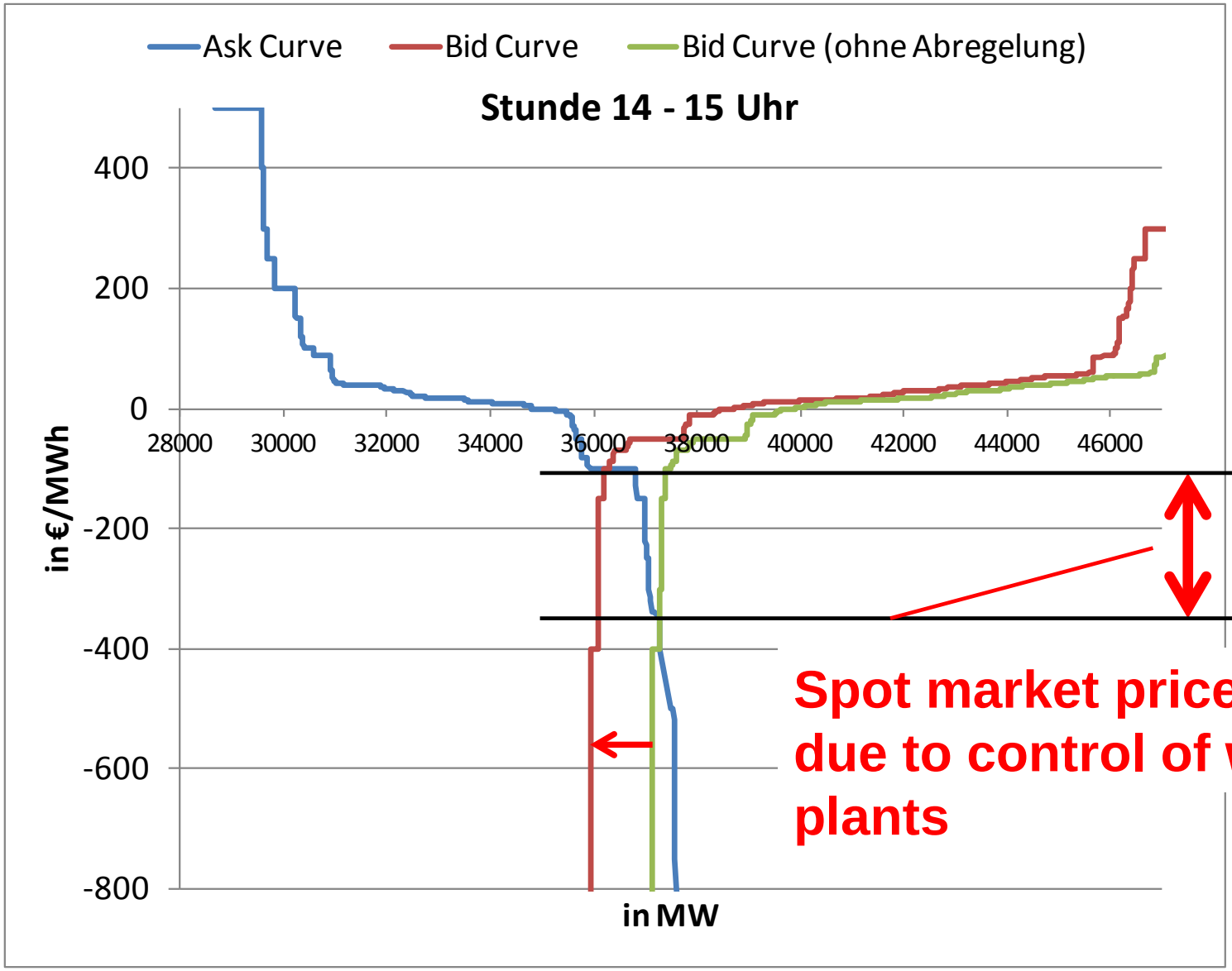
The idea of a market premium

- **Why? Optimize the market value of electricity generated from variable RES;**

Total Revenues = market revenues + market premium

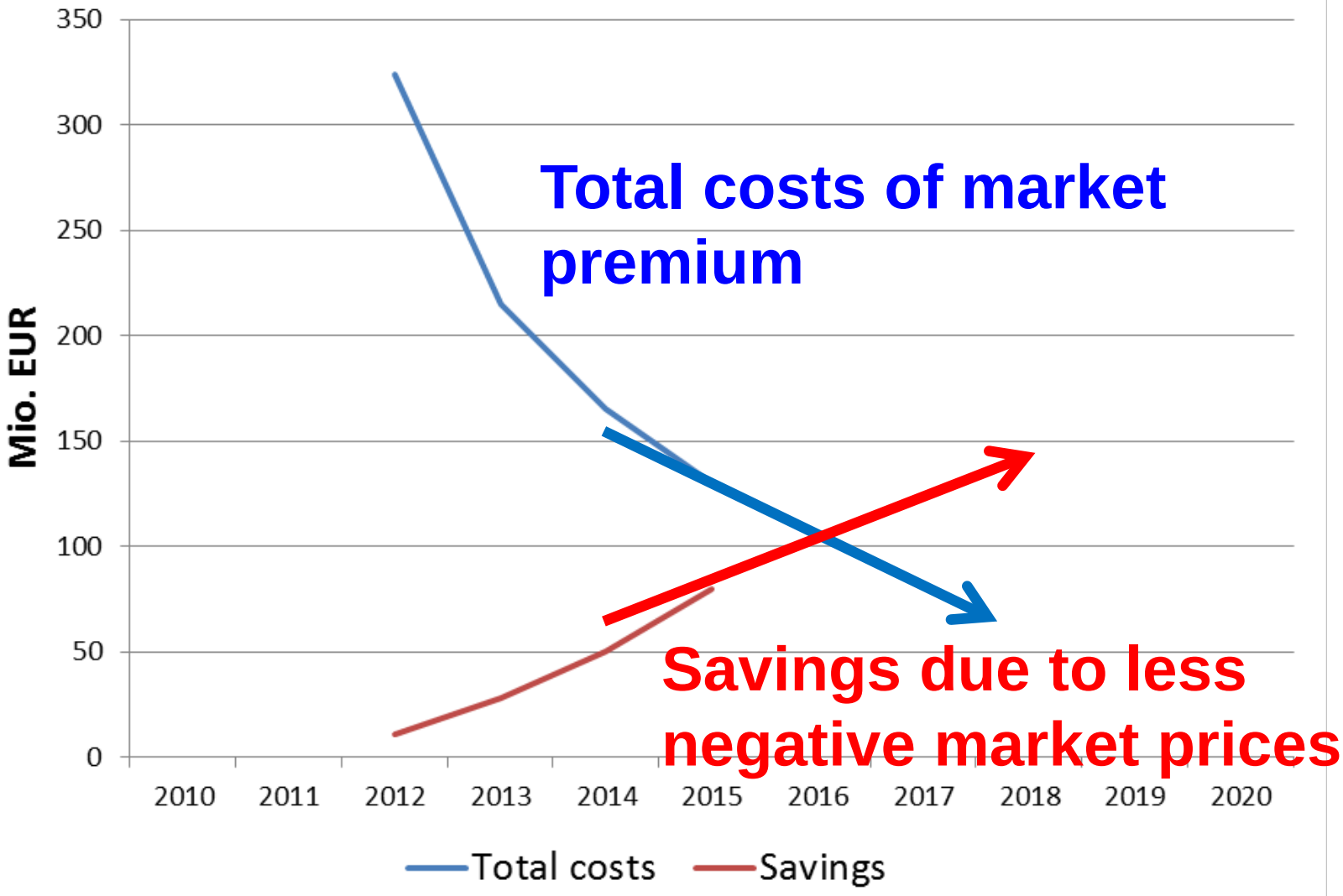
Market premium = EEG – reference market value

The impact of control



Spot market price changes due to control of wind power plants

The effects of the market premium



Improve Forecasting

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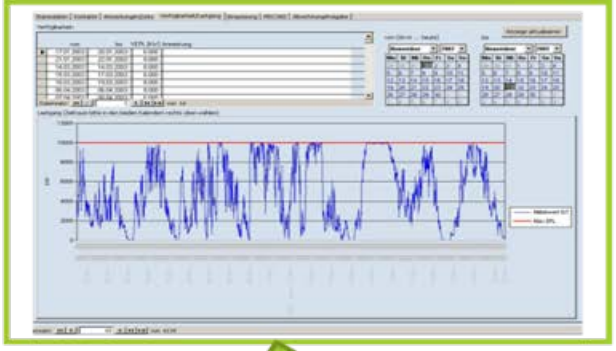
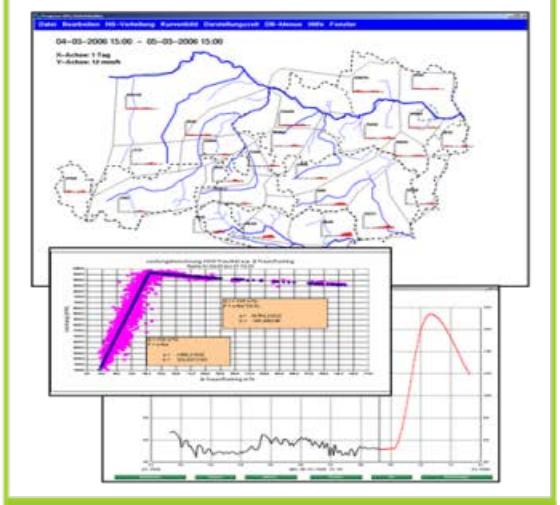
TU VIENNA — Technische Universität Wien / Vienna University of Technology

Stammdaten

Einspeisedaten/Abschaltungen

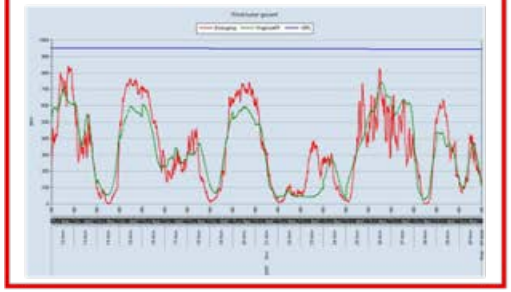


Pegel- u/o Niederschlagsprognose

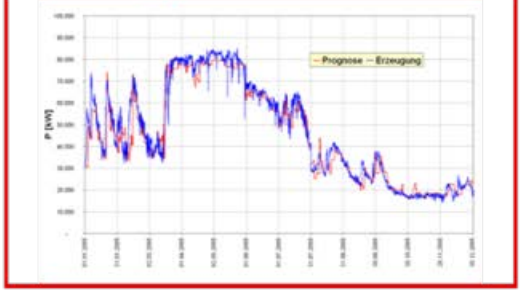


Prognosemodell für Wind- u. Wasserkraft, sonst.

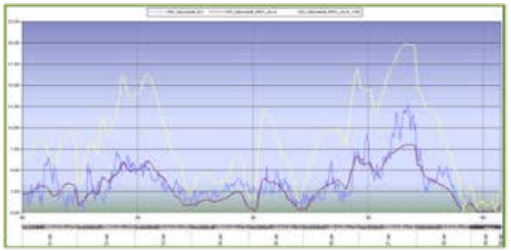
Prognose - Windkraft



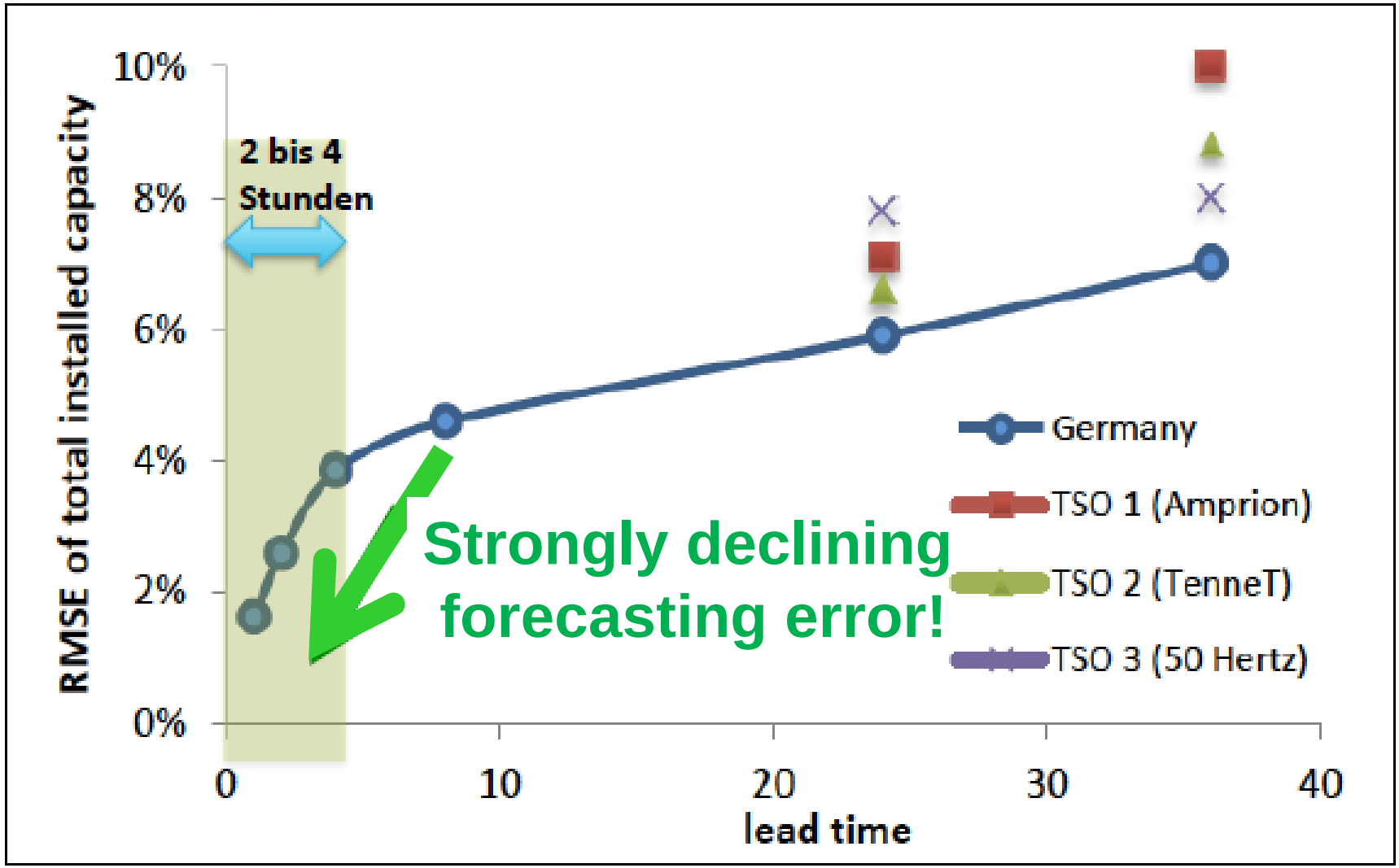
Prognose - Kleinwasserkraft



Wetterprognosedaten



Shorter forecasting periods



Additional measures:

- **Shorter scheduling day-ahead**
  1/4h instead of one hour
  Optimizing control energy markets;
- **Tuning of control and spot markets;**
- **….**

6. CONCLUSIONS

- Ensure correct short-term price signals – high shortage prices if electricity is scarce, negative prices for excess electricity
- From highly centralized supply planning (monopolies) → → decentralized competition of flexibility measures
- Provide incentives for market integration of all categories of RES
- most important now: exhaust the full potential for flexibility of all market participants especially of the demand-side!