ON THE ROLE OF ELECTRICITY STORAGE IN SMART ENERGY SYSTEMS

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2. How variable renewables impact the electricity system
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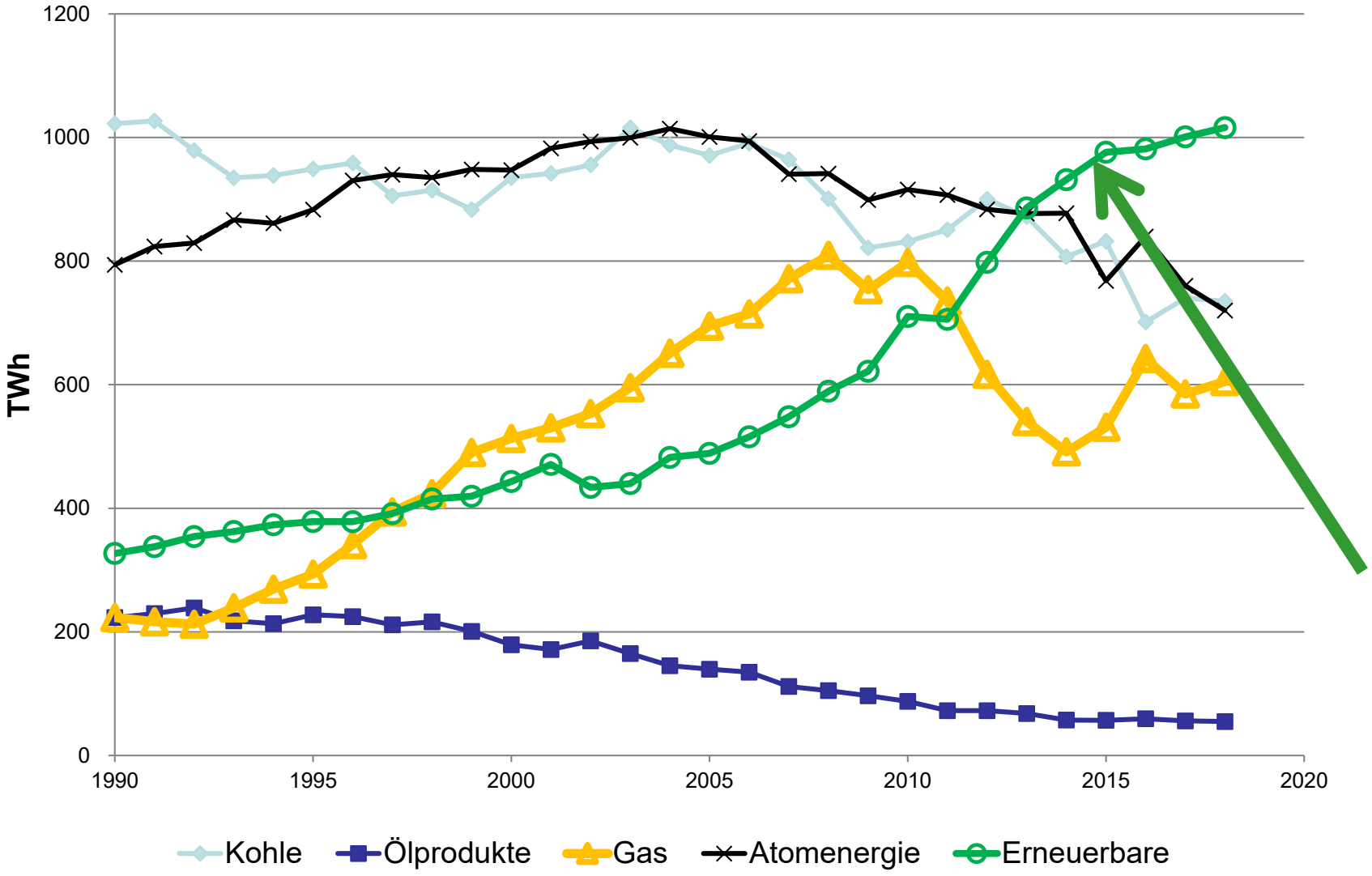
1. INTRODUCTION

Motivation:

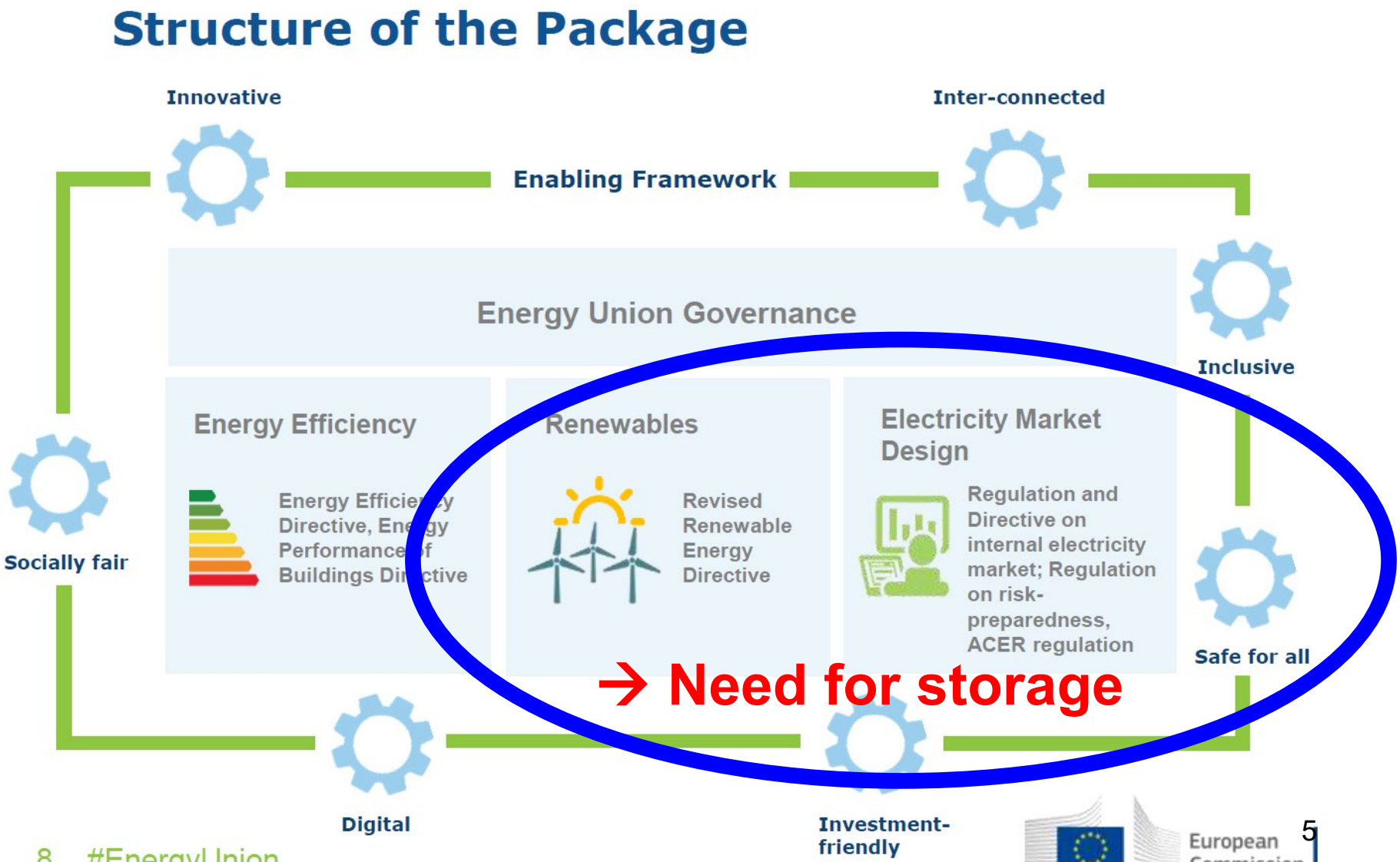
* Climate change → Paris agreements
* Targets for renewables → Need for storage
* Europe: The clean energy package → energy communities → Need for storage
* Not possible to force variable renewables into the system → Need for storage
* Strong desire of some customers to participate in electricity supply

Electricity generation EU-28



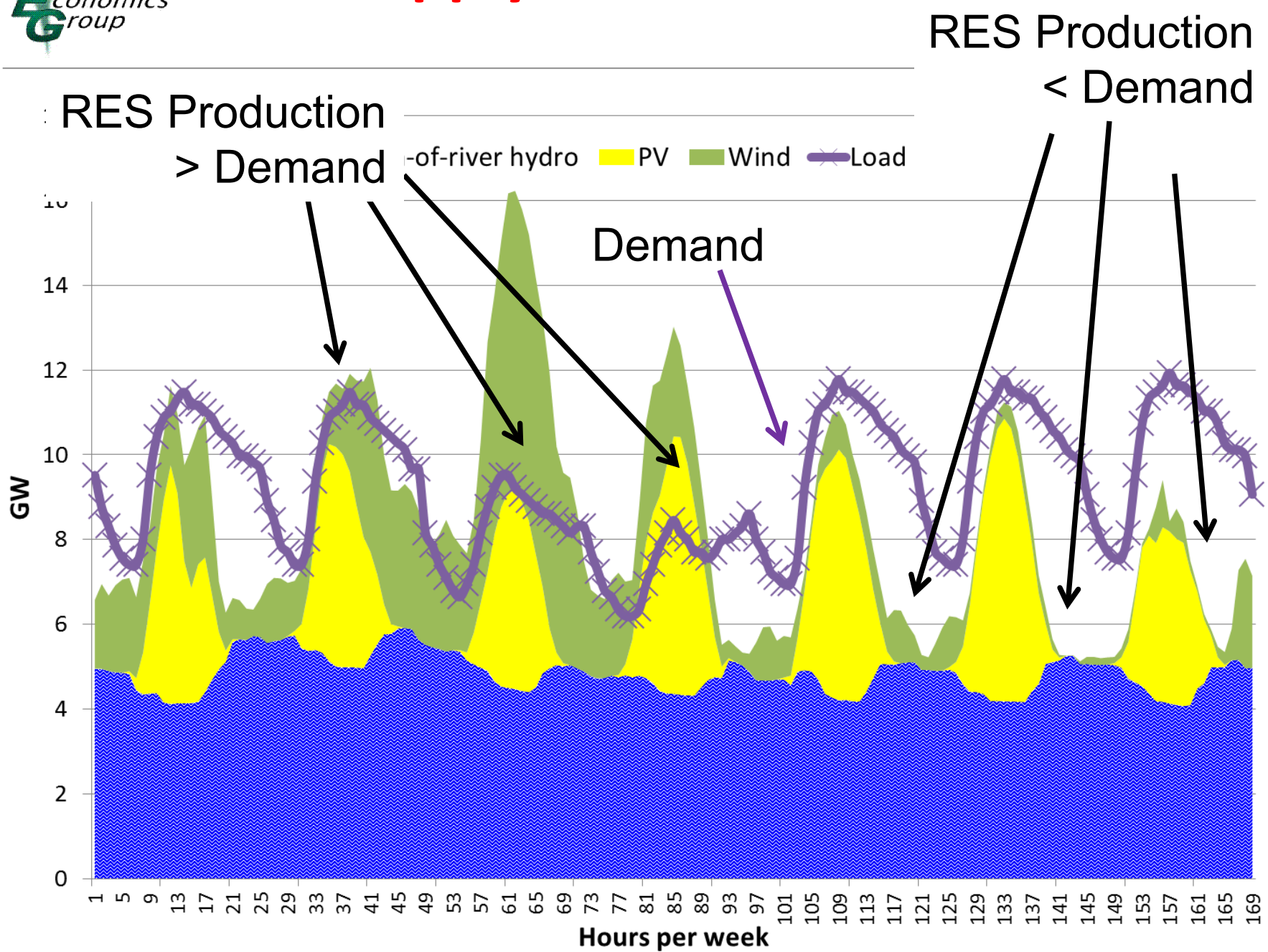
Werte für 2017 und 2018 vorläufig

The clean energy package of the EU

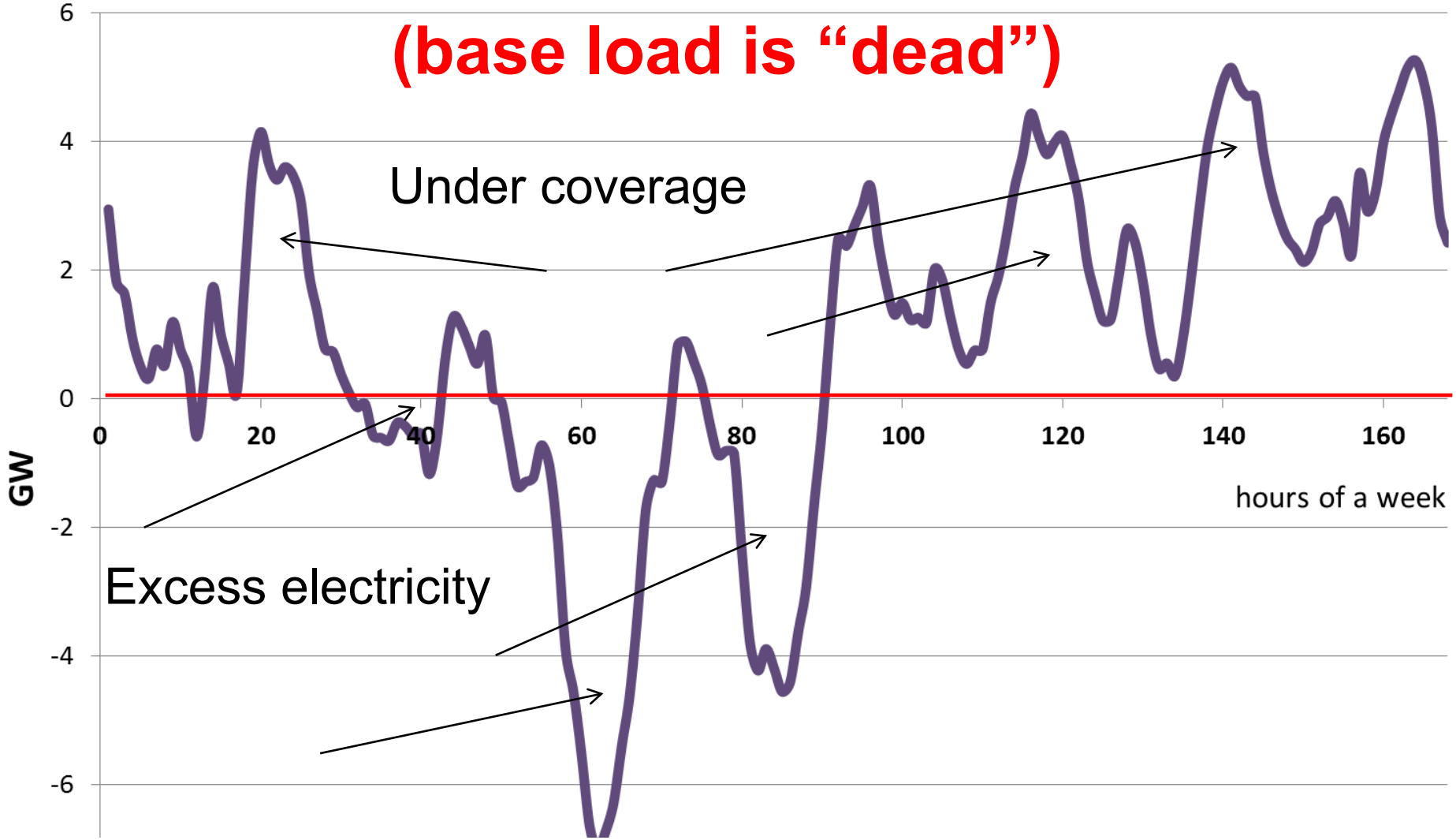


2 HOW VARIABLE RENEWABLES IMPACT THE ELECTRICITY SYSTEM

Supply and Demand

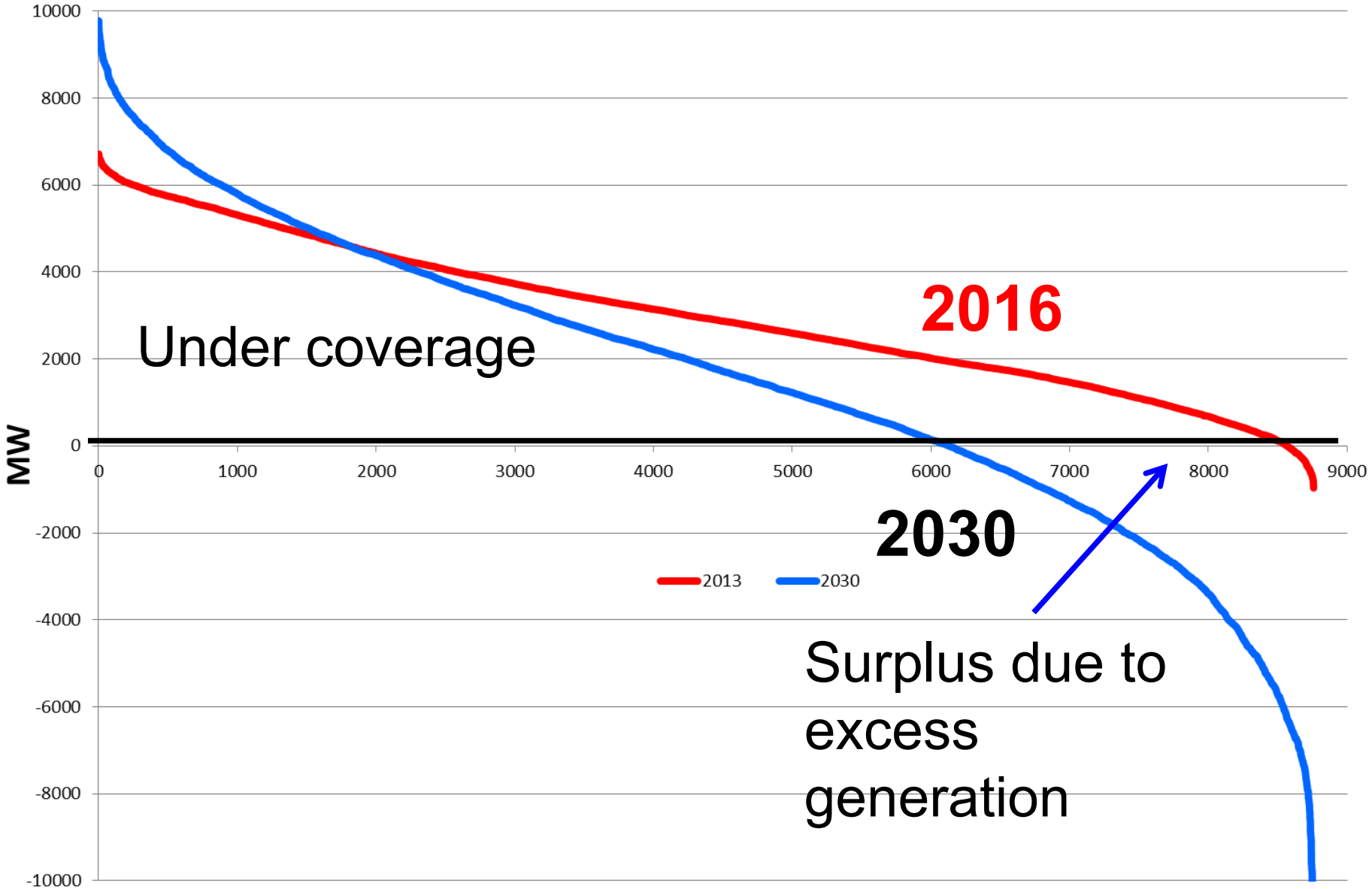


Key term of the future: Residual load (base load is “dead”)

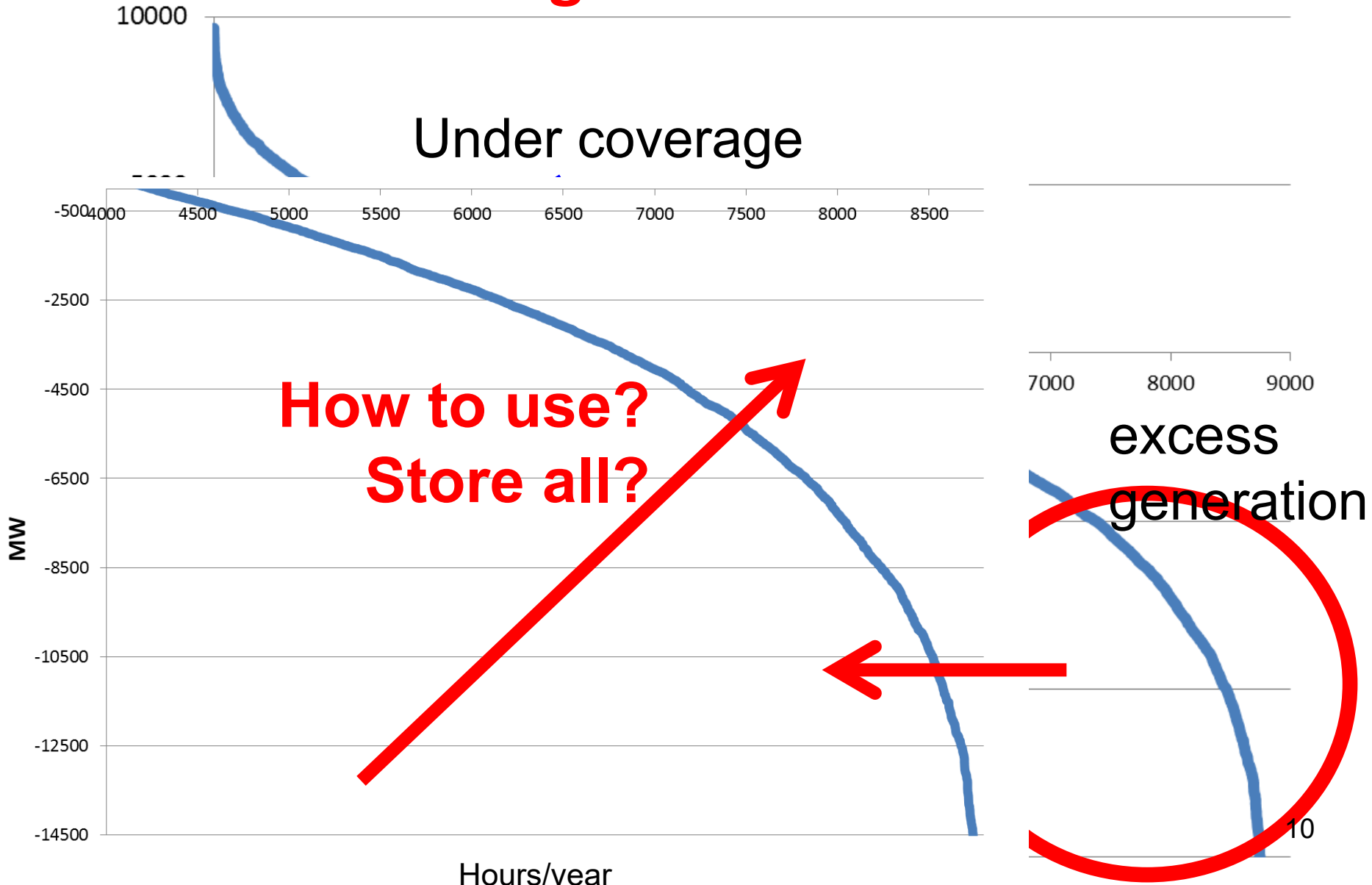


Residual load = Load – non-flexible generation

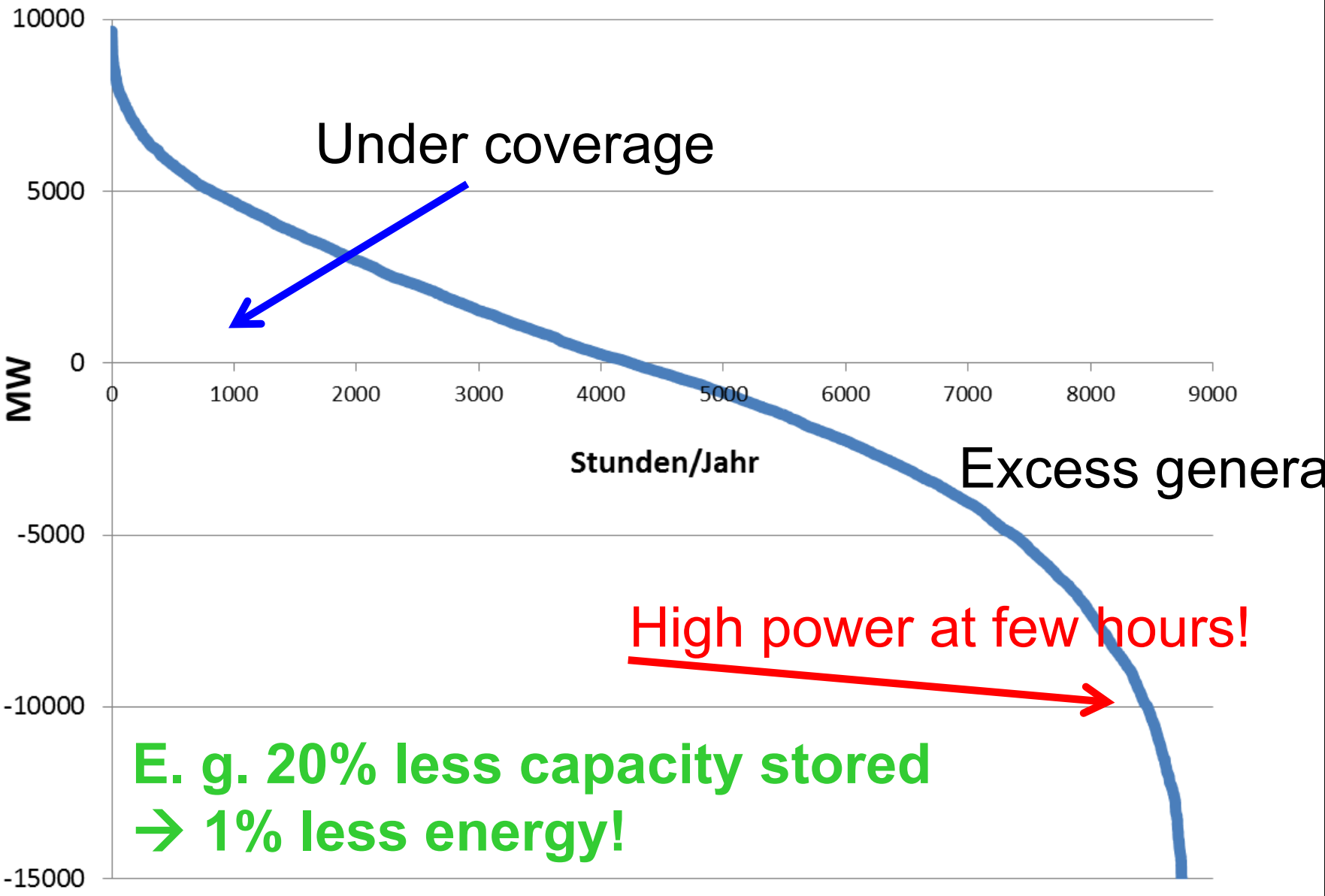
Classified residual load over a year



3. Specific question: How much storage do we need?



Storing every peak?



4. 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

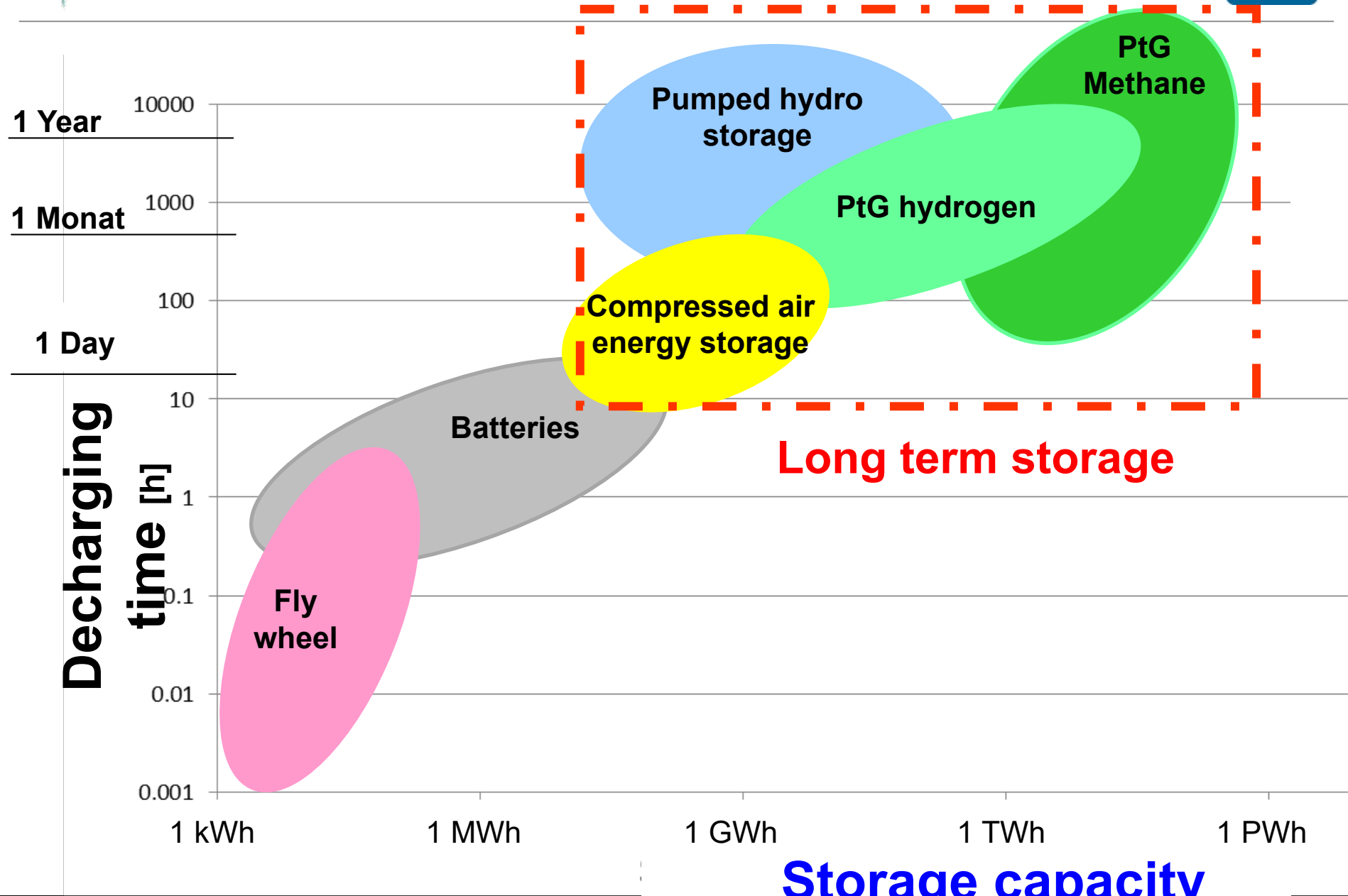
T … Fullloadhours (hours per year)

η_{SP} … Efficiency of storage

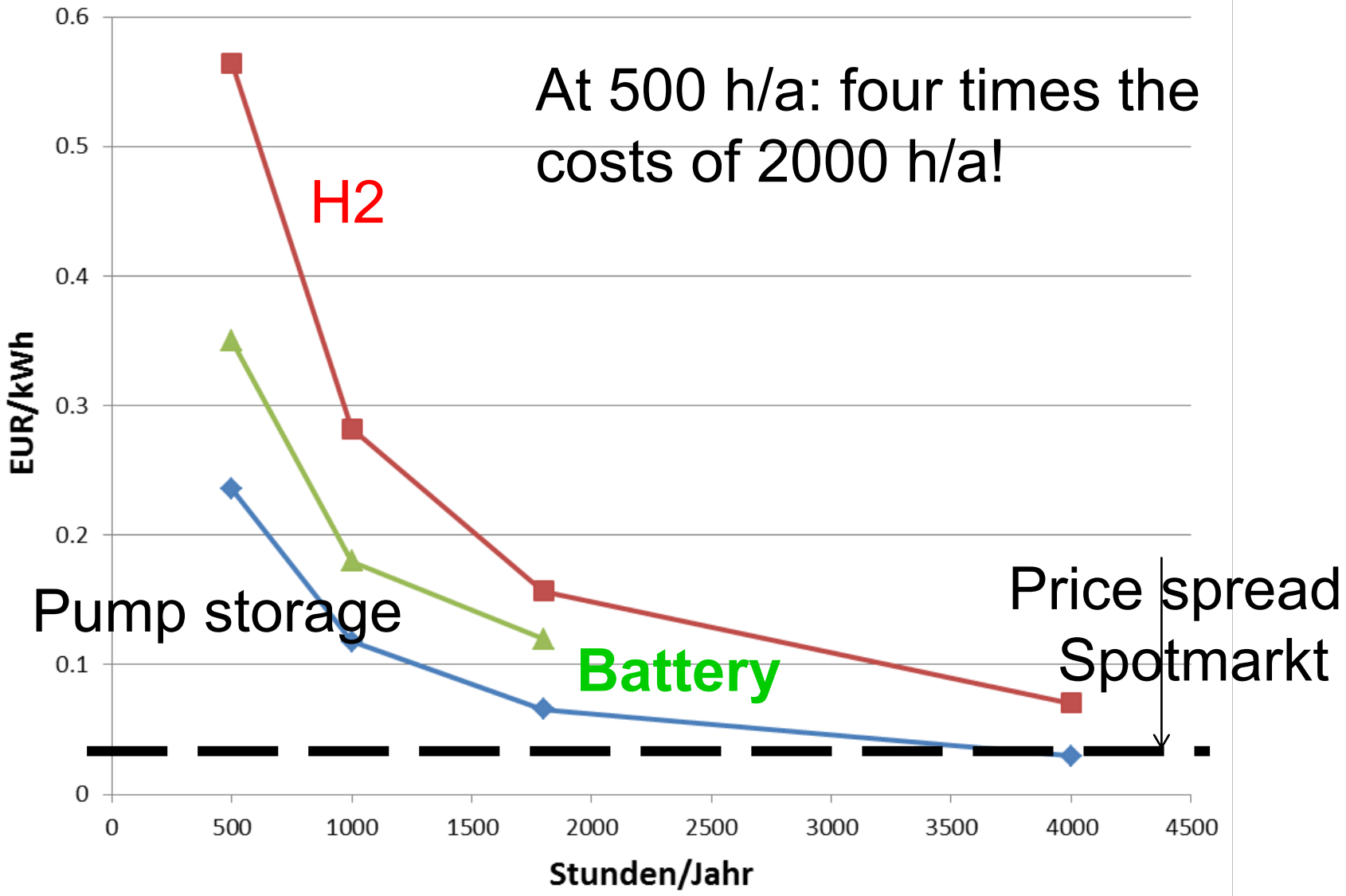
Key factors:

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

Short term vs Long term storage



Impact of fullloadhours

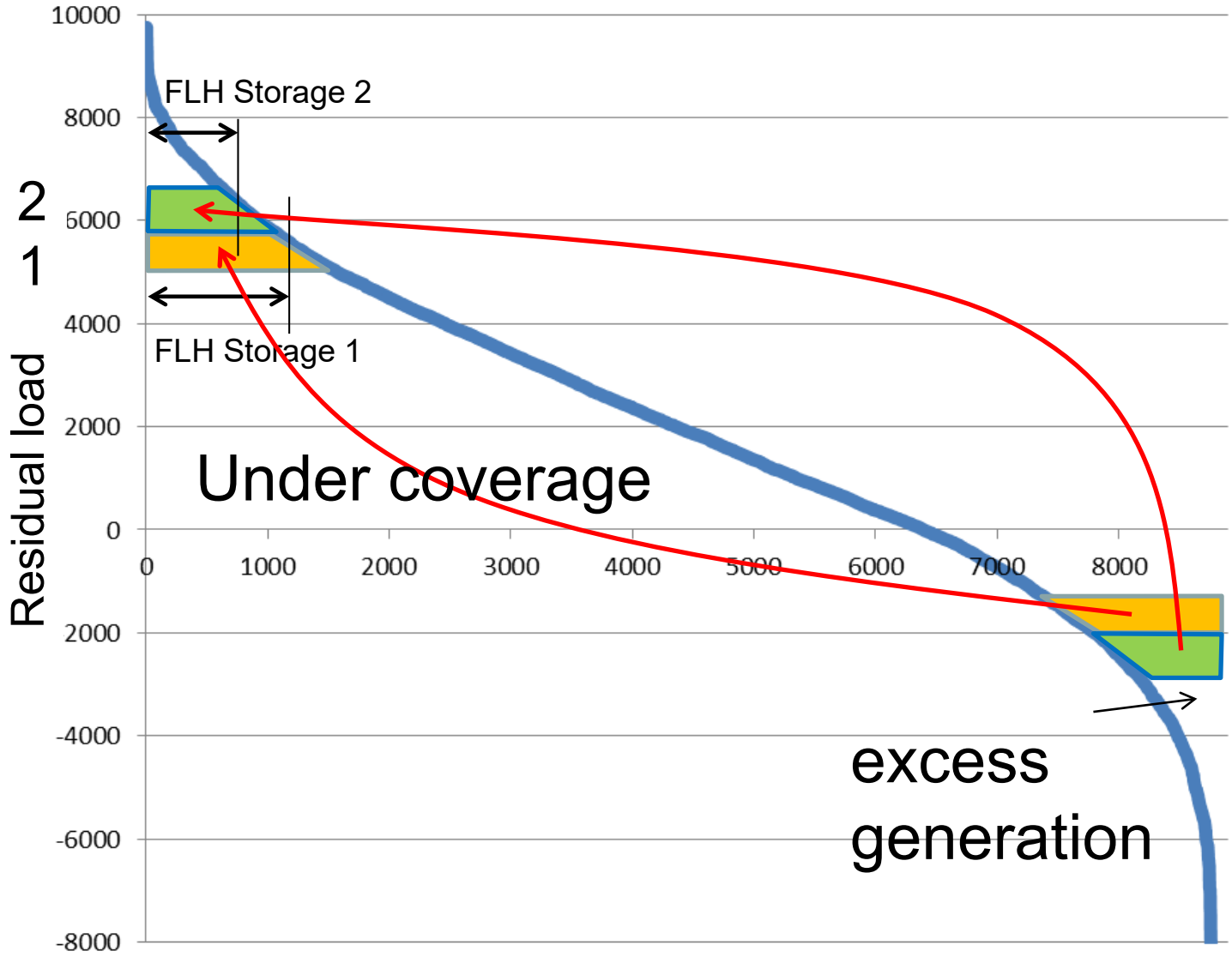


PRINCIPLE OF SELF CANNIBALISM IN ENERGY ECONOMICS:

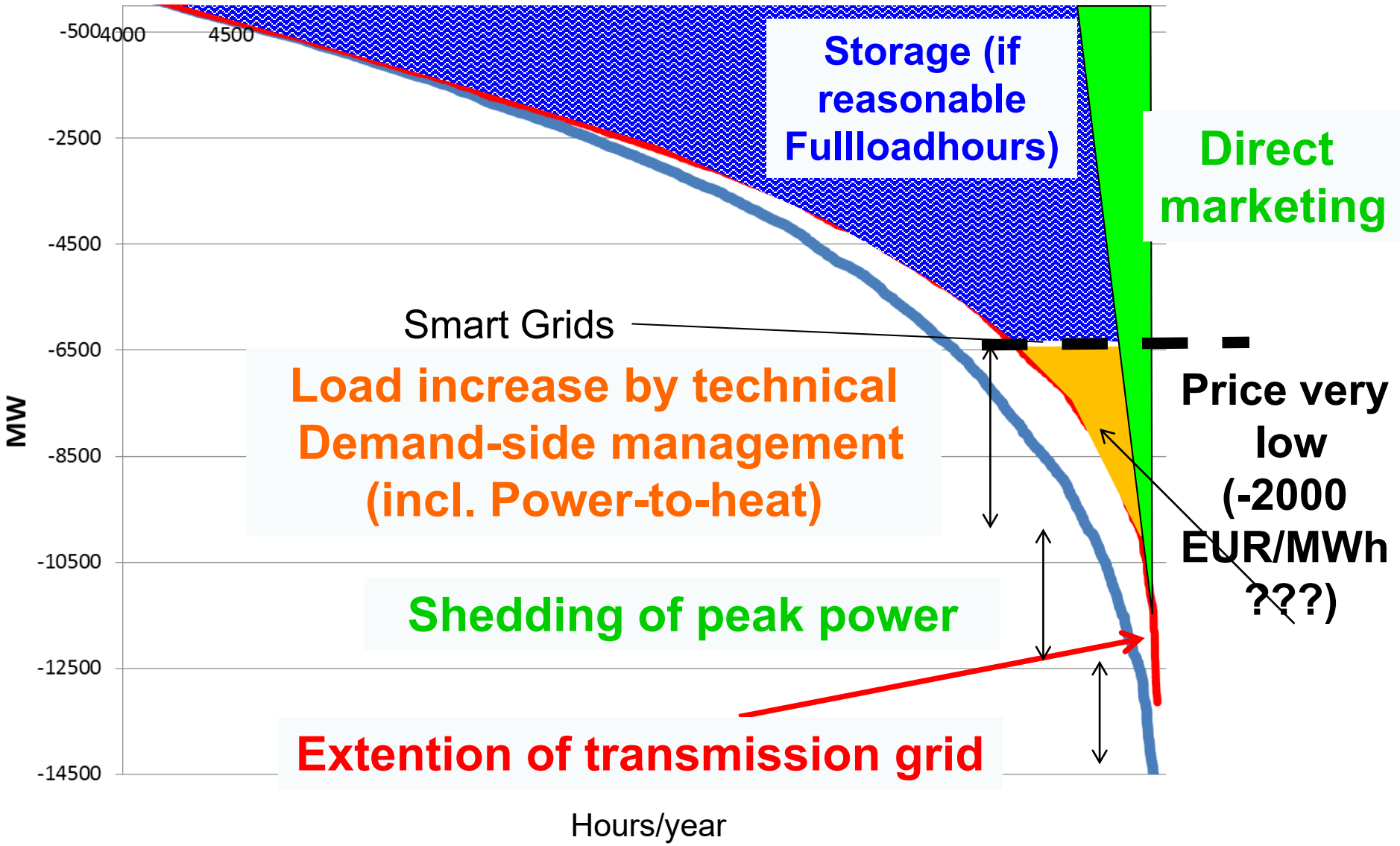
Example storage:
Every additional storage unit makes this one and every other less cost-effective!

Decreasing full-load hours of storages

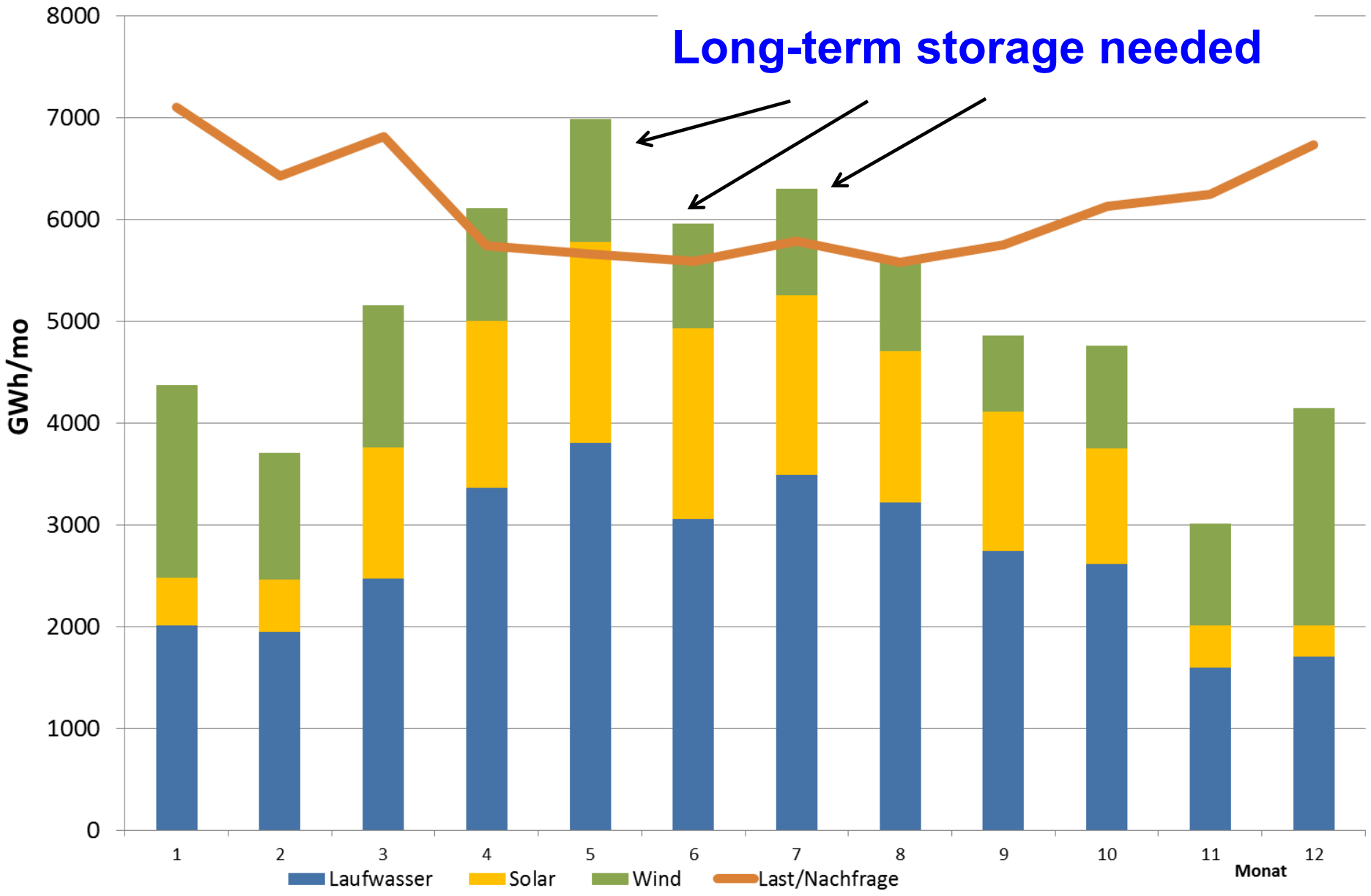
Storage 2
Storage 1



5. Flexibility



Demand for long-term storage



Sector coupling / Sector integration

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

Heating/Cooling

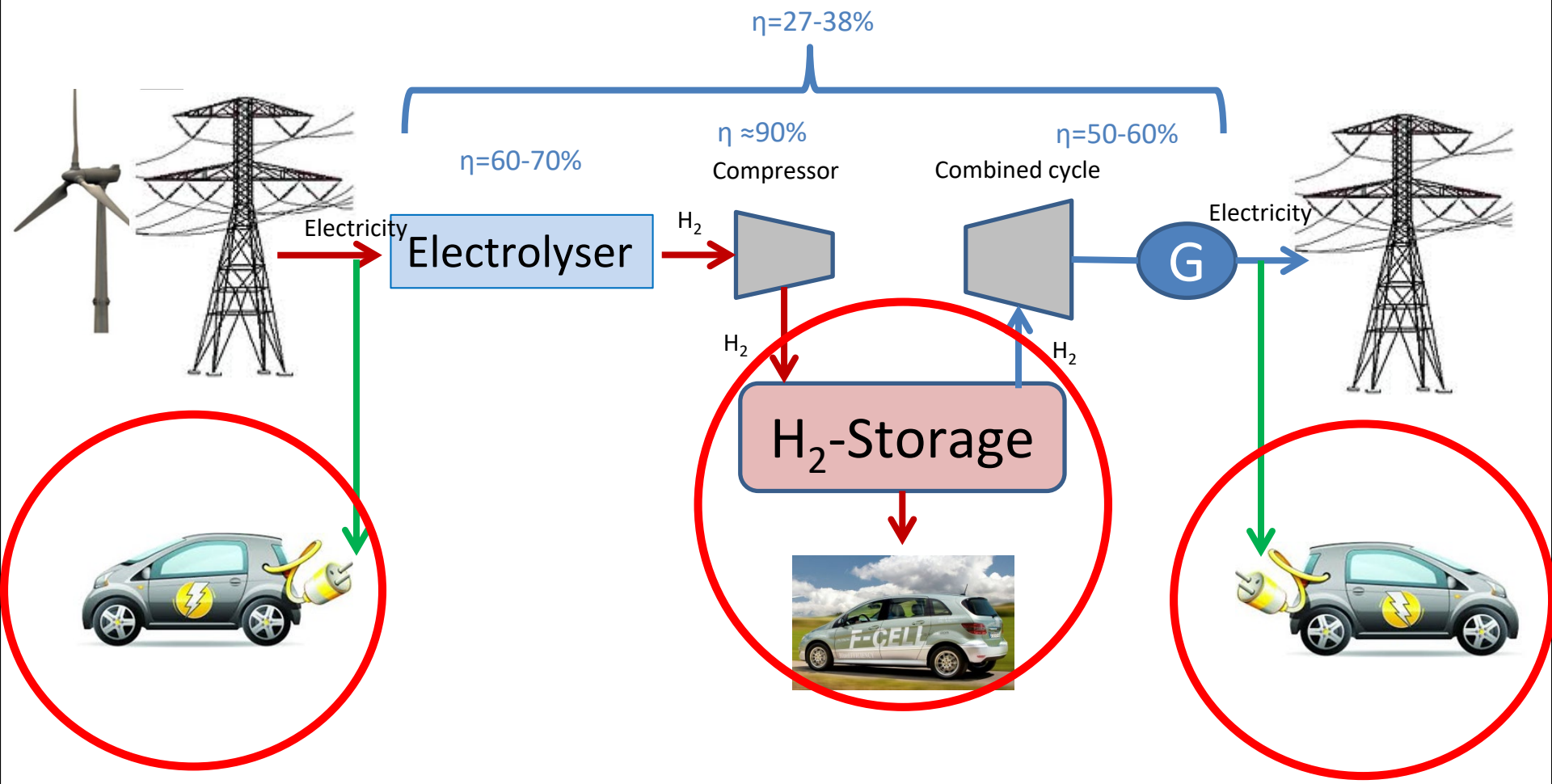
Transport

* Vague simplified suggestions, no convincing long-term solutions

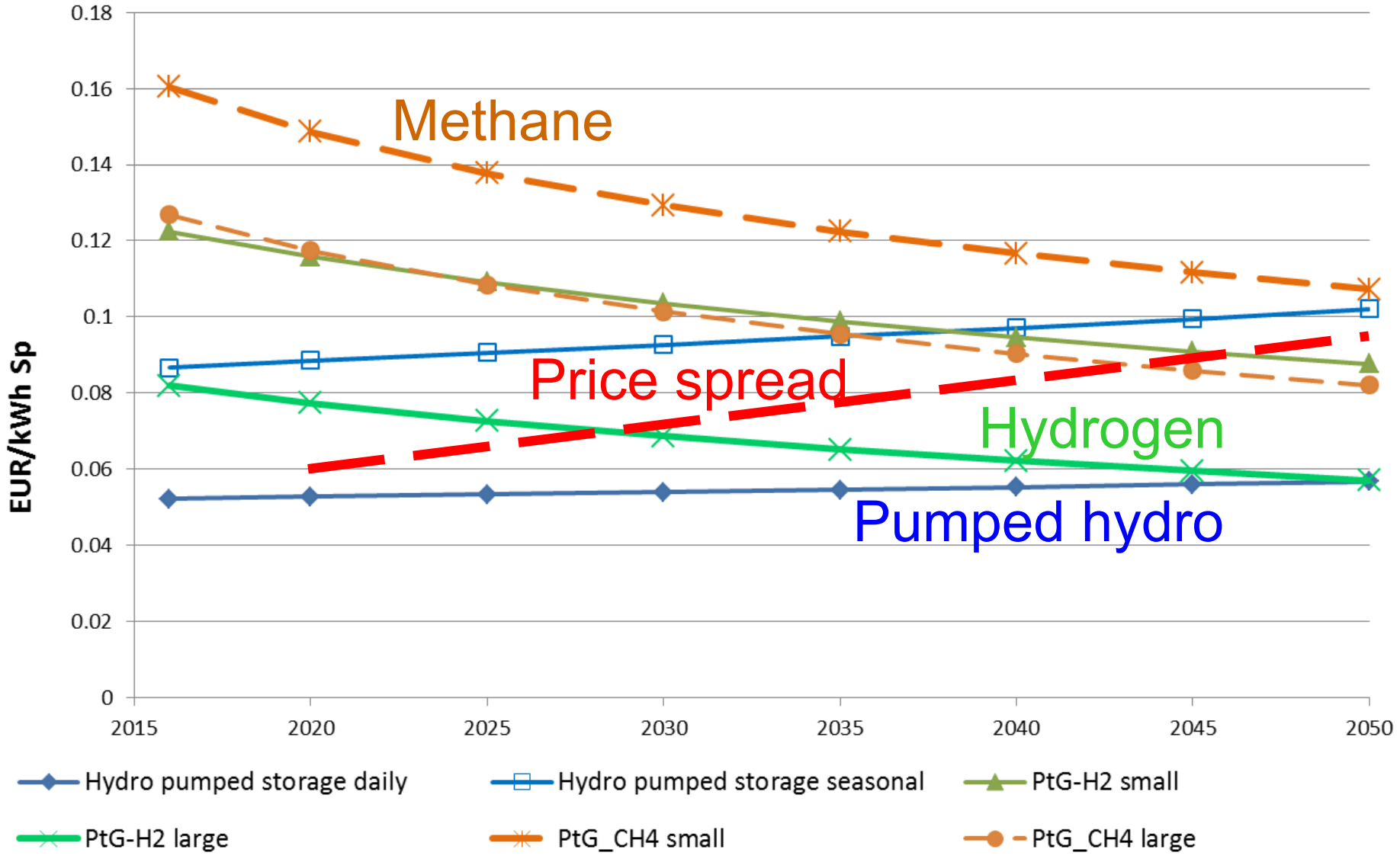
* Central (Ptx approaches, e.g. H2) vs decentral (end user level, E.g. Evs, heat pumps for heating) applications

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

Sector coupling hydrogen: Storage and fuel in transport?



Long term scenarios



6. CONCLUSIONS

- Increasing electricity generation from variable RES → need for new long-term storage options
- Economic problem of all storage options: low full-load hours
- Decentralized batteries: major benefit relieve of the distrib grid
- PtG as electricity storage: low round trip efficiency
- Stated storage needs do not comply with economics
- In transport: need for environmentally friendly technologies → Zero-emission vehicles