

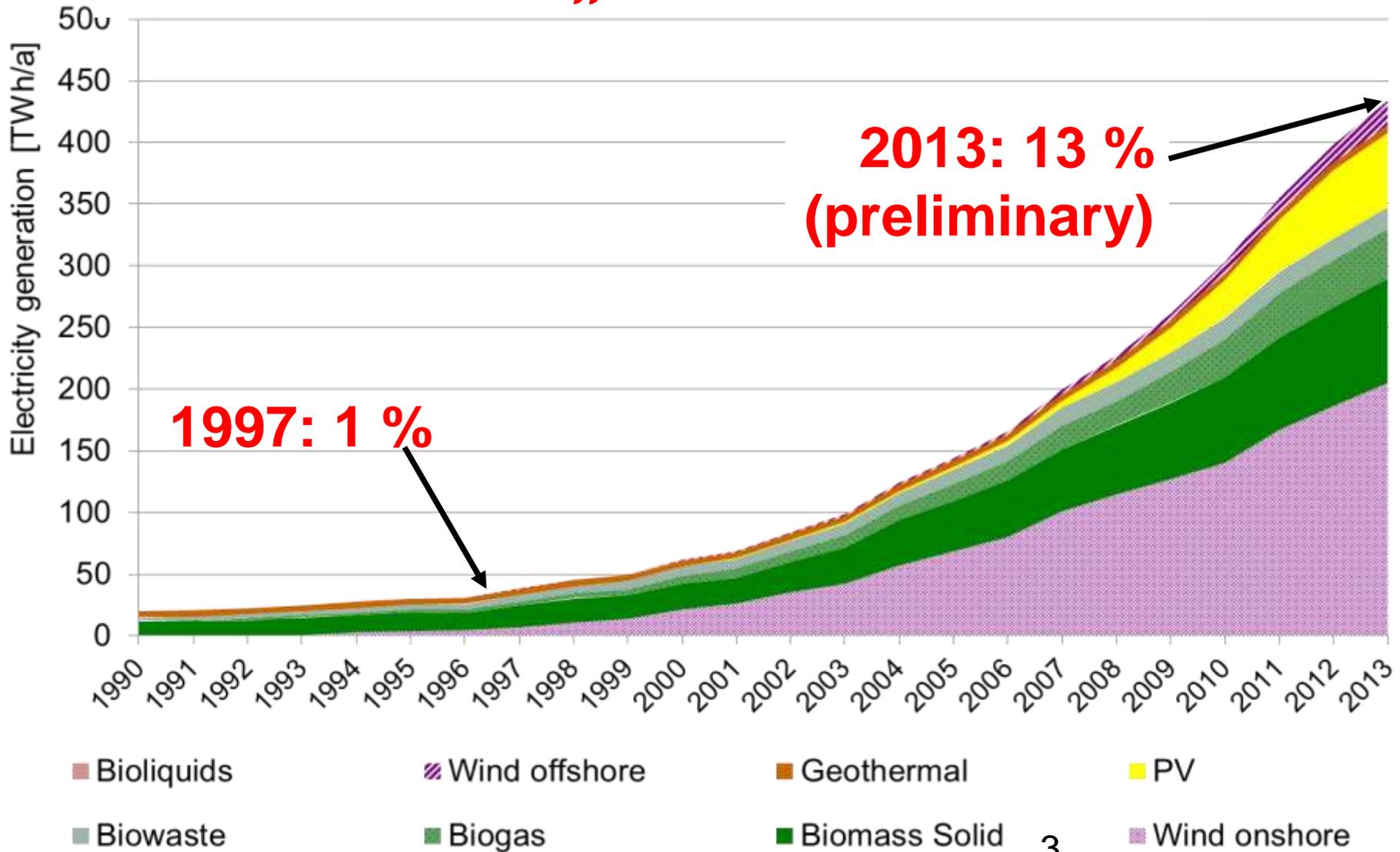
On the market prospects of long-term electricity storage

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1. Introduction
2. Supply, demand and residual load
3. Costs of storages
4. Cost scenarios for long-term storage technologies
5. How much storage do we need?
6. Conclusions

1. EU-27: Electricity generation from „new“ RES

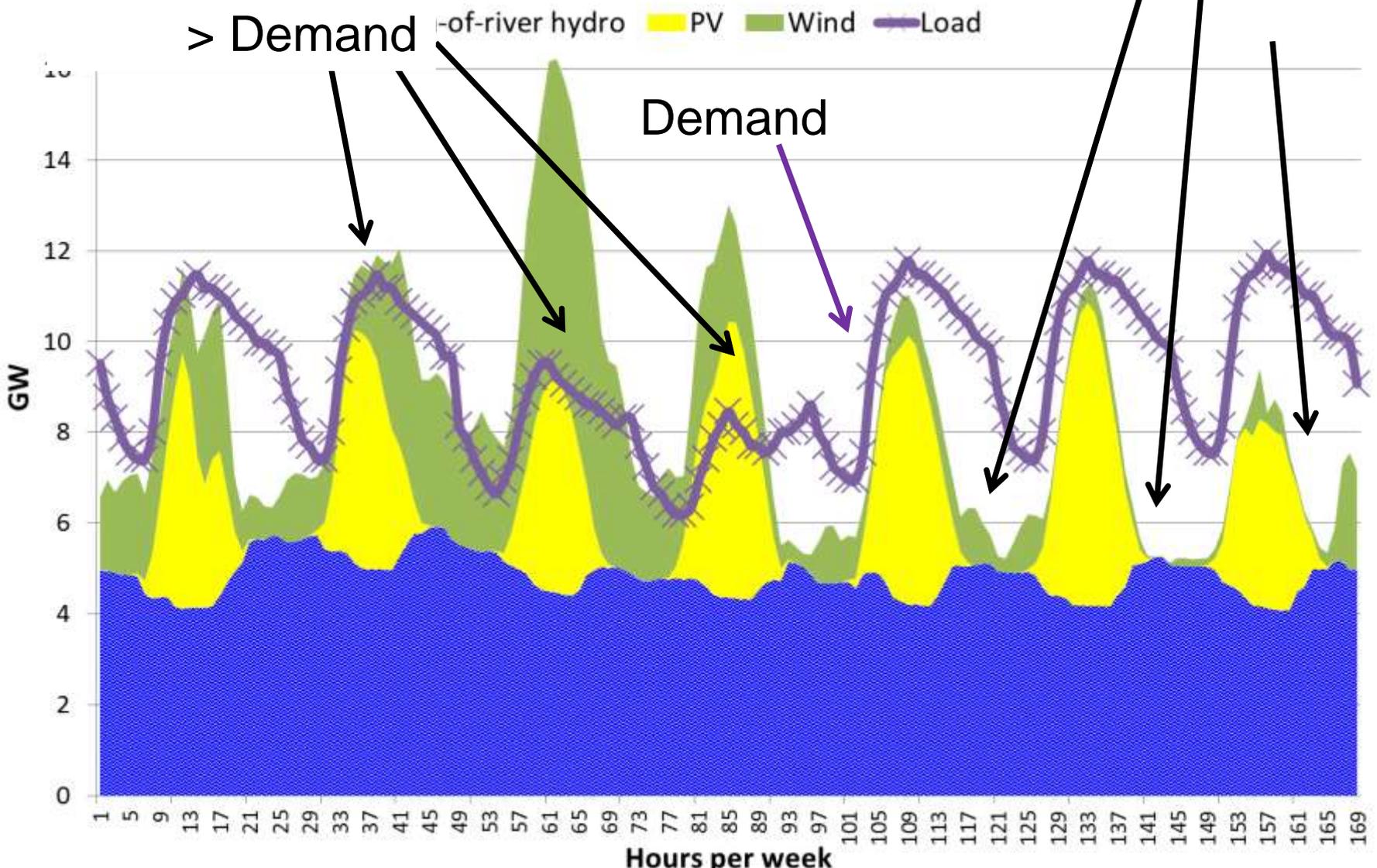


Source: EUROSTAT, own estimations

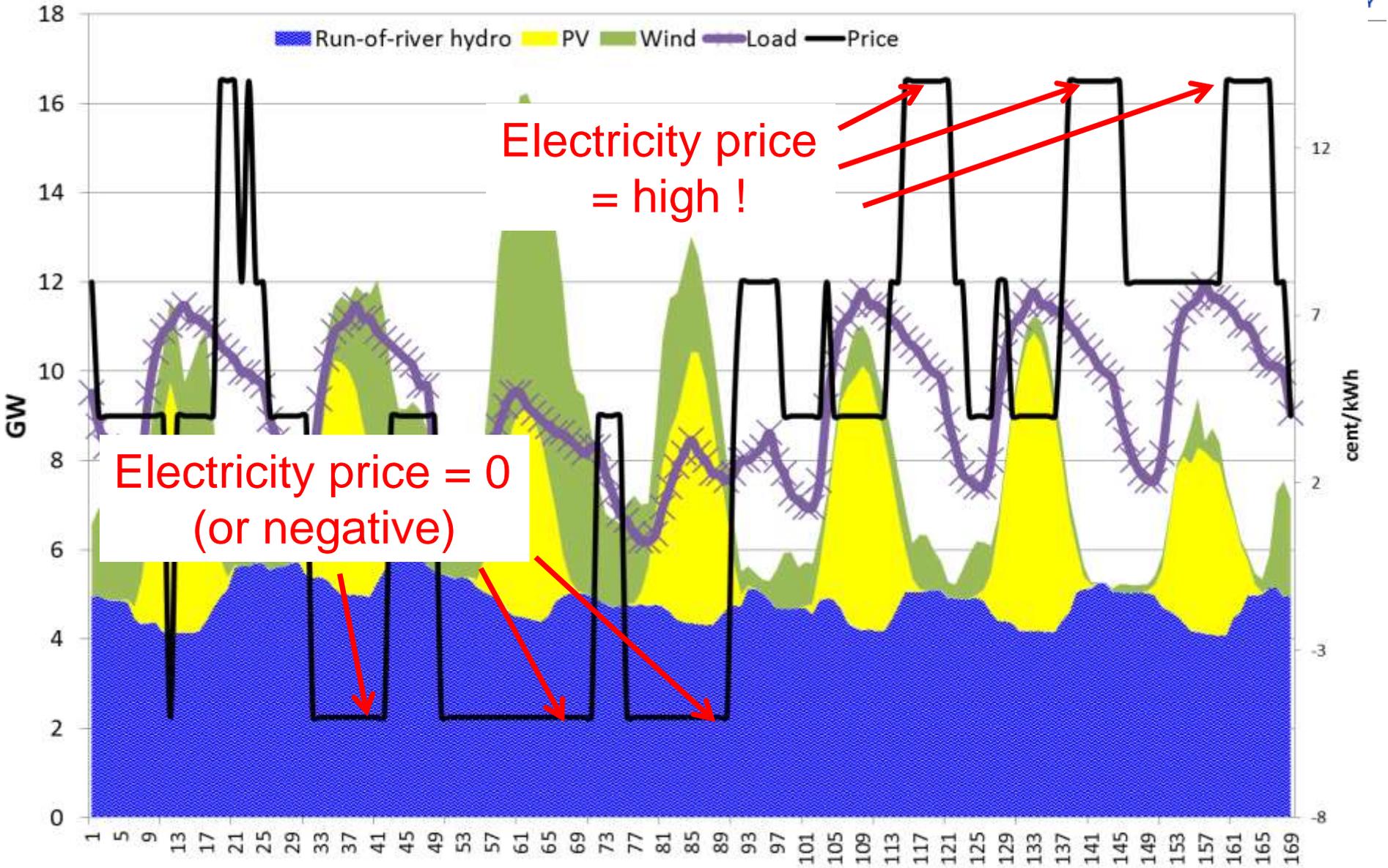
2. Supply, demand and residual load

RES Production > Demand

RES Production < Demand



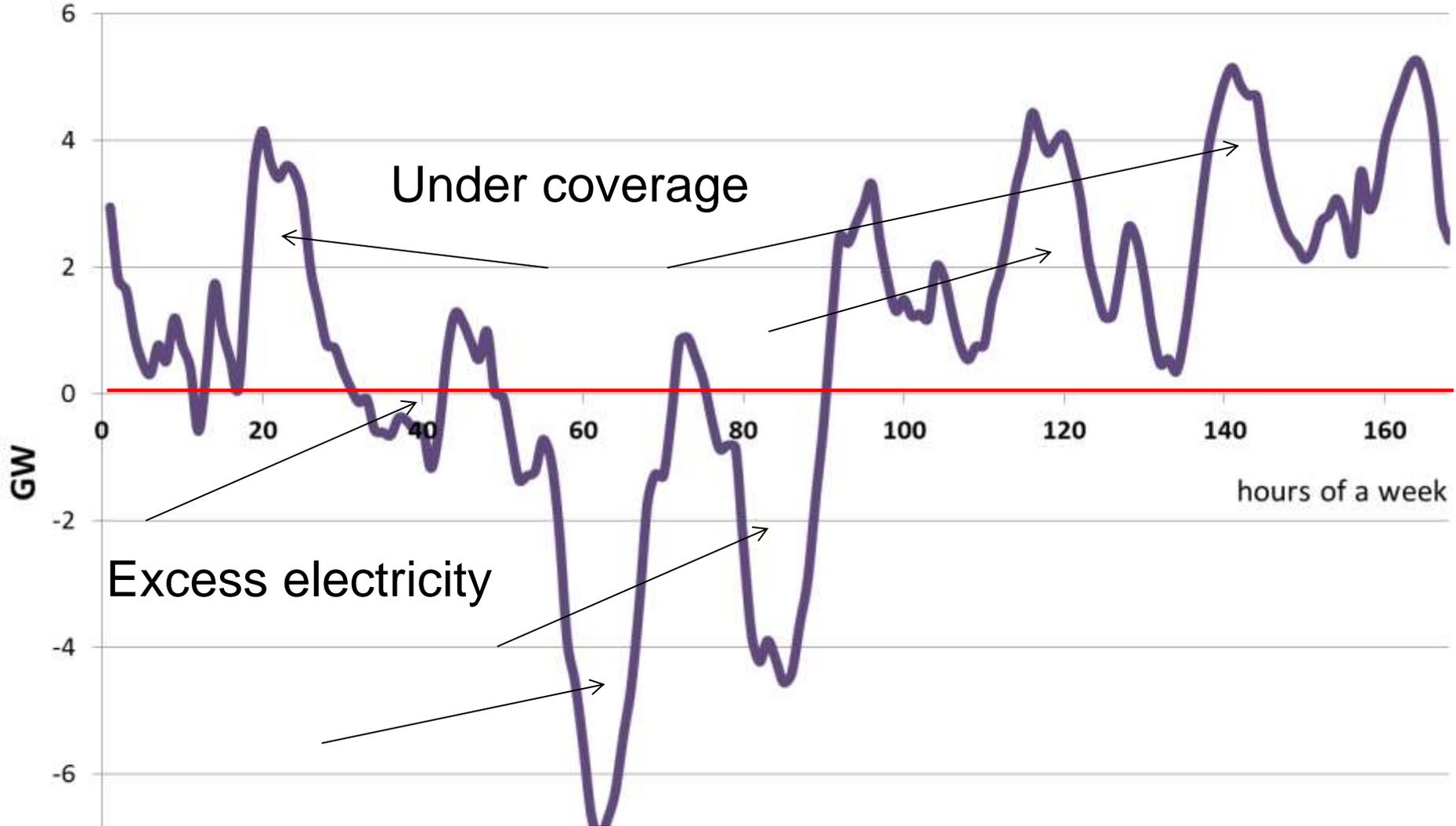
Temporarily high prices



Electricity price = 0
(or negative)

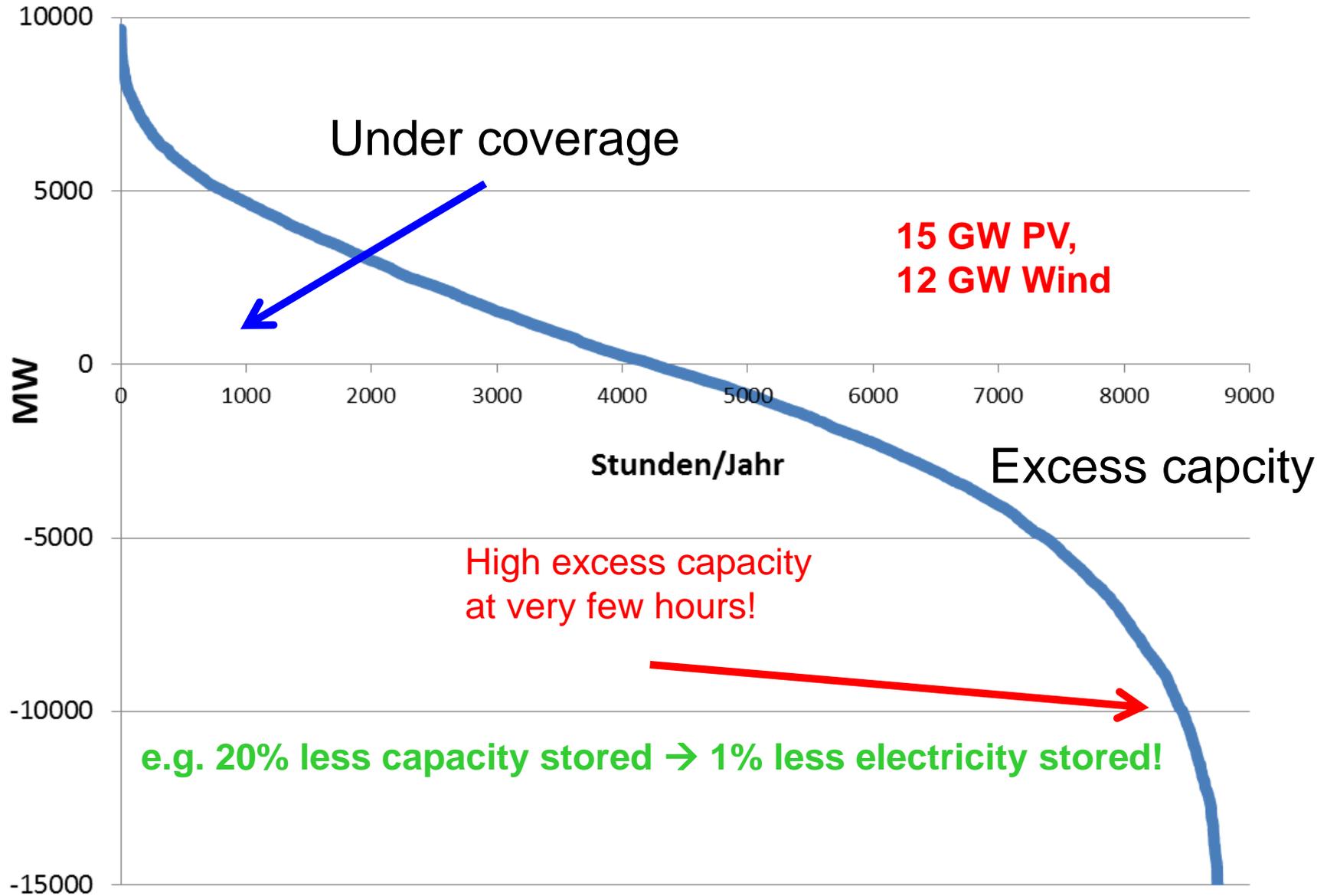
Electricity price = high !

Key term of the future: Residual load



Residual load = Load – non-flexible generation

Classified residual load curve



3. The costs of storage

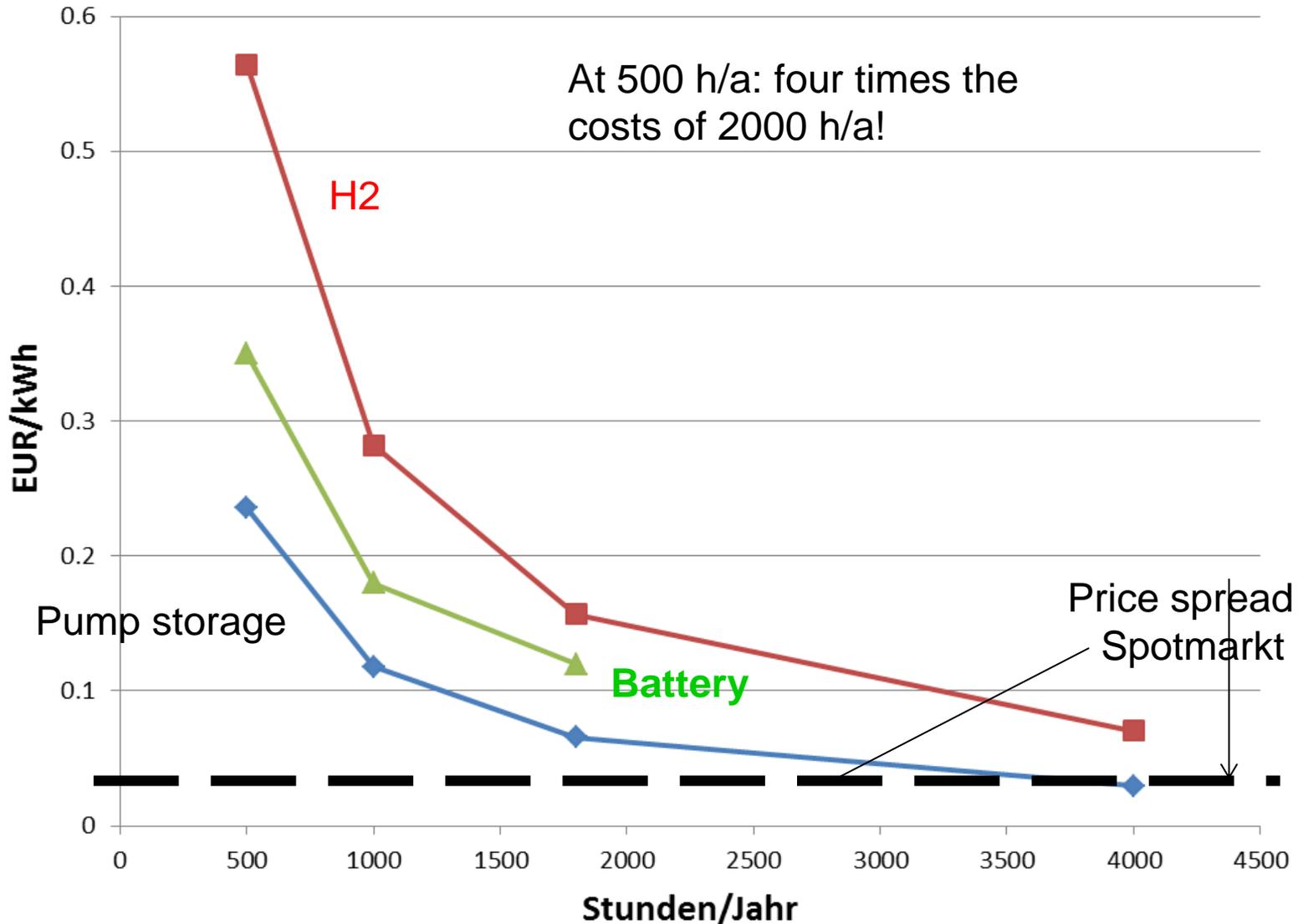
$$C = \frac{IC \cdot \alpha + C_{OM} + C_E}{T \cdot \eta_{STO}} \left[\frac{EUR}{kWh} \right]$$

- 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:

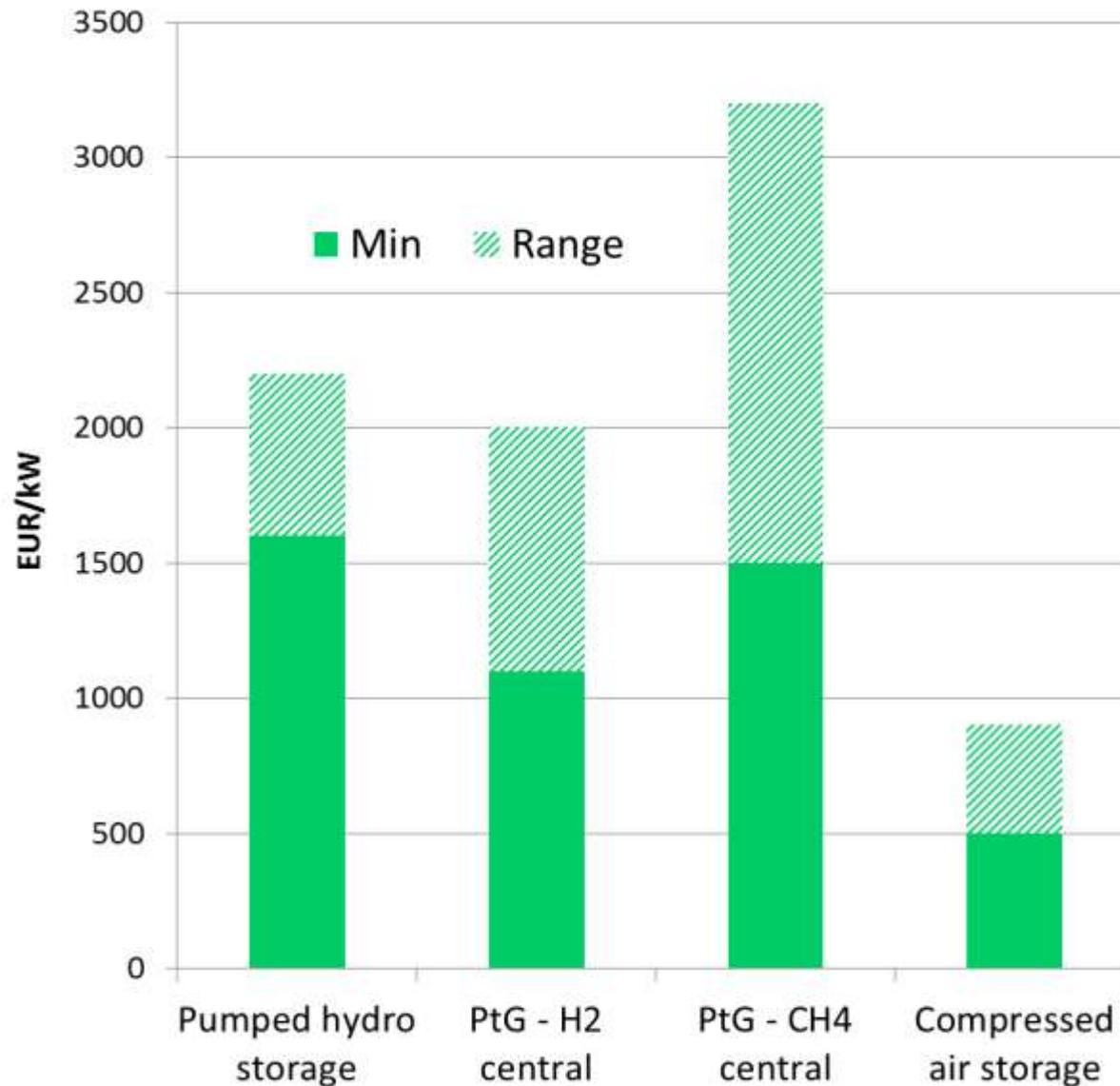
- T (Fullloadhours)!
- C_E (electricity price)

Impact of fullloadhours

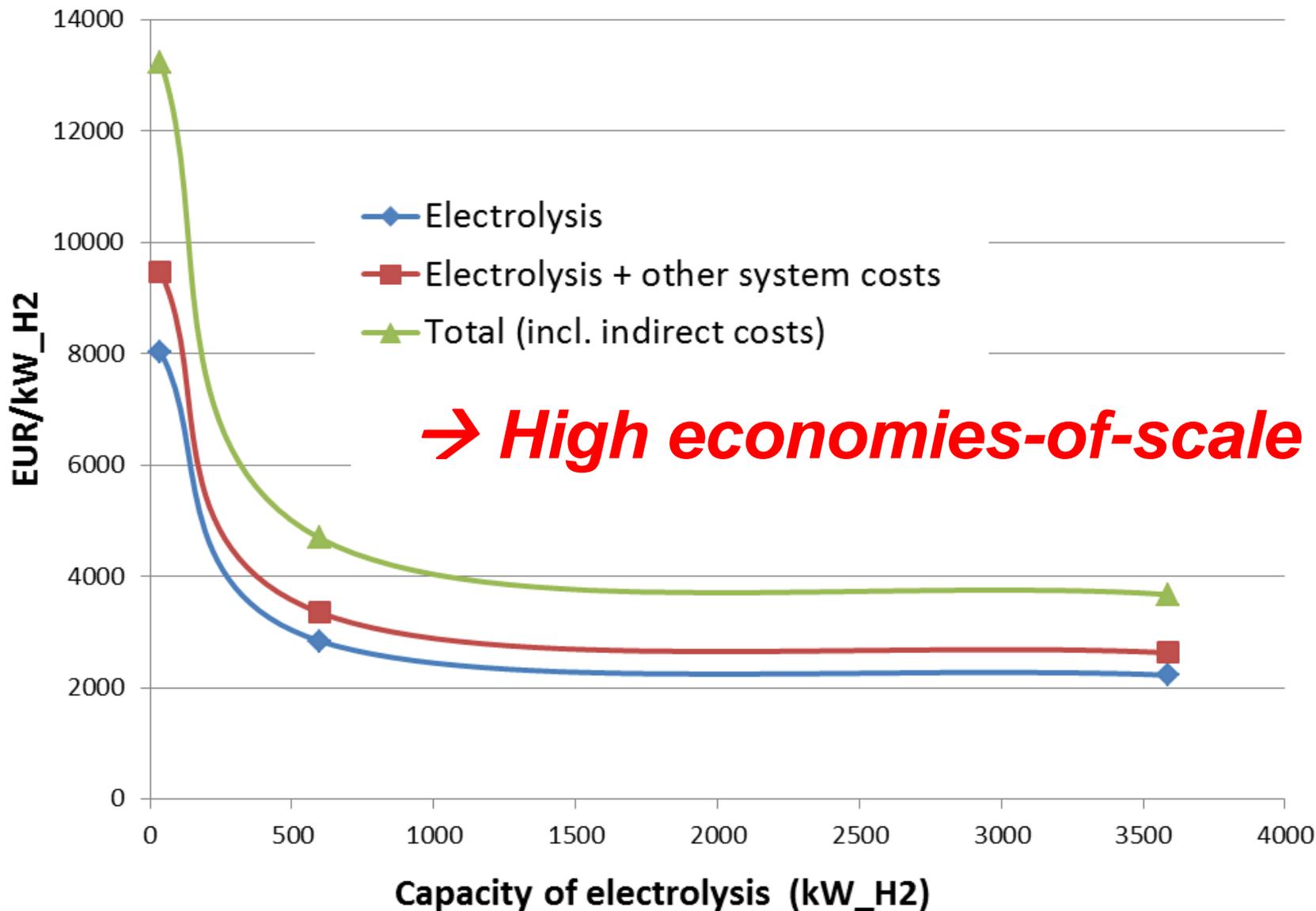


3. Economic assessment

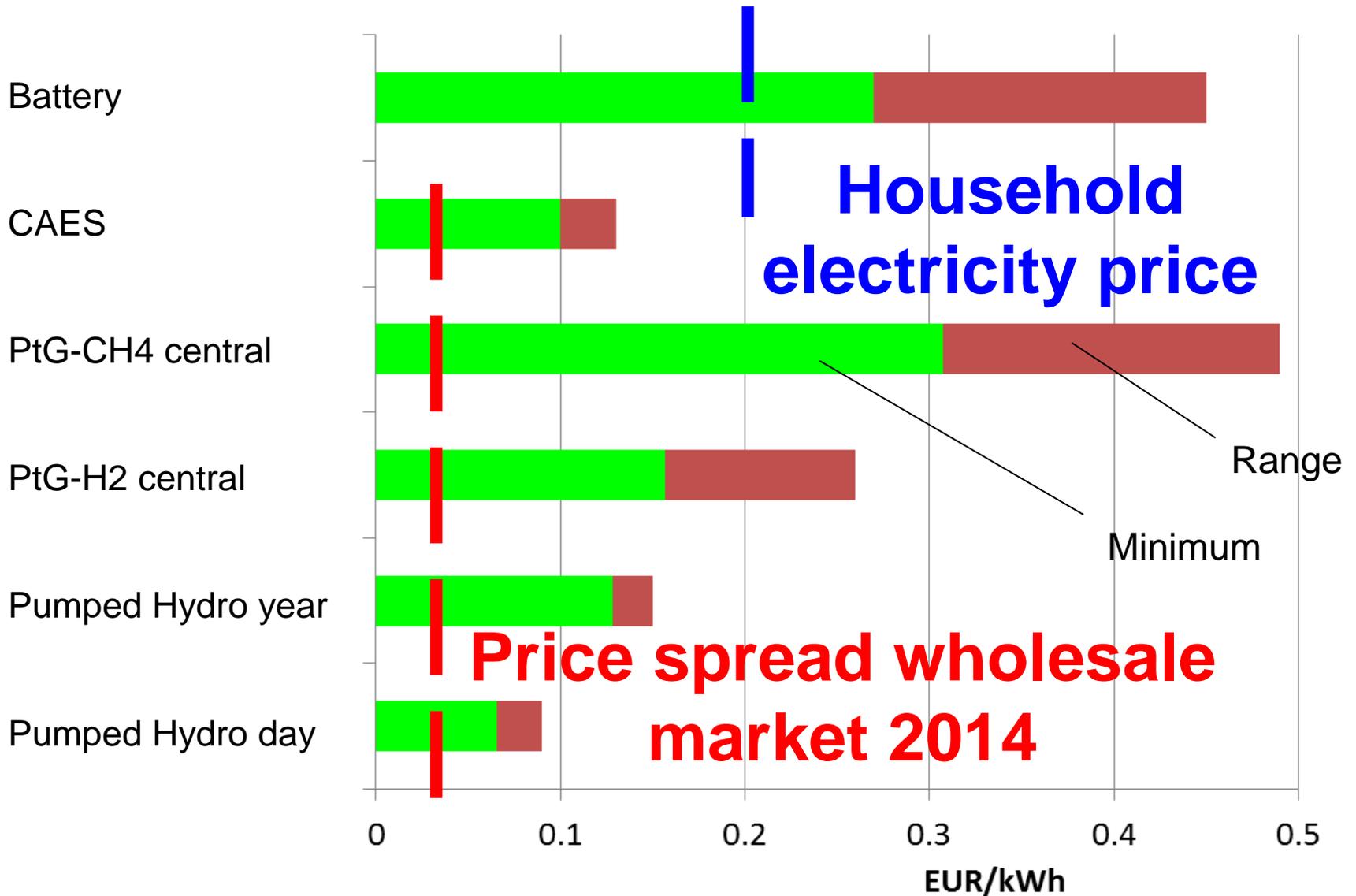
Range of investment costs



Investment costs of hydrogen production 2014



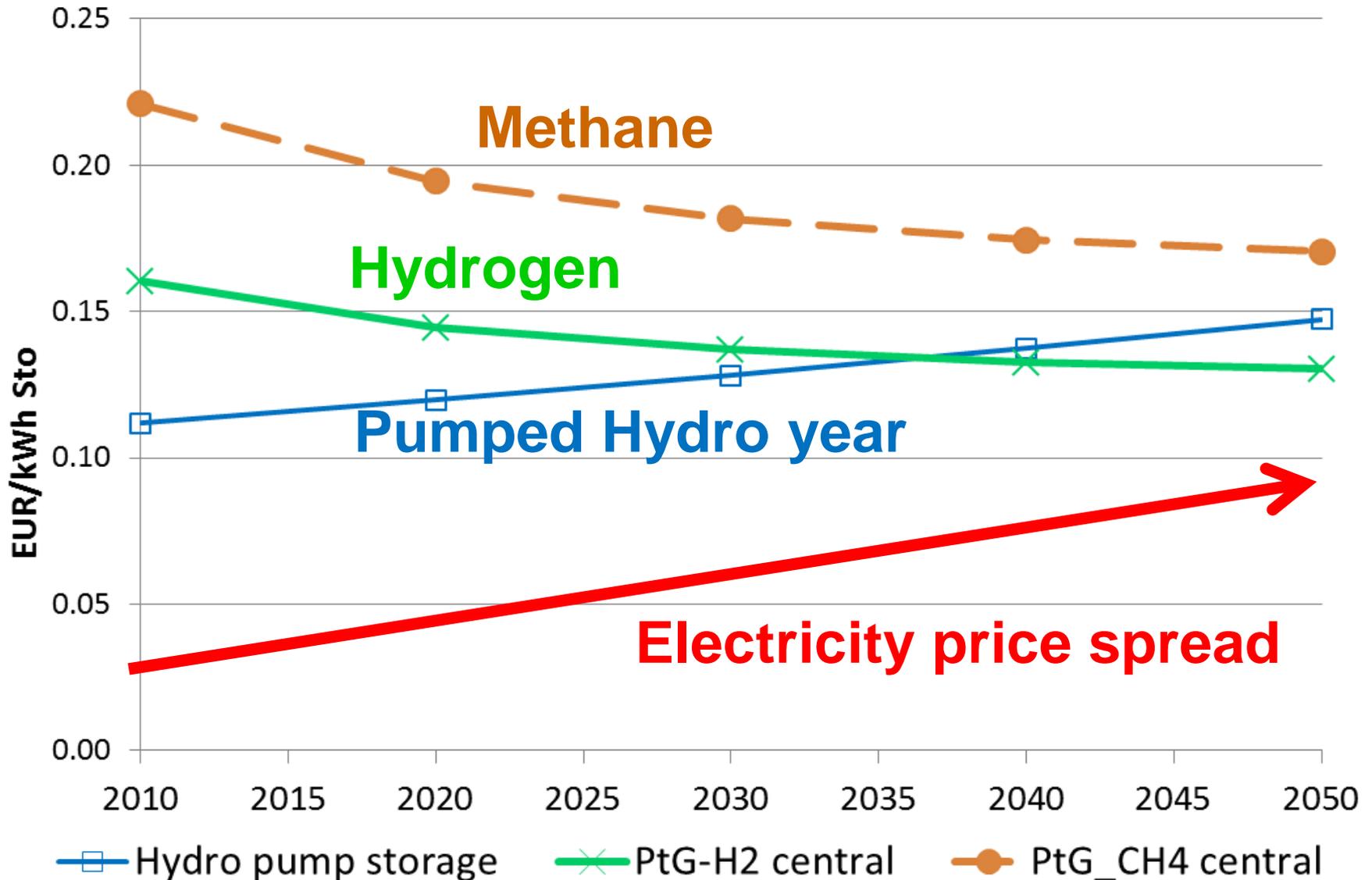
Range of costs 2014



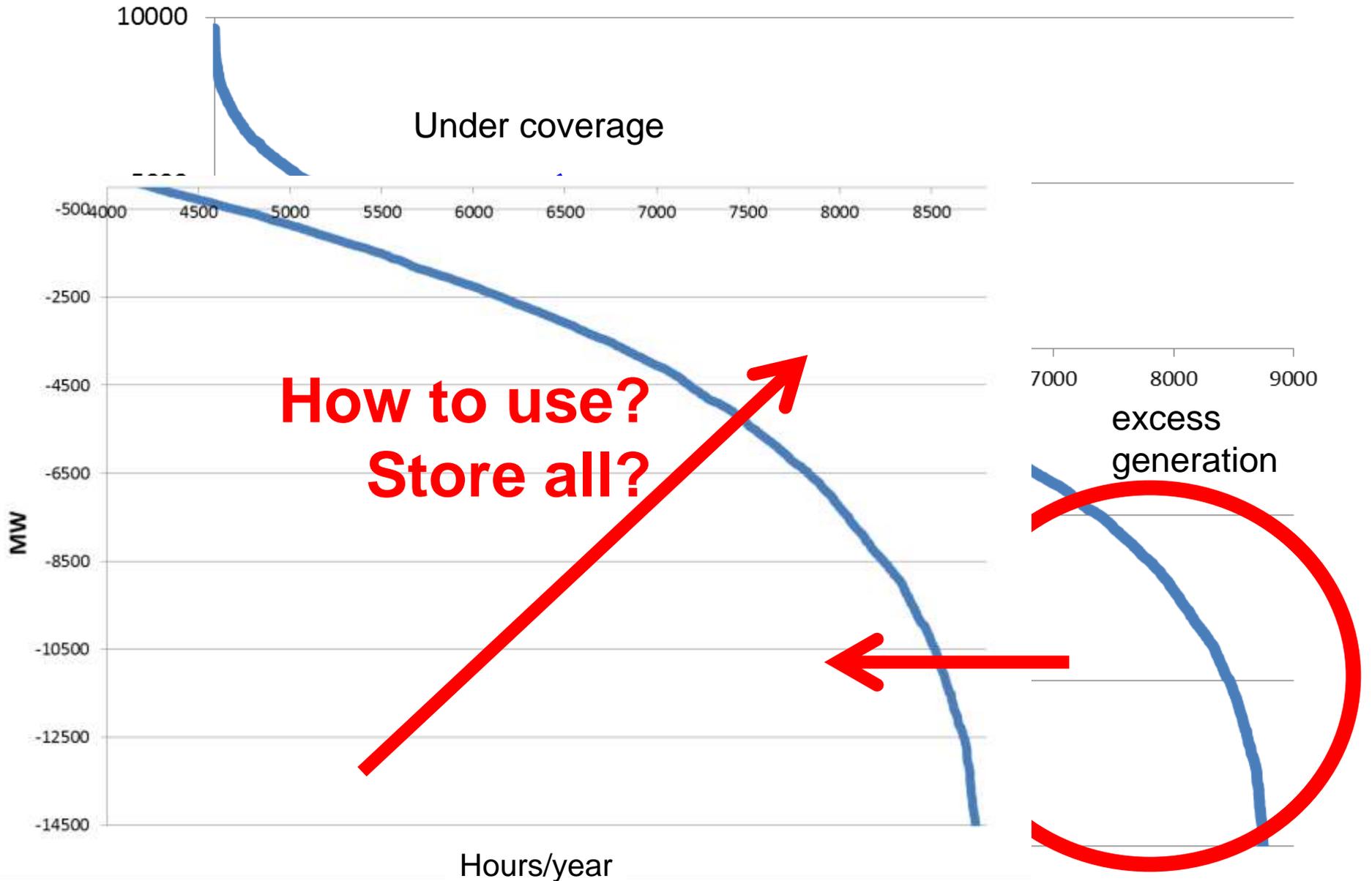
4. Costs scenarios for long-term storage technologies

Storage costs optimistic 2010 - 2050

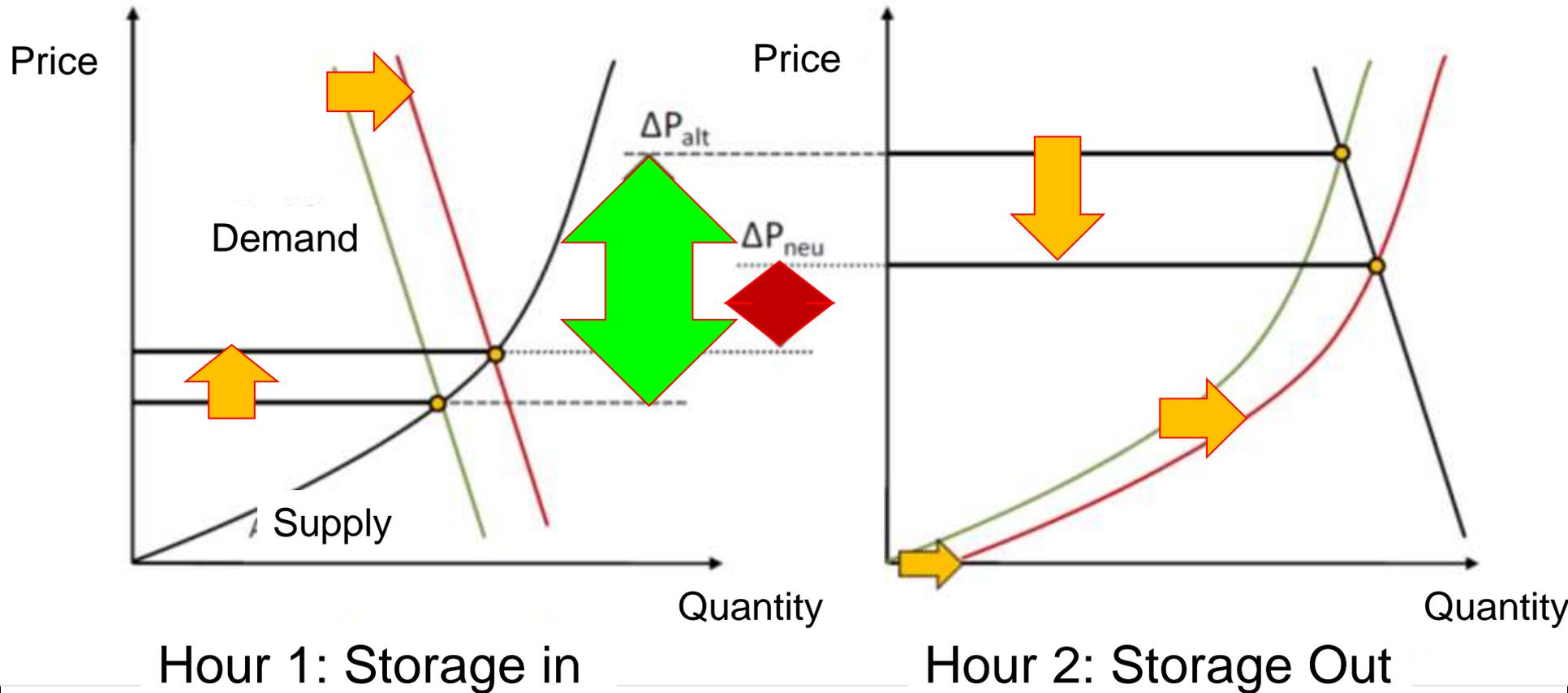
(Electricity costs = 0, T=1800 hours/year)



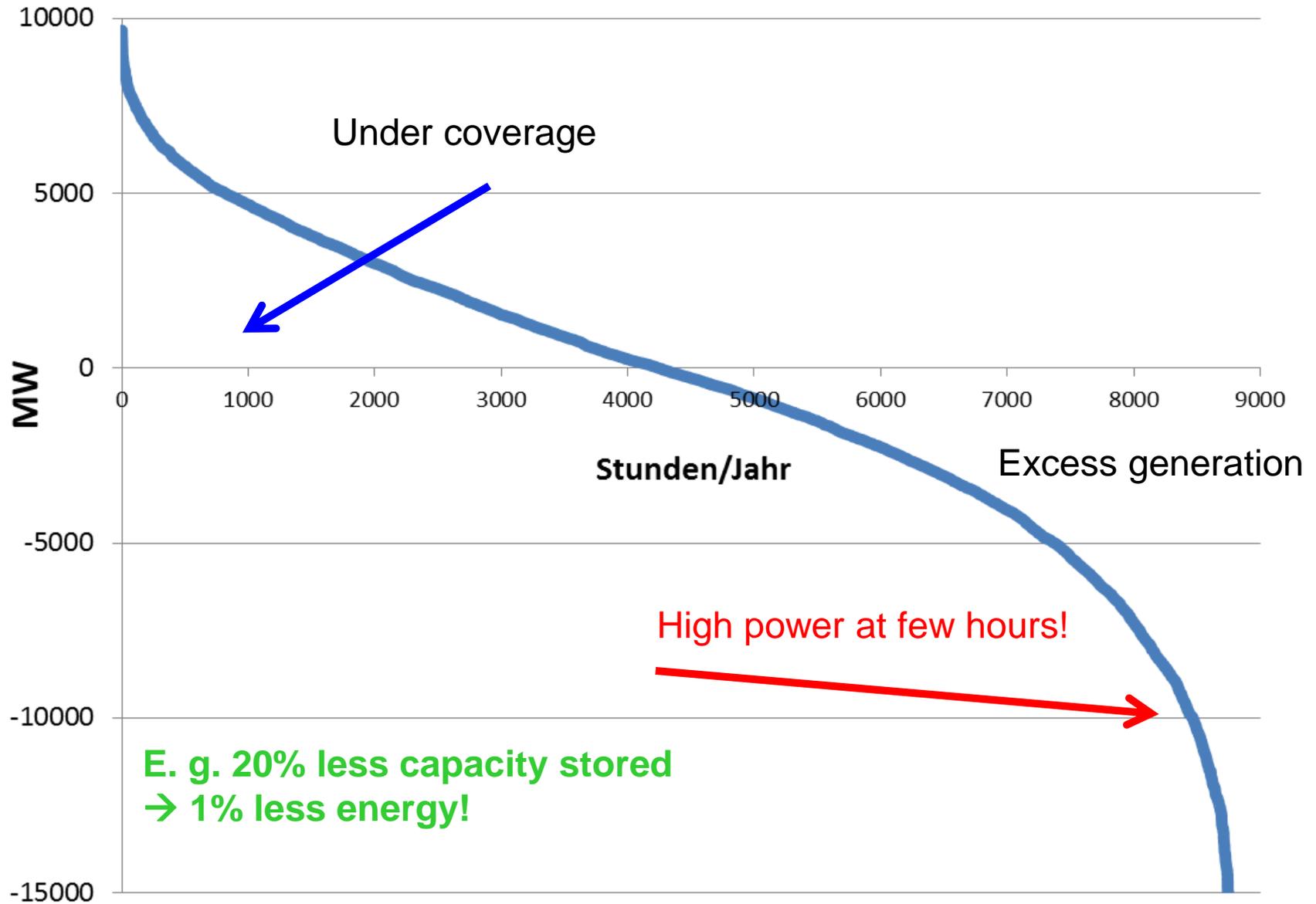
5. HOW MUCH STORAGE DO WE NEED?



Impact of new storage on price spread



Classified residual load

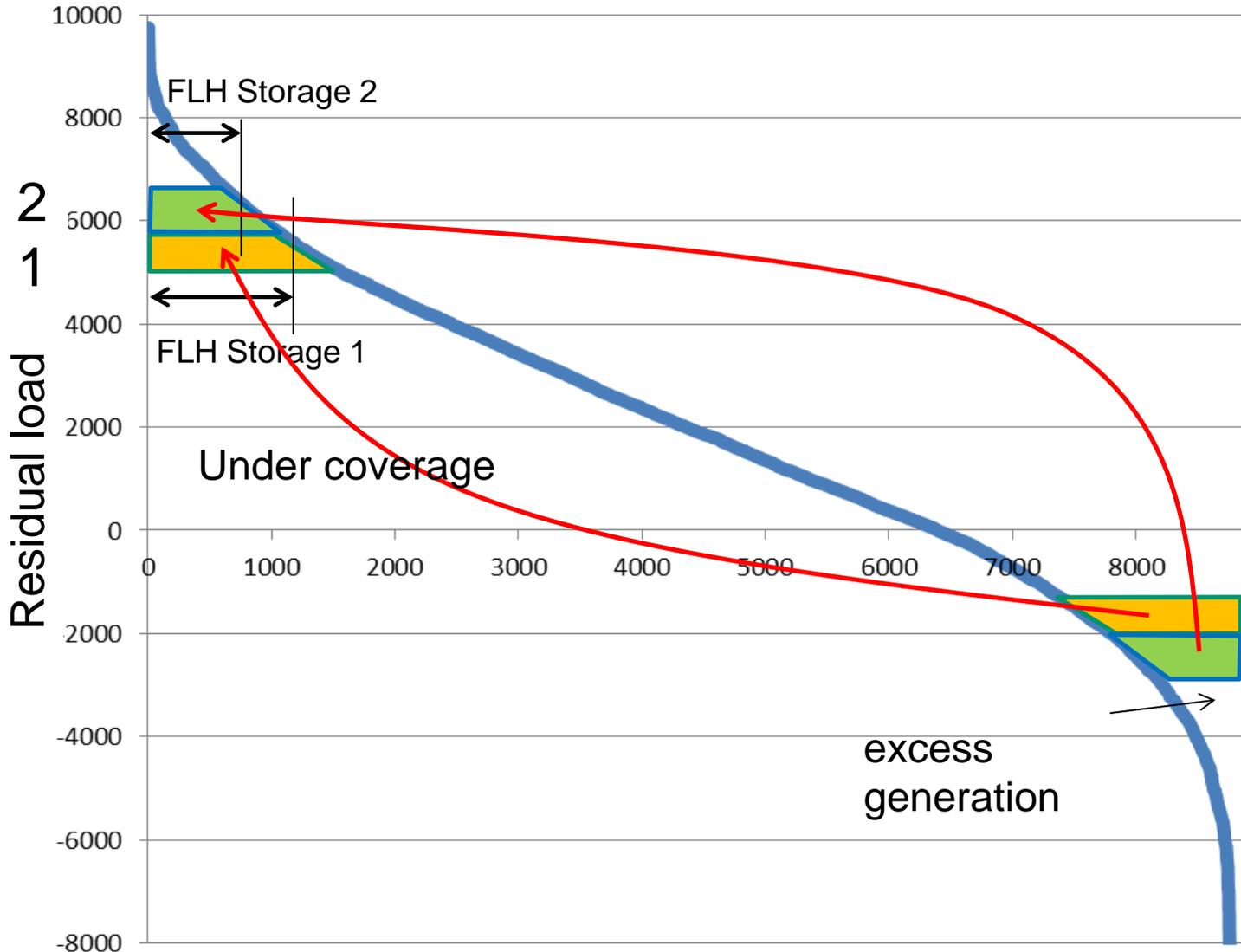


PRINCIPLE OF SELF CANNIBALISM IN ENERGY ECONOMICS:

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

Decreasing full-load hours of storages

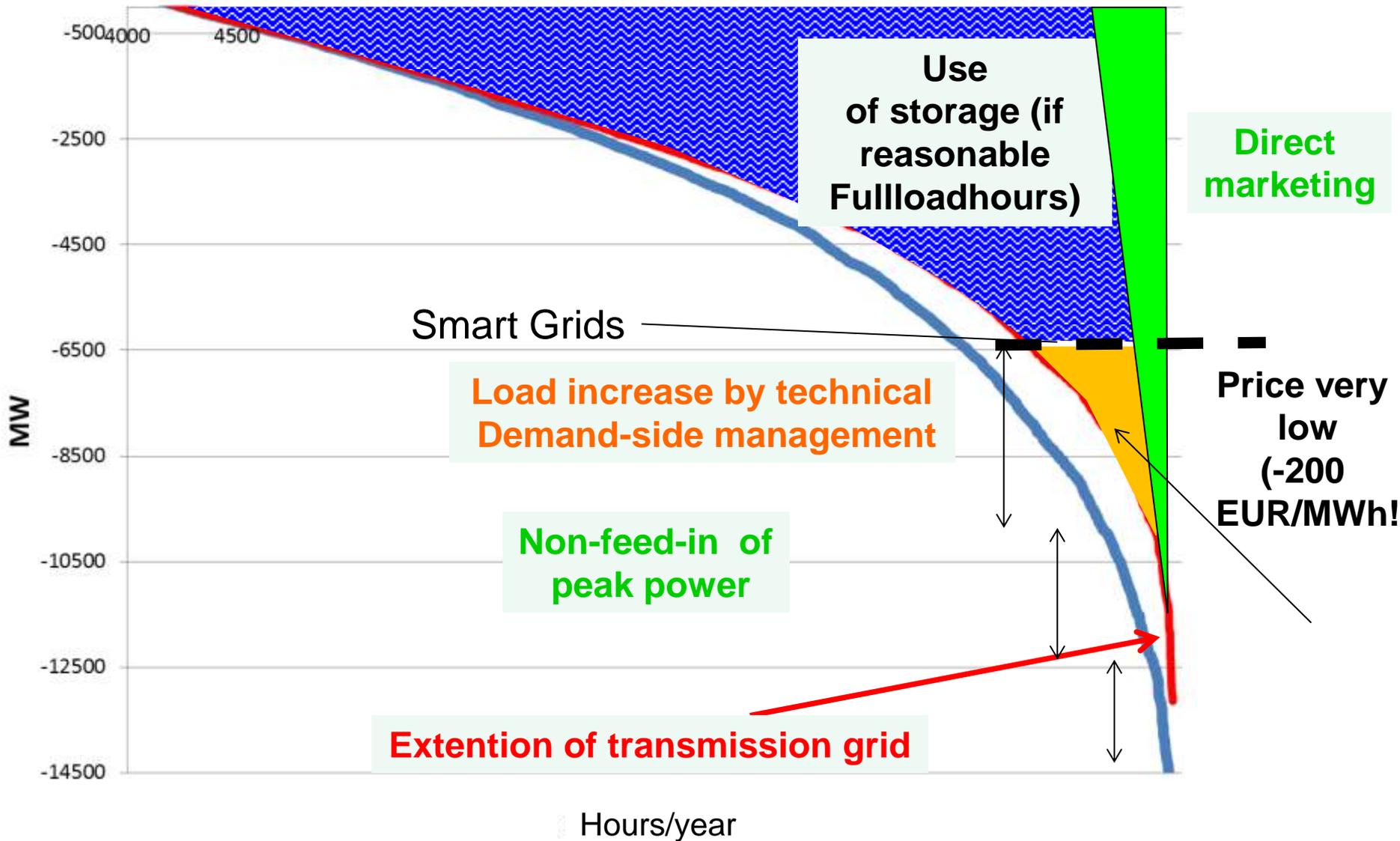
Storage 2
Storage 1



Under coverage

excess generation

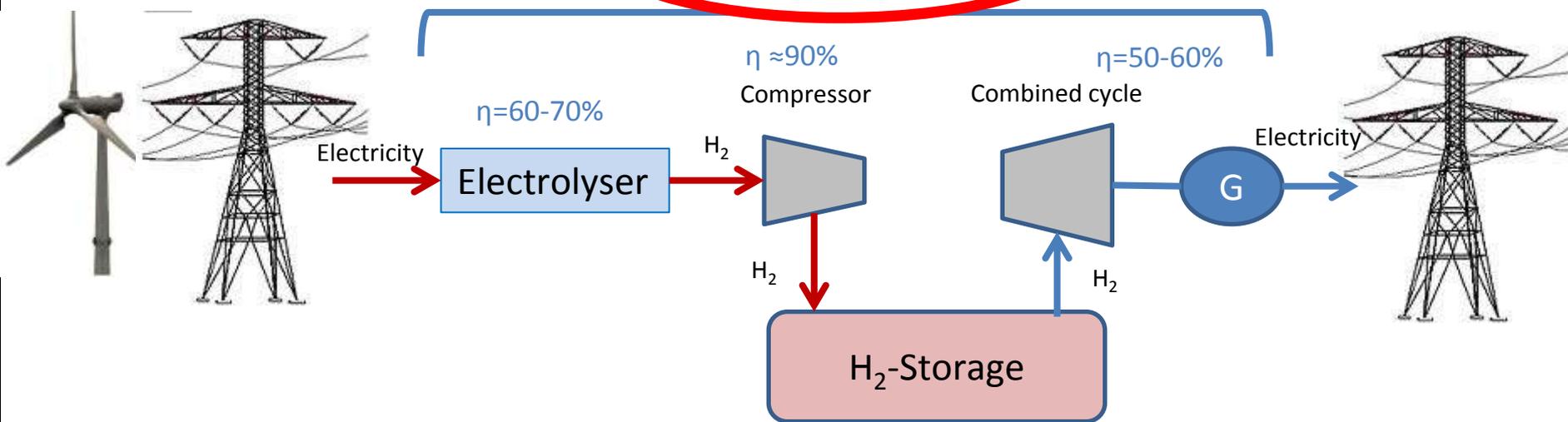
FLEXIBLE USE OF EXCESS ELECTRICITY



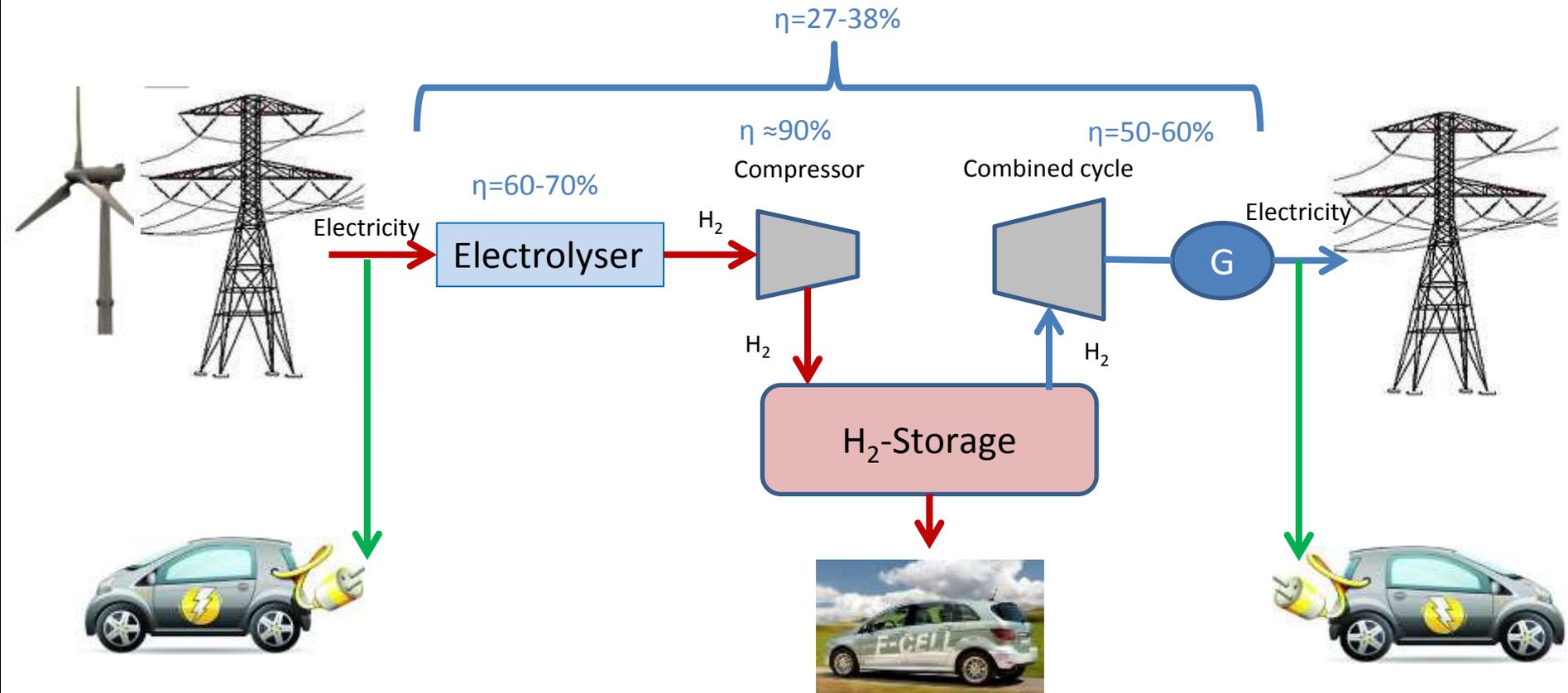
Hydrogen: storage and roundtrip use for electricity generation

Very low roundtrip efficiency for electricity!

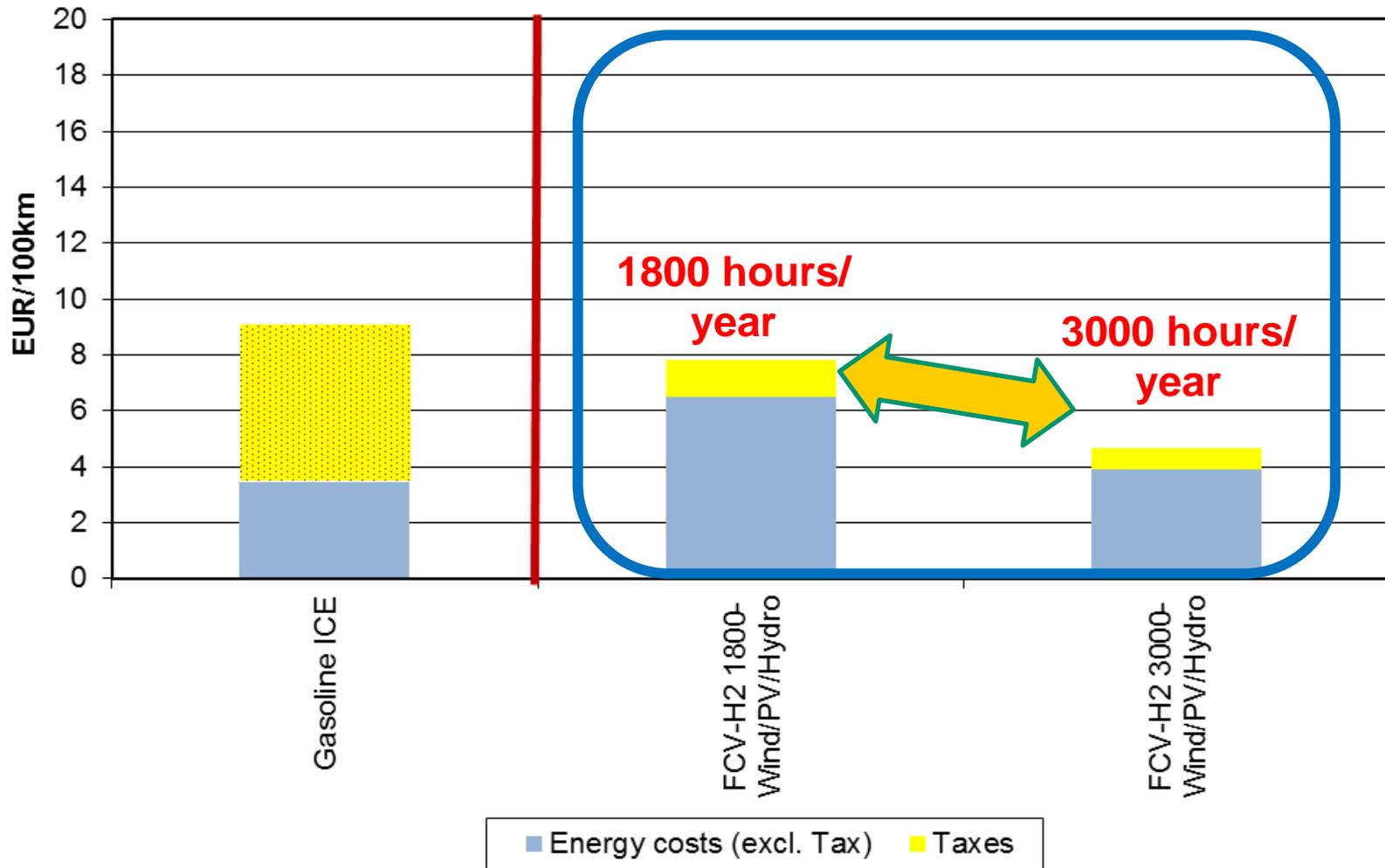
$$\eta = 27-35\%$$



4. Using hydrogen and methane in transport



Energy supply chains: Storage and/or use of RES for mobility



Based on average of EU-15 countries depending on full-load hours of the electrolysis for hydrogen production

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
- PtG as electricity storage: low round trip efficiency
- Energetic needs do not comply with economics
- In transport: need for environmentally friendly technologies → Zero-emission vehicles

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