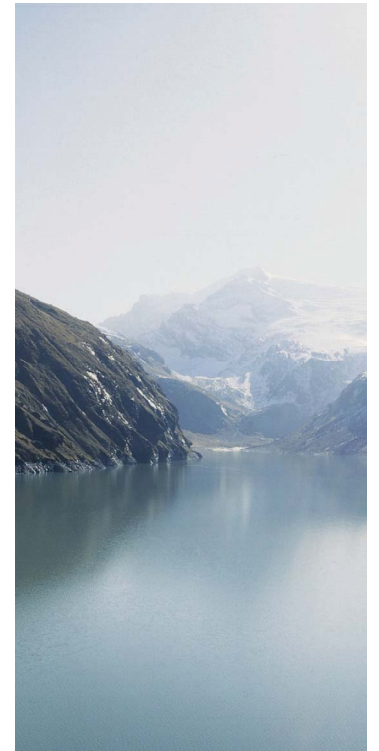


Energy Storage event

Pumped Hydro Storage

Karl Wimmer, Brussels, 26.6.2013

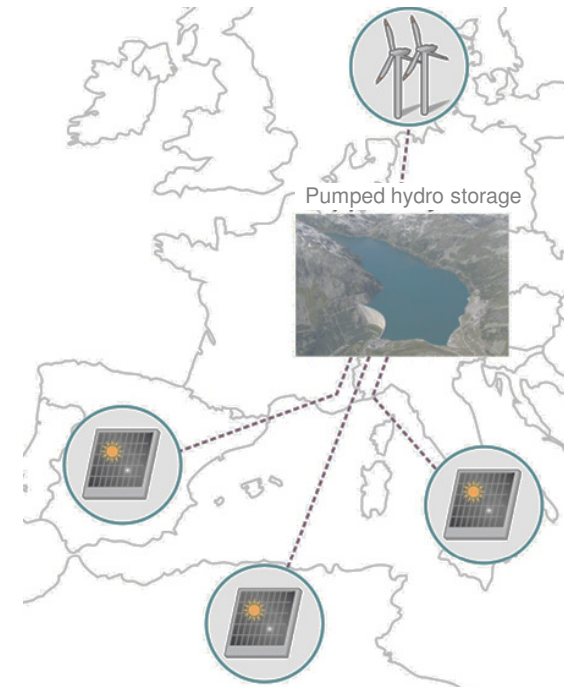
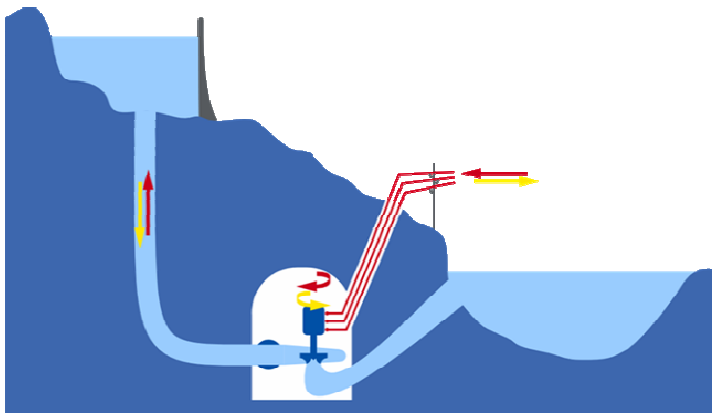


Pumped hydro storage— how does it work?

- **Electricity can not be stored directly in the grid**
 - Electricity production has to match the demand for electricity at any time
 - In case of a mismatch the system turns instable



- Most efficient (**indirect**) storage: Pumped hydro storage

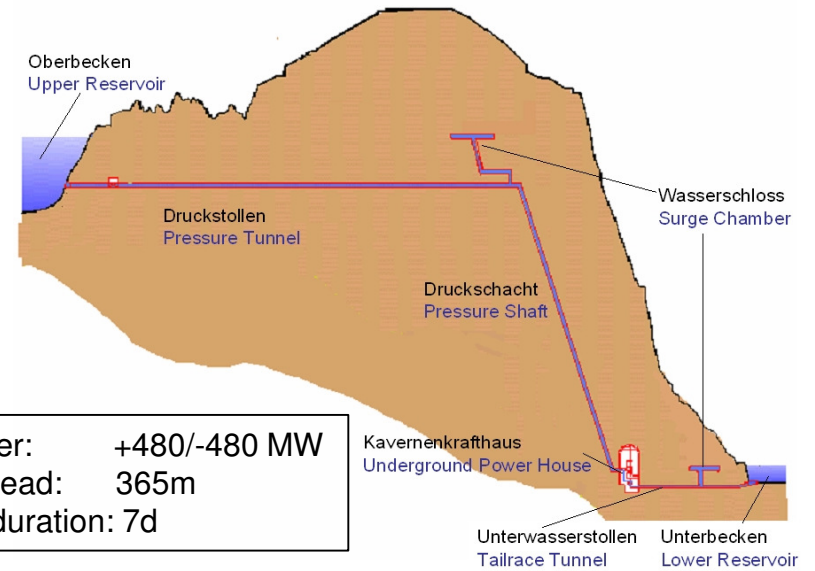
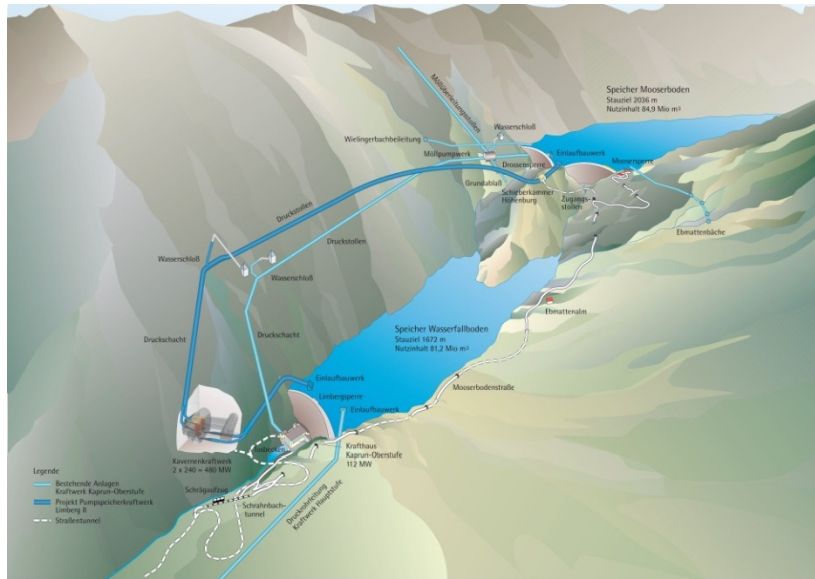


- Roundtrip efficiency: ~ 75-85 %
- Capacity: ~ 30 - 1000 MW
- Pumping duration: ~ 4-10 h/d
- Availability: > 95 %
- High flexibility: in 1 min from 0 to maximal capacity

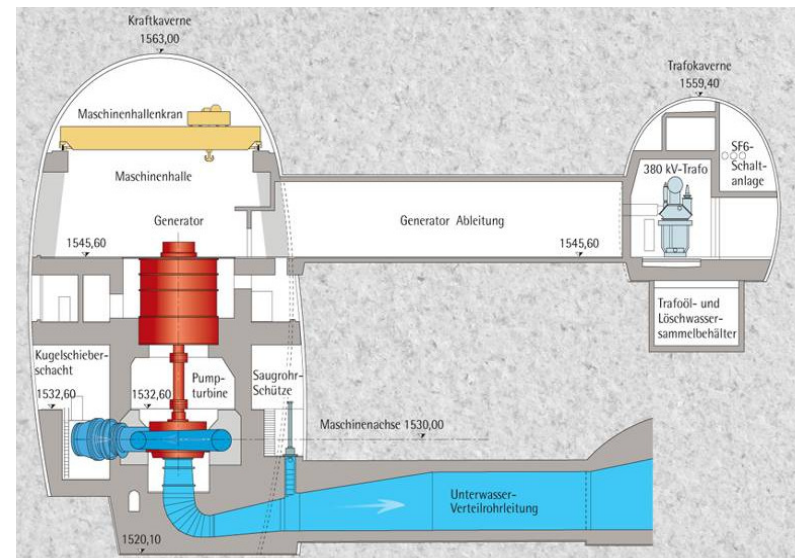
Verbund

pumped storage in Austria

add on project Limberg II – use of existing infrastructure



max. power: +480/-480 MW
average head: 365m
pumping duration: 7d



Market environment - Pumped Storage Power Plants

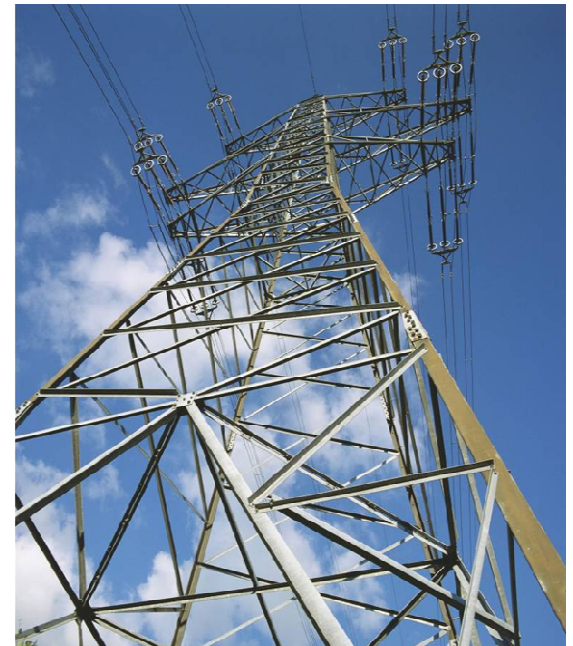
Forward market	➔ long-term hedging of peak and off-peak energy (decreasing relevance)
Spot market	➔ balancing of scheduled/predicted supply and demand
Intraday market	➔ short-term balancing of deviations

Ancillary Services

- Balancing energy
 - Primary Control
 - Secondary Control
 - Tertiary Control

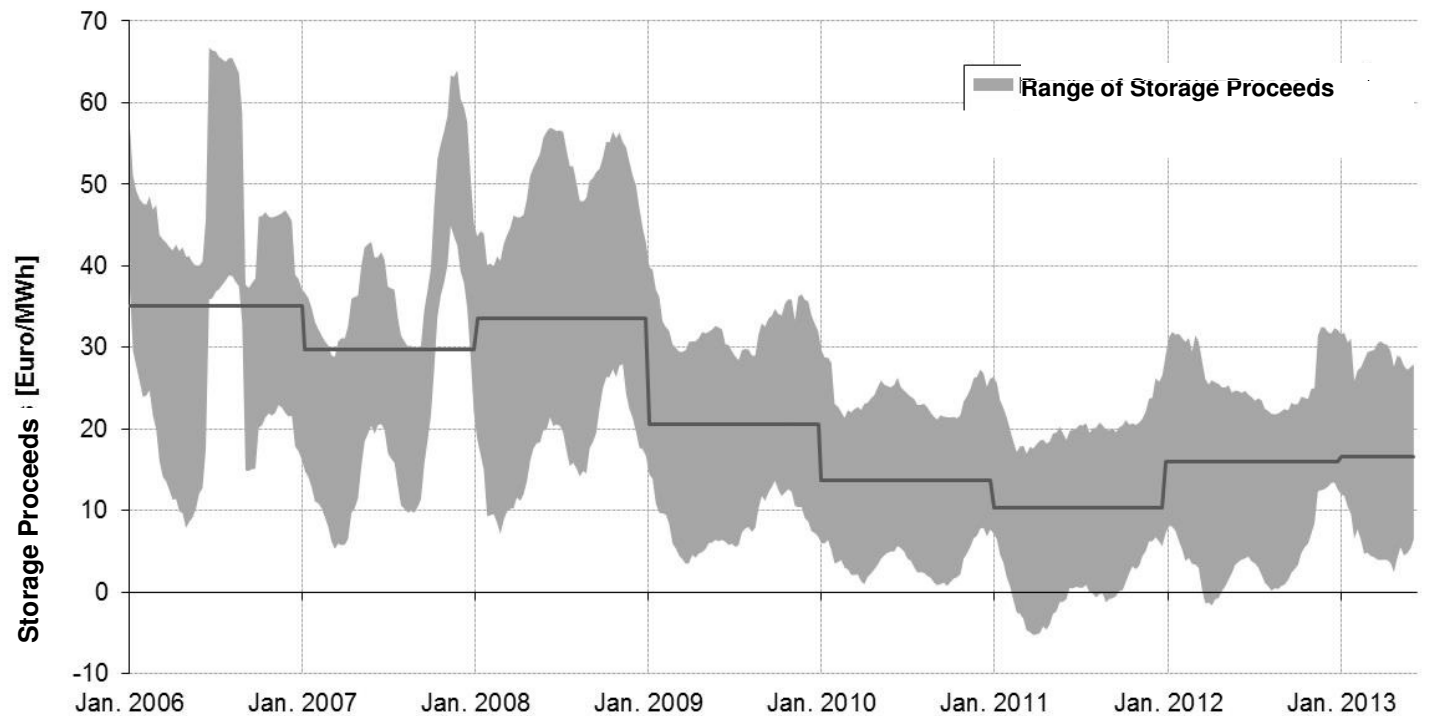
Grid services

- Reactive power
- Energy and Power in Emergency Situations
- Black start capability
- Congestion management capabilities
(possibility for redispatch)



Trend of Storage Proceeds for Pumped Storage Power Plants

- Mainly affected by the difference between high spot-prices (turbine) and low spot-prices (pumping).
- since 2008: **decreasing spreads**
 - downturn in demand due financial crisis
 - development of renewables (PV)



aktualisiert: 18.06.2013

Barriers for Pumped Hydro Storage have to be removed

Grid Charges

- EU wide harmonisation of grid charges → no double charging of PHSP

Ancillary Services

- Improve possibility for cross-border marketing for electricity from pumped hydro storage in the balancing and intraday markets → harmonisation of balancing regimes (pre-qualification procedure)
- Increase of cross-border transmission capacities

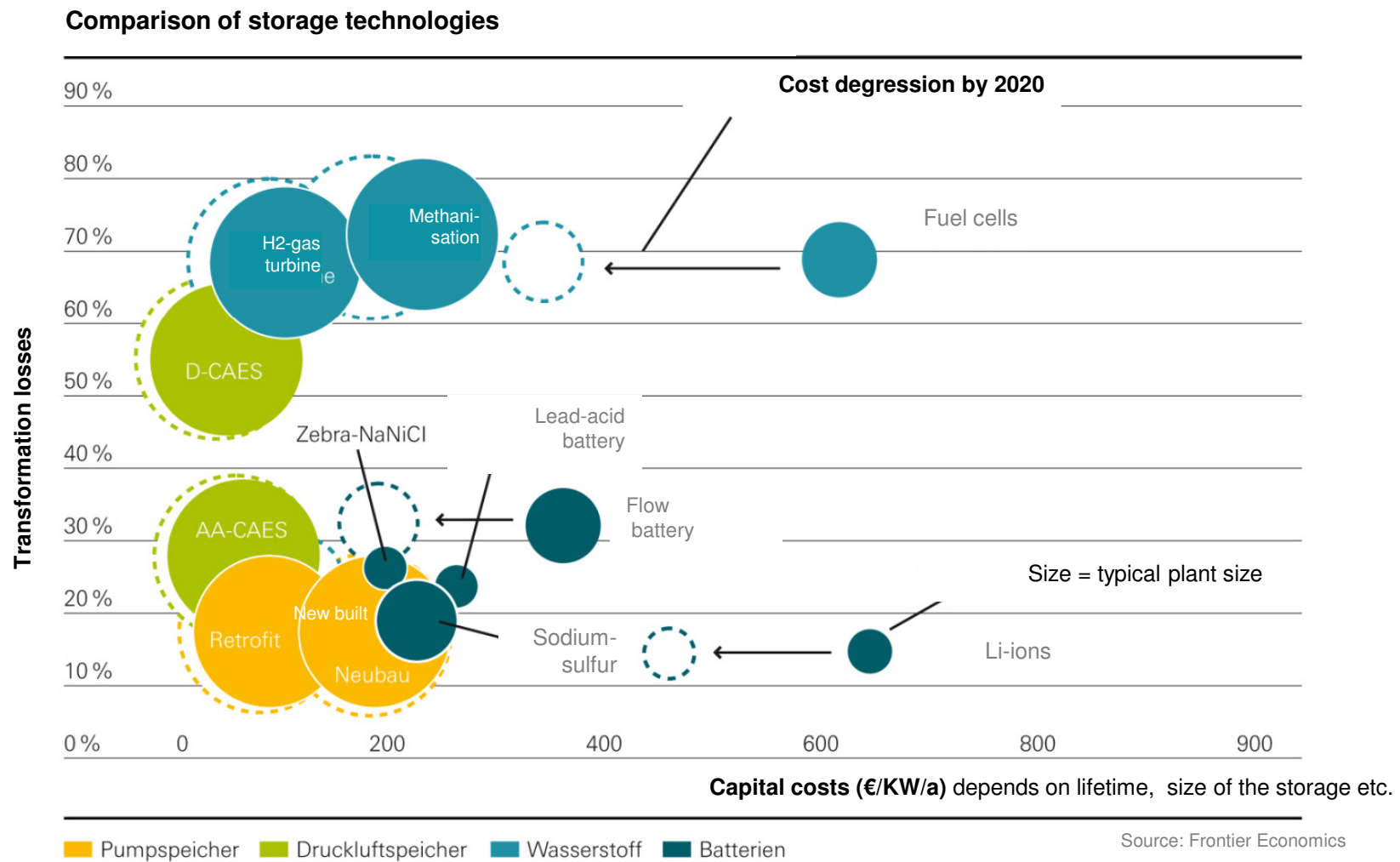
Support Schemes

- Avoid market distortions by unduly subsidising generation and storage technologies
- Swift integration of renewables / new technologies in the market

Market !

- No further regulation - e.g. capacity markets
- Make the market function!

Comparison of alternatives



Pumped hydro storages are the most efficient storage technology

Competitors on the electricity market

Pumped hydro storage



- Retrofit in Alpine storages
- Potential for new construction on major rivers

Compressed air storage (CAES)



- Needs salt caverns – potential in northern Europe
- Attractive in combination with network congestion

Competitors also on the transport market

Power to Gas



- Might make sense on the long-term
- Mobile, i.e. appropriate for „power- to-transport“

Batteries

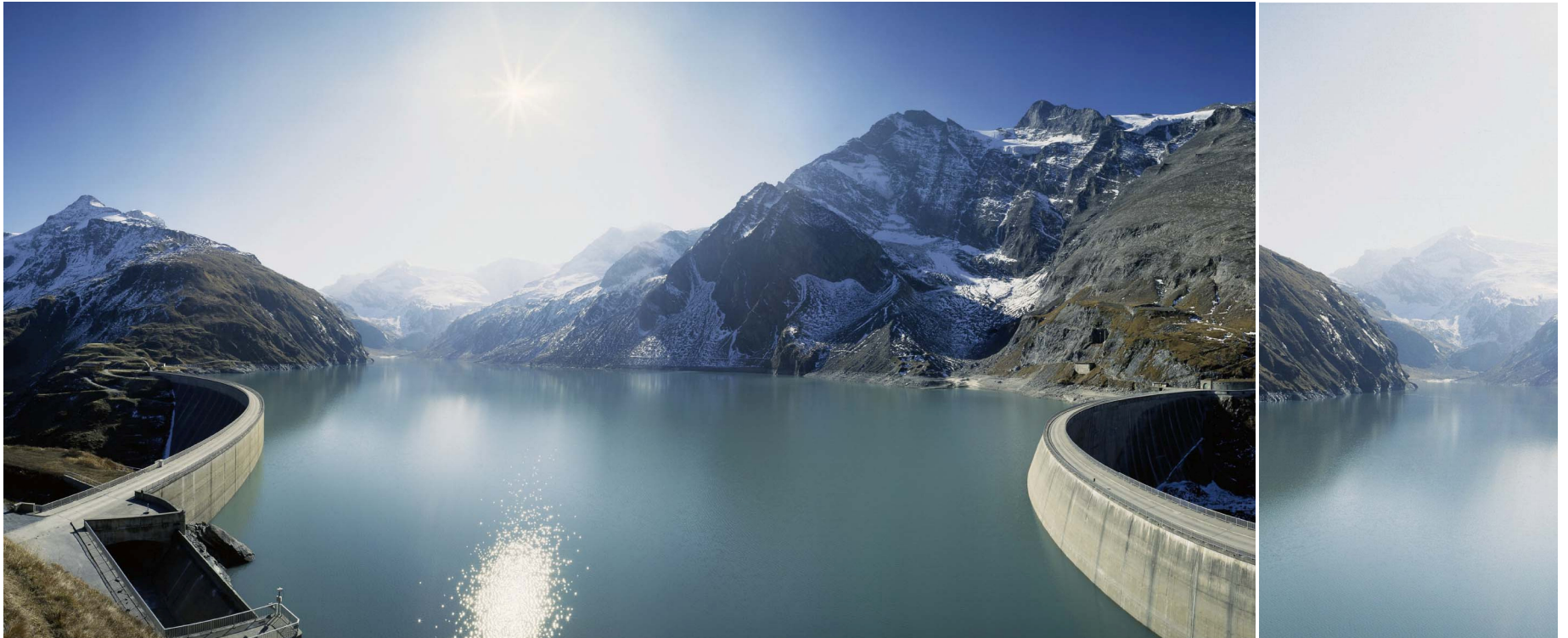


- Potential depends on learning effects
- Might make sense decentrally
- Mobile

Source: Frontier Economics

Conclusion

- **Pumped hydro storages show the by far best combination of investment costs, lifetime and efficiency**



Thank's for attention!