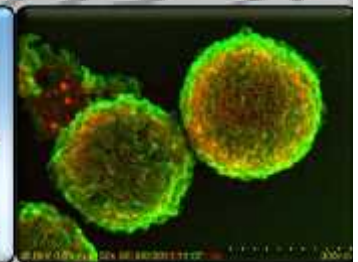
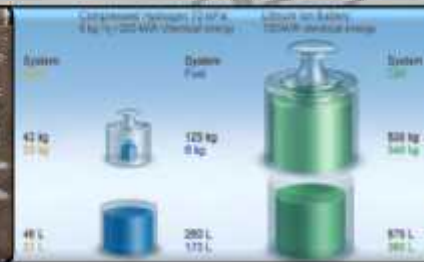
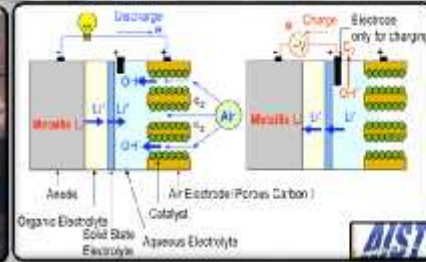


Energy Storage

F. Schüth

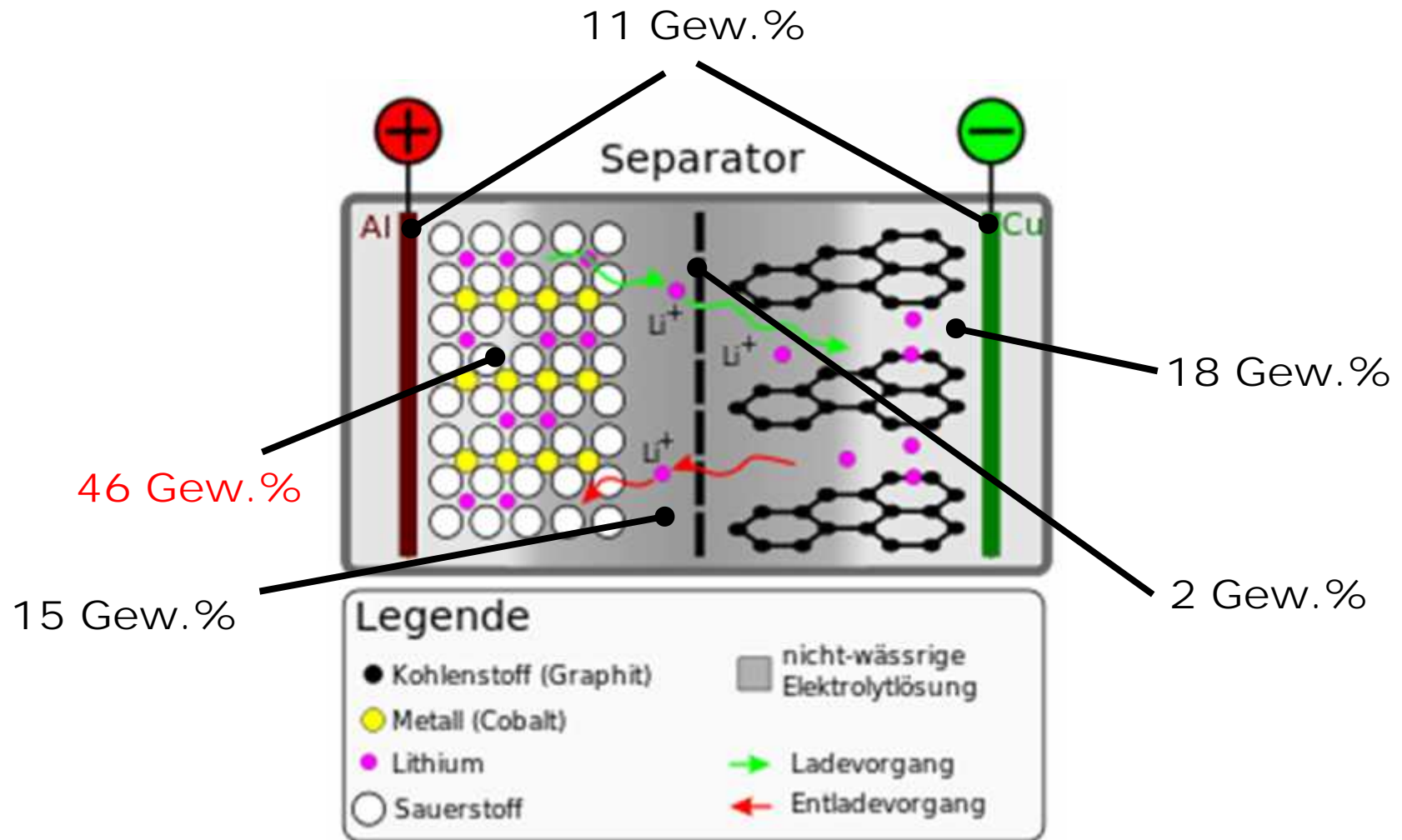
Max-Planck-Institut für Kohlenforschung



Storage density of different energy storage methods for automobility



State-of-the-art: Li-ion battery

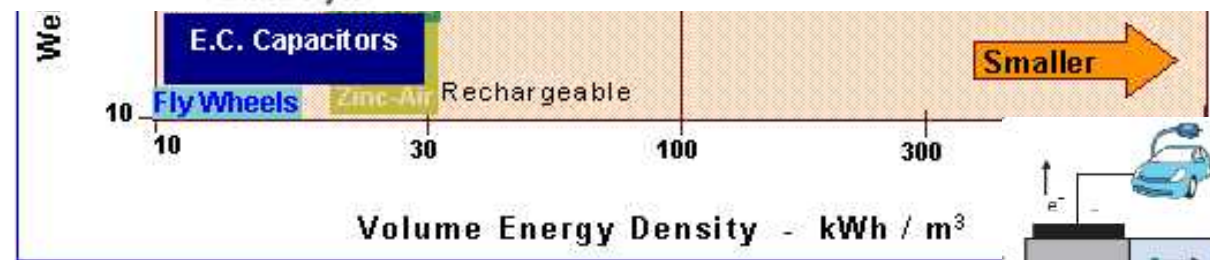
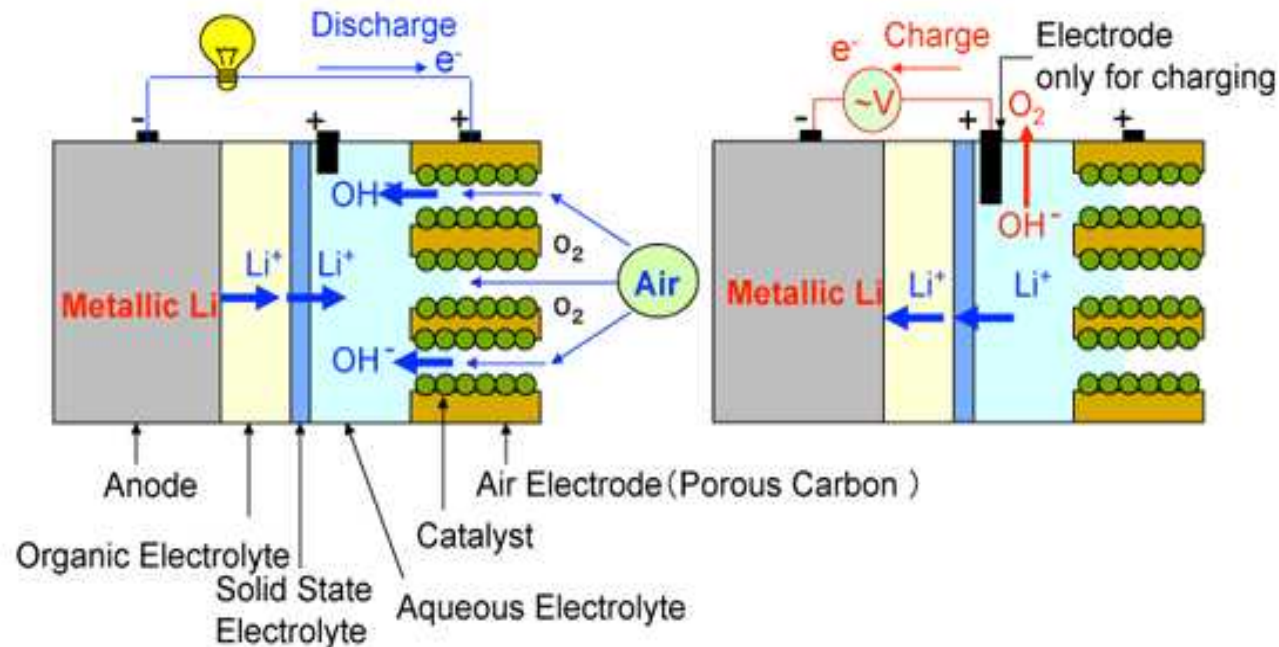


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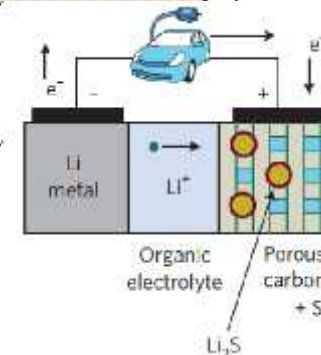
8 Gew. %: electrode additives, for instance binders

Data from: M. Broussely, G. Archdale, J. Power Sources 136, 386 (2004)

Future battery generations



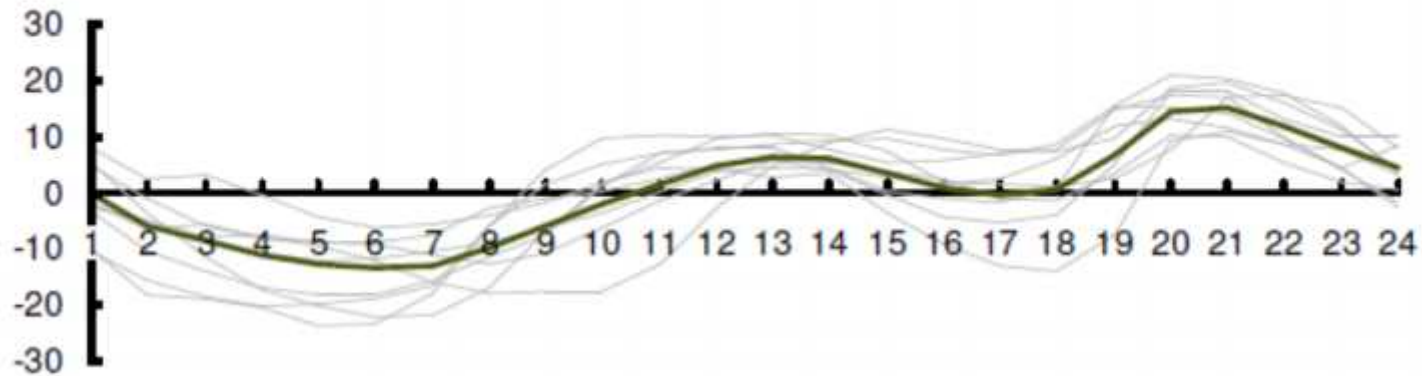
High potential for lithium-sulfur batteries



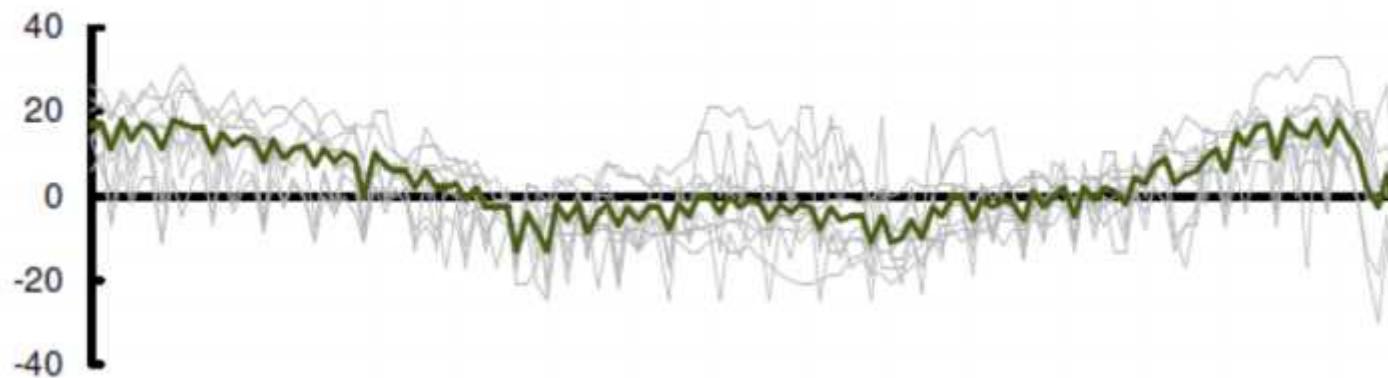
Load characteristics for Europe



Example: Regional demand variation from average per hour during one day



Regional demand variation from average over the year



Source: European Climate Foundation

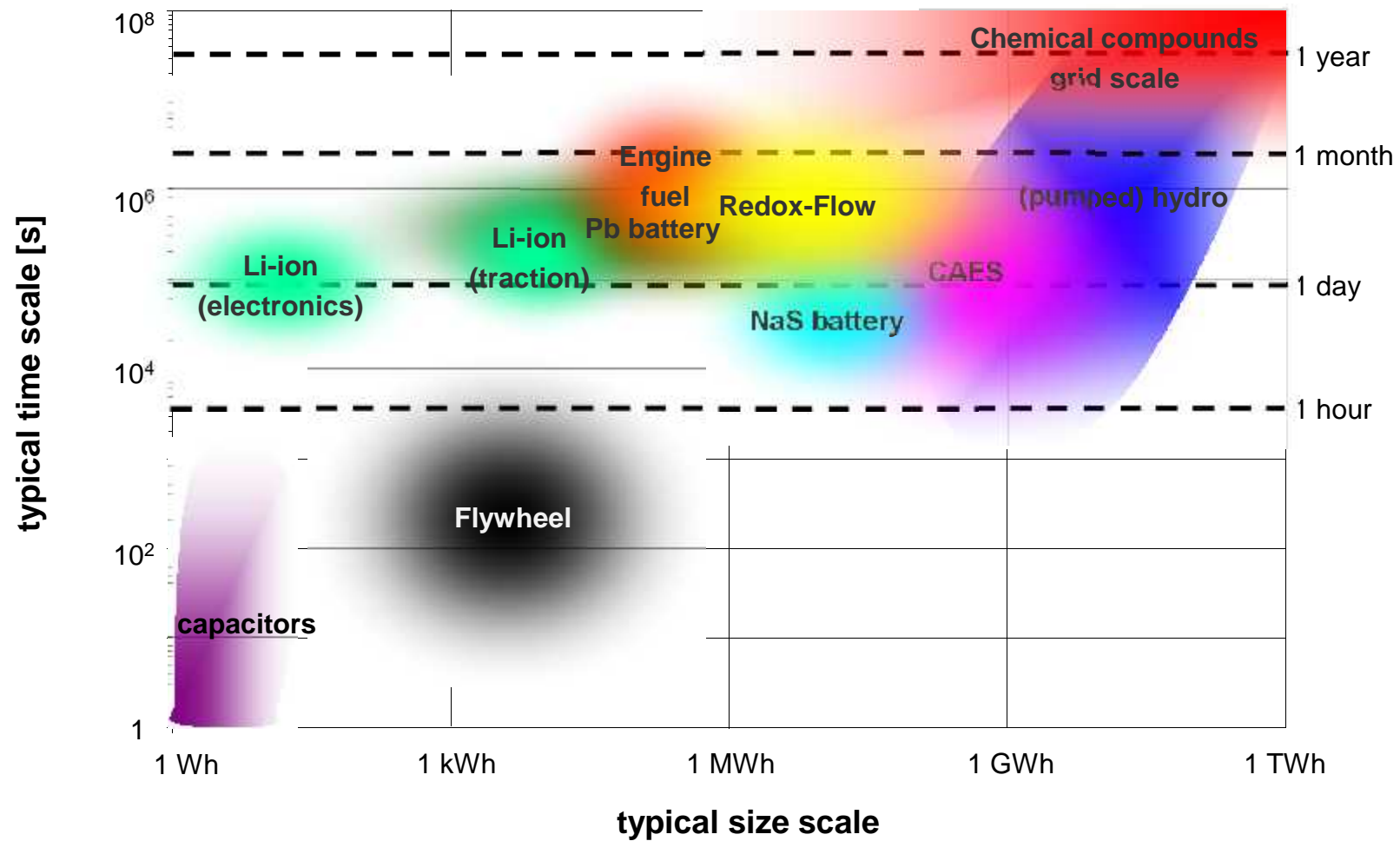
How to cope with intermittent supply?



- Grid extension
- Backup-capacity
- Demand side management
- Storage



Size and time scales of storage options



Chemical storage: hierarchy of uses



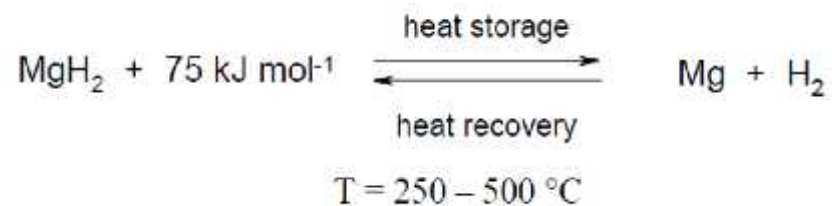
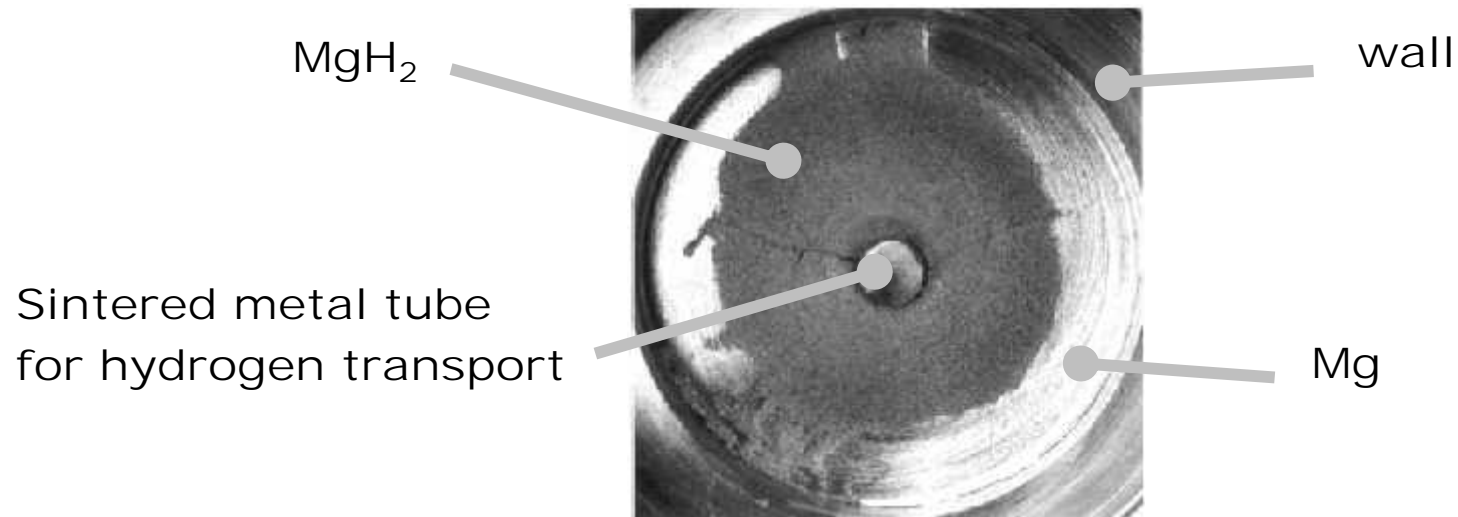
Heat storage: often neglected, although about 50 % of energy sector



Example: magnesium/hydrogen



- Storage density $0.9 \text{ kWh kg}^{-1}_{\text{Mg}}$
- Temperature from 300 to 500°C
- Tested over 1800 Cycles
- Hydrogen needs to be stored or setup close to pipeline



Summary



- Mobility: advanced batteries
- Seasonal/surplus electricity: chemical
- Heat storage: increasing importance

