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GEFÖRDERT VOM
Bundesministerium
für Bildung
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Online workshop „The role of energy storage in power sectors with fossil fuel phase-out“

Electricity storage and the renewable energy transition

Wolf-Peter Schill
9 October 2020

ENERGY TRANSITION HUB an Australian-German innovation partnership

Future of Fossil Fuels

Recent commentary published in *Joule*

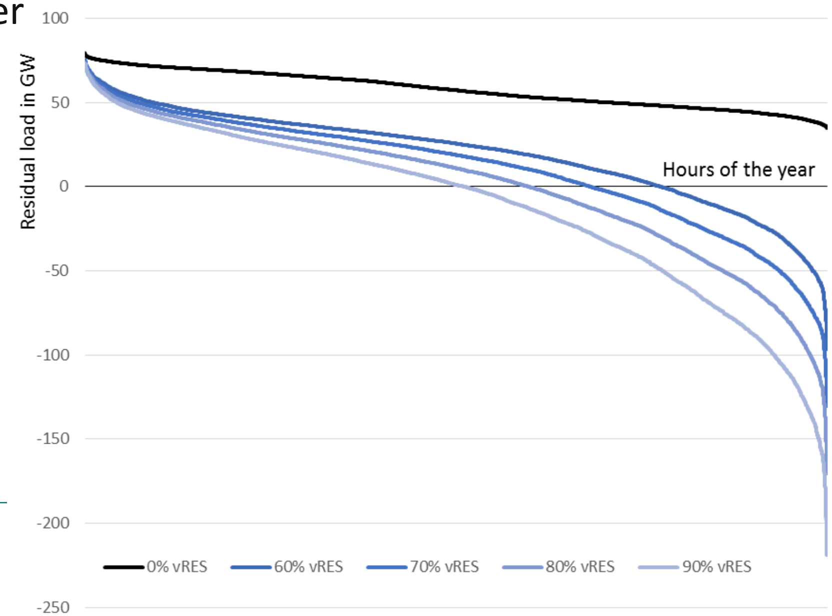
- Three strands of storage research literature
- Illustration how storage use changes with increasing renewables and sector coupling
- Some policy and research conclusions


Joule
CellPress
Commentary
Electricity Storage and the Renewable Energy Transition
Wolf-Peter Schill

Schill *Joule* (2020)
https://doi.org/10.1016/j.joule.2020.07.022

Residual load duration curves (RLDC)

- RL: electric load – potential renewable generation
- RLDC: Hourly RL values, sorted in decreasing order
- Generated with stylized version of DIETER, calibrated to Germany



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Electricity storage: technologies, applications, and competitors

Different technologies

- Always: „Power-to-Power“
- Differences in roundtrip efficiency and costs related to energy and power
  → different typical E/P ratios

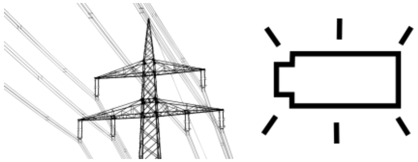
Many different applications

- Focus here: bulk electricity storage (energy arbitrage)
- Other applications: ancillary services, transmission or distribution grid relief, …

Competing flexibility options

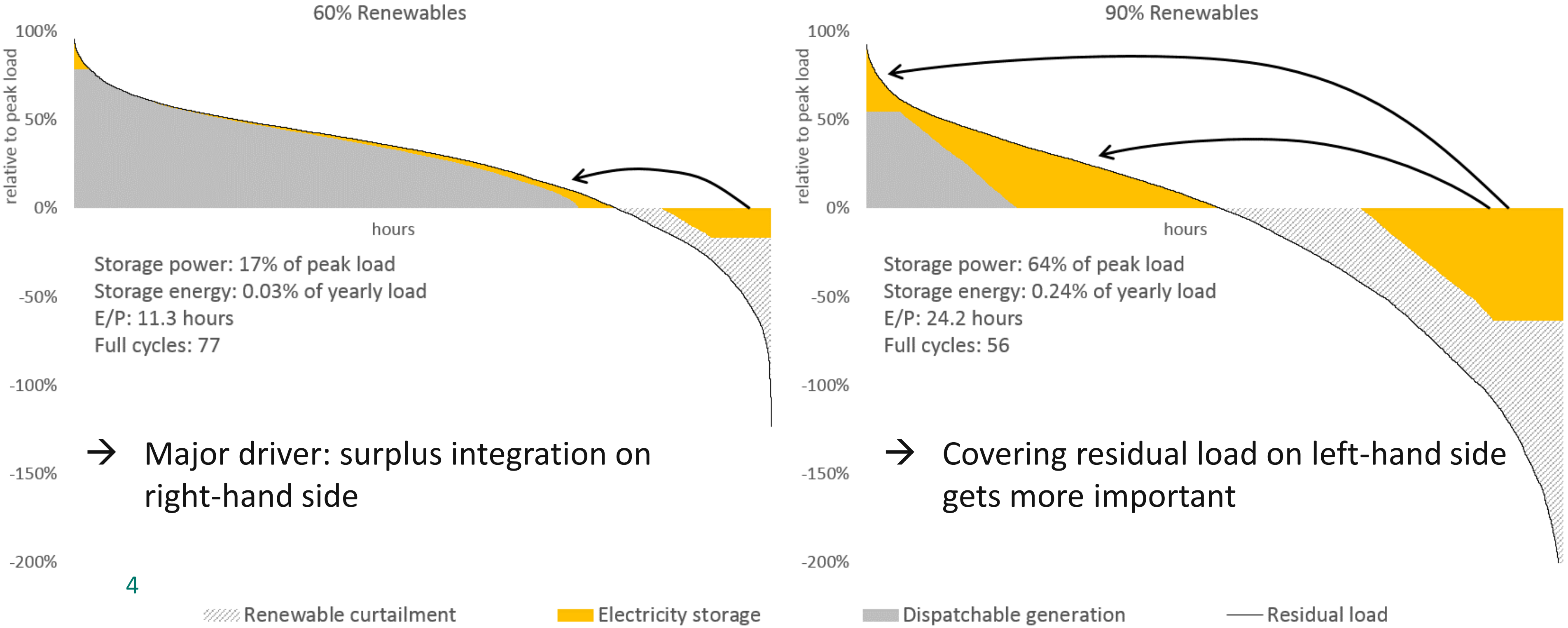
- Power-to-Power: e.g. demand-side management of existing load
- X-to-Power: Flexible operation of dispatchable plants
- Power-to-X: New and flexible loads related to sector coupling, e.g. Power-to-Heat
  - Without reconversion to electricity, incl. other forms of energy storage
- Geographical balancing

Literature strand 1: Grid-scale electricity storage in traditional power sectors



Common findings in the literature and some intuition

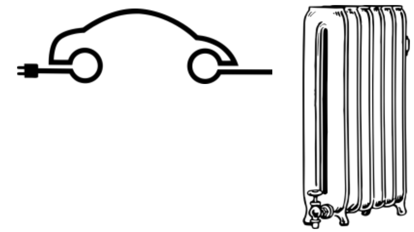
- Optimal storage deployment moderate until ~80% RES
- Increases substantially towards 100% renewables
- Depends on other sources of power sector flexibility



→ Major driver: surplus integration on right-hand side

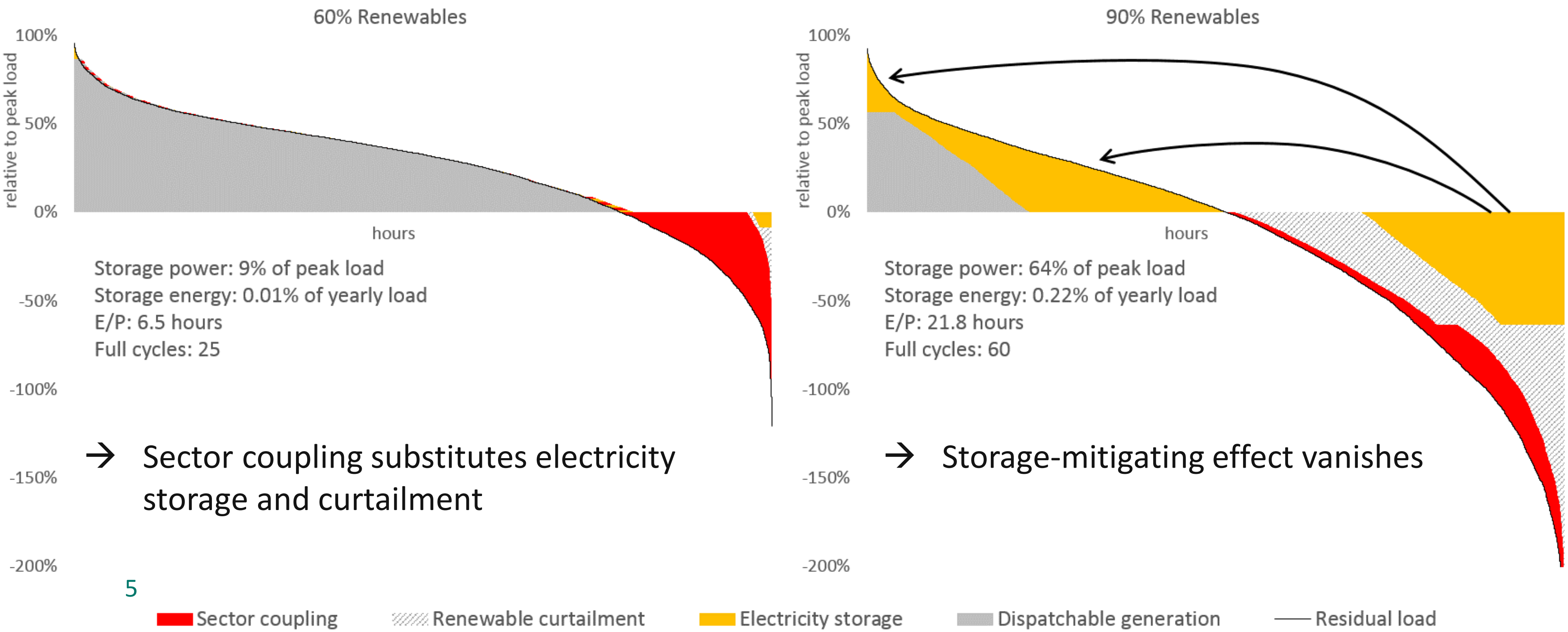
→ Covering residual load on left-hand side gets more important

2 Literature strand 2: Other types of energy storage related to sector coupling



More intuition

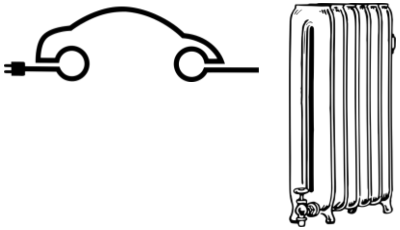
- New loads can increase the demand-side flexibility of the system
- E.g. Power-to-heat, electric vehicle batteries, green hydrogen
- This can mitigate storage needs for lower RES shares



→ Sector coupling substitutes electricity storage and curtailment

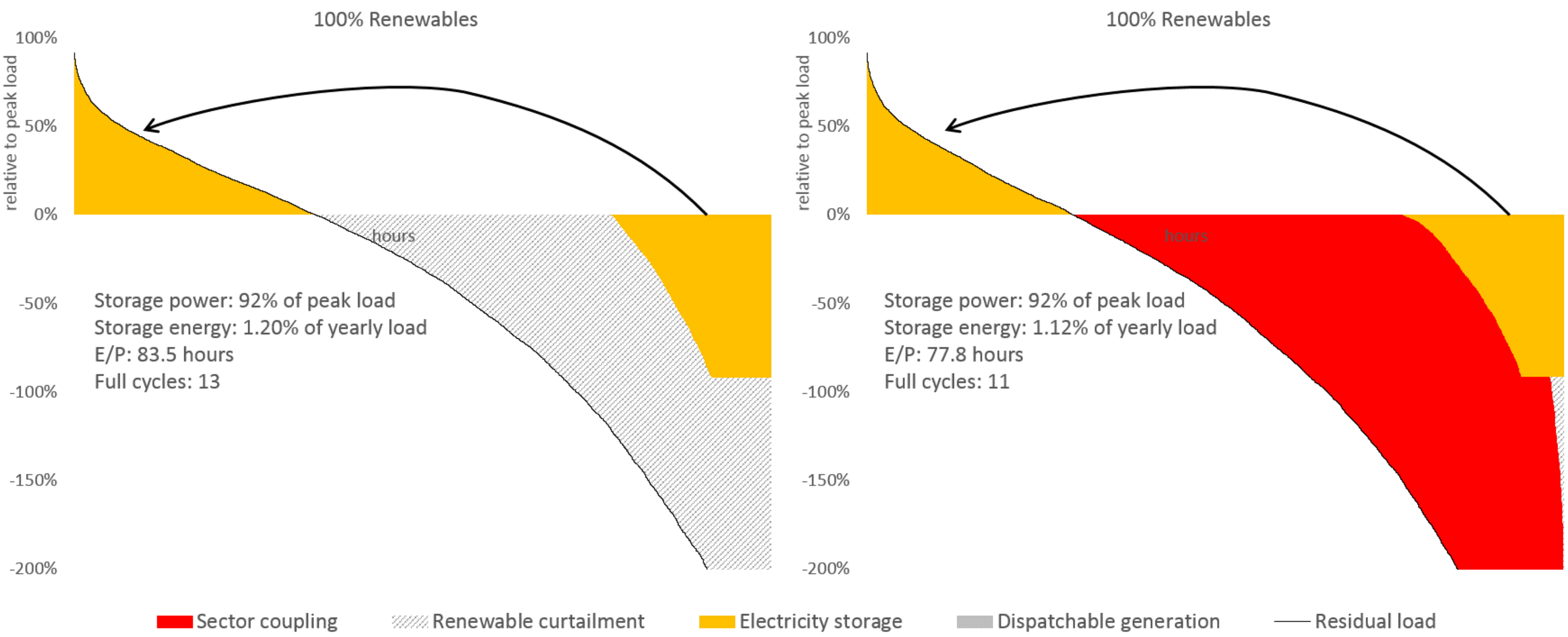
→ Storage-mitigating effect vanishes

2 Literature strand 2: Other types of energy storage related to sector coupling

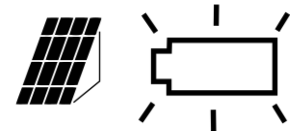


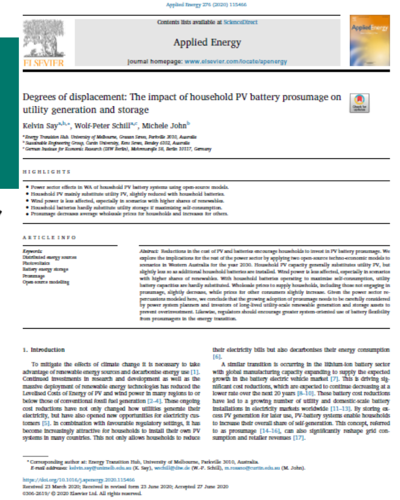
100% renewables

- Storage needs strongly increase vs. 90%
- Even massive sector coupling hardly changes optimal storage deployment
  → Storage driven by left-hand side
- If sector coupling is less flexible, additional electricity storage may be required…



Literature strand 3: PV-batteries for solar prosumage




Applied Energy
Degrees of displacement: The impact of household PV battery prosumage on utility generation and storage
Kelvin Say, Wolf-Peter Schill, Michele John

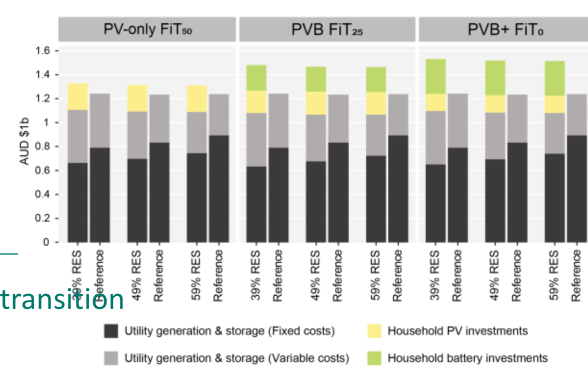
Prosumage

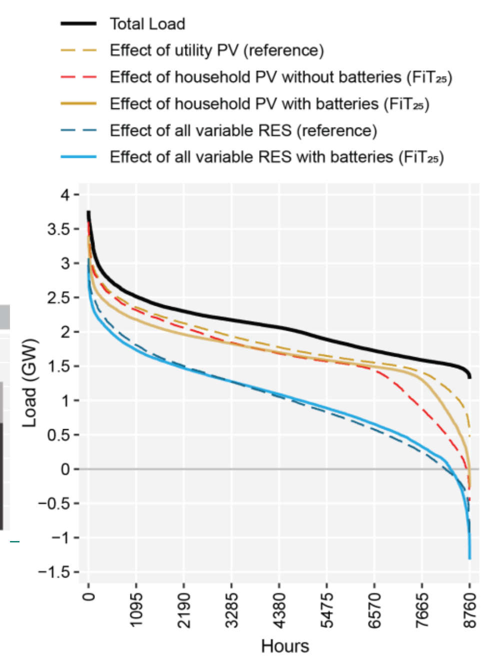
- **Pro**duction, con**sum**ption, and stor**age**
- PV-battery systems, operated to optimize self-consumption
- Major growth in several markets, e.g. some US regions and Australia
- Neither investments nor operations usually guided by energy system considerations

Say, Schill, John *Applied Energy* (2020)
https://doi.org/10.1016/j.apenergy.2020.115466

Glimpse on another recent paper: prosumage in Western Australia

- Residual load smoothing comparable to grid-scale batteries, but more costly
- Desirable: make additional (system-oriented) use of PV-batteries





Policy conclusions

- Electricity storage concerns currently no reason to slow down renewable deployment
- In highly renewable systems, longer-term storage becomes key
  - Focus for R&D
  - Incentives for market uptake to scale up, foster technological learning, and develop supply chains
  - But avoid unintended path dependencies and excessive hydrogen use vs. direct electrification
- Enable sector coupling to become temporally flexible
  - Sufficient investment in heat or hydrogen storage
  - Non-distortive charges and tariffs

Conclusions for energy system research

- Research strand 1 is done
- Put flexibility aspects of sector coupling in the focus

Thank you for listening

DIW BERLIN

DIW Berlin — Deutsches Institut
für Wirtschaftsforschung e.V.
Mohrenstraße 58, 10117 Berlin
www.diw.de

Contact
Wolf-Peter Schill | wschill@diw.de | @WPSchill

Backup: less flexible storage

Inflexible sector coupling increases electricity storage needs