DIW BERLIN

Keynote Speicherkonferenz OFATE/DFBEW

# Battery storage: challenges and perspectives

Dr. Wolf-Peter Schill

Berlin, 25. September 2019

ENERGY TRANSITION HUB an Australian-German innovation partnership

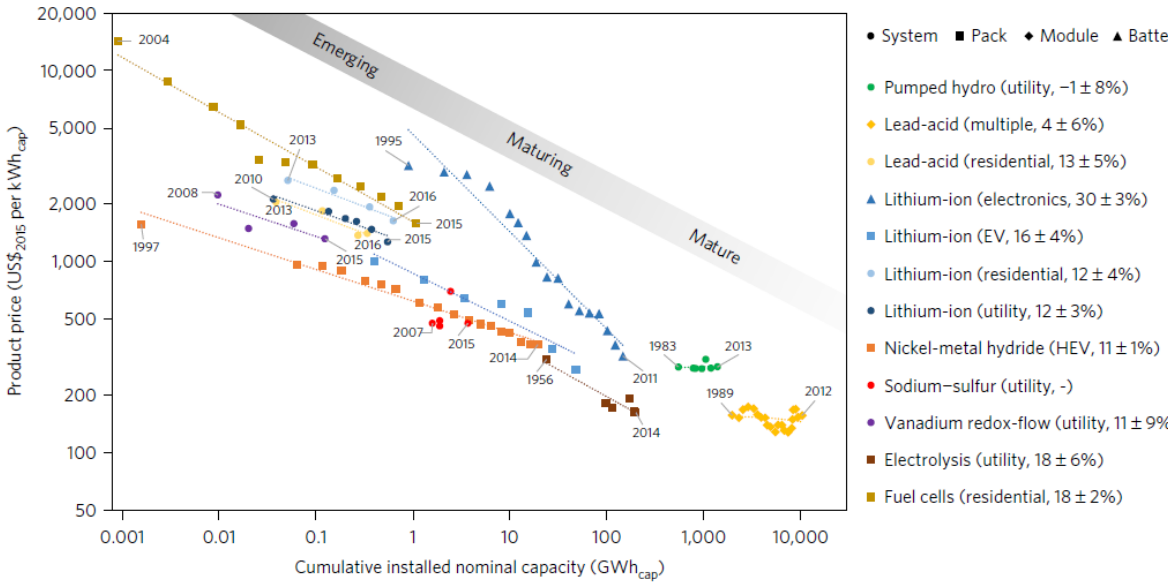
Gefördert durch:

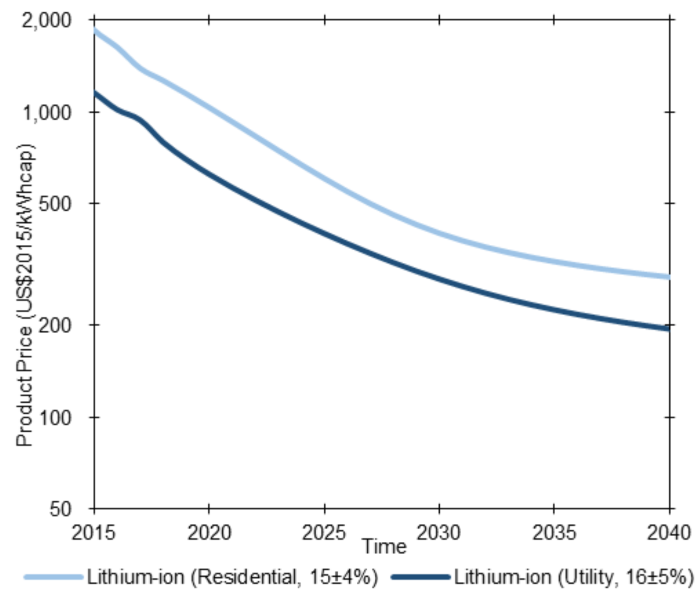
Bundesministerium für Wirtschaft und Energie

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

# Ongoing decline in battery costs




Left: Schmidt et al. (2017), *Nature Energy* http://dx.doi.org/10.1038/nenergy.2017.110;

Right: own depiction from online update 2018 https://figshare.com/articles/Update_2018_-_The_future_cost_of_electrical_energy_storage_based_on_experience_rates/7012202

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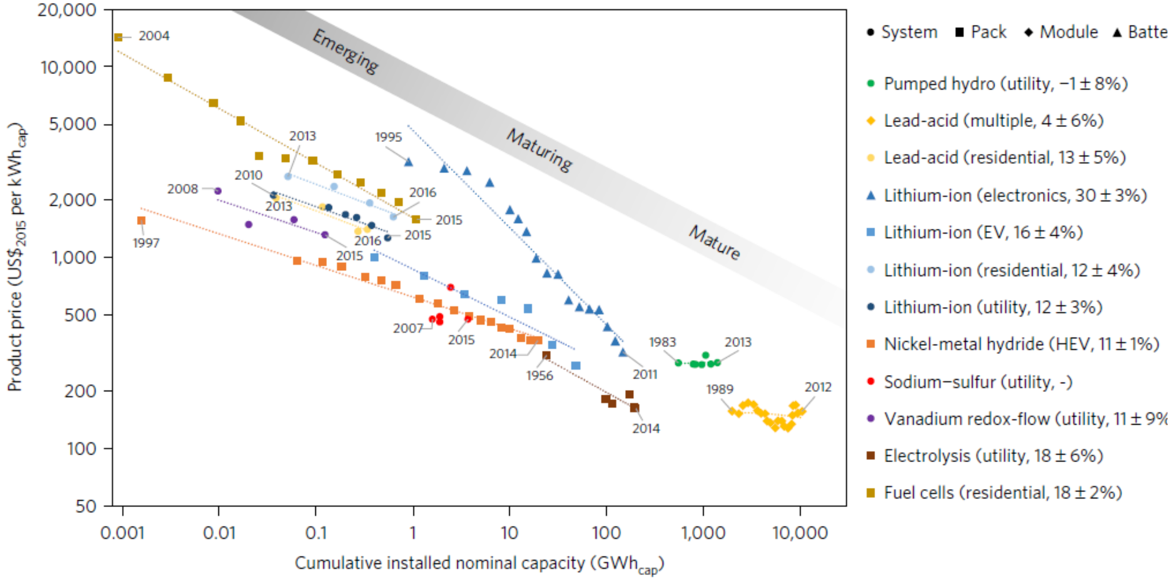


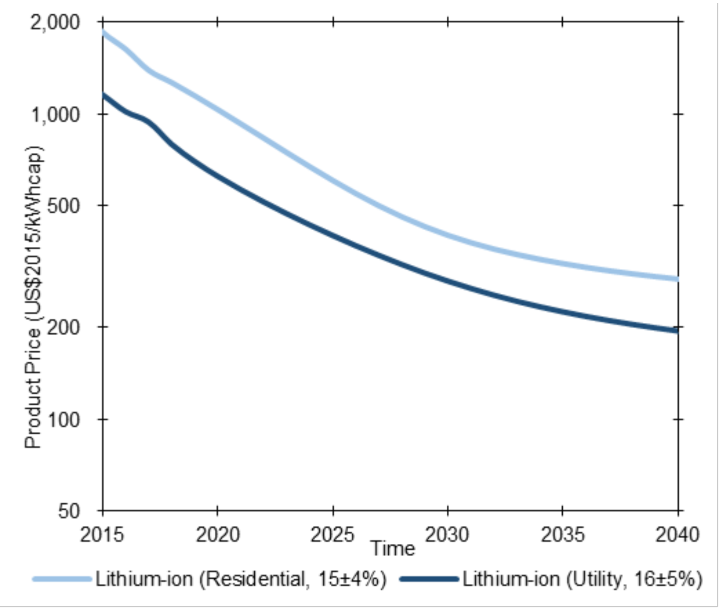


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→ Batteries become increasingly viable in various energy market segments

# Introduction

- Different (potential) applications for batteries
  - Energy arbitrage, residual load smoothing
  - Balancing reserves and other ancillary services
  - Relief of grid constraints
  - Decentral optimizations, e.g. prosumage

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- But also many competing options for flexibility
  - Flexible dispatchable plants (also CHP, hydro reservoirs)
  - Renewable curtailment
  - Demand-side flexibility
  - „Power-to-Anything“ (sector coupling)
  - Geographical balancing

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System perspective

Household perspective

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# Overall system perspective, long-term

# Power storage needs in a long-term greenfield scenario

- Research question
  - Optimal power storage investments in long-run scenarios with very high shares of renewables


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- Method
  - New open-source dispatch and investment model DIETER
  - Long-run greenfield setting, loosely calibrated to Germany
  - Consideration of arbitrage, capacity and balancing reserve value


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# Power storage needs in a long-term greenfield scenario

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- Method
  - New open-source dispatch and investment model DIETER
  - Long-run greenfield setting, loosely calibrated to Germany
  - Consideration of arbitrage, capacity and balancing reserve value
- Key findings
  - Storage needs strongly increase above 80% renewables
  - Optimal capacity depends on various assumptions


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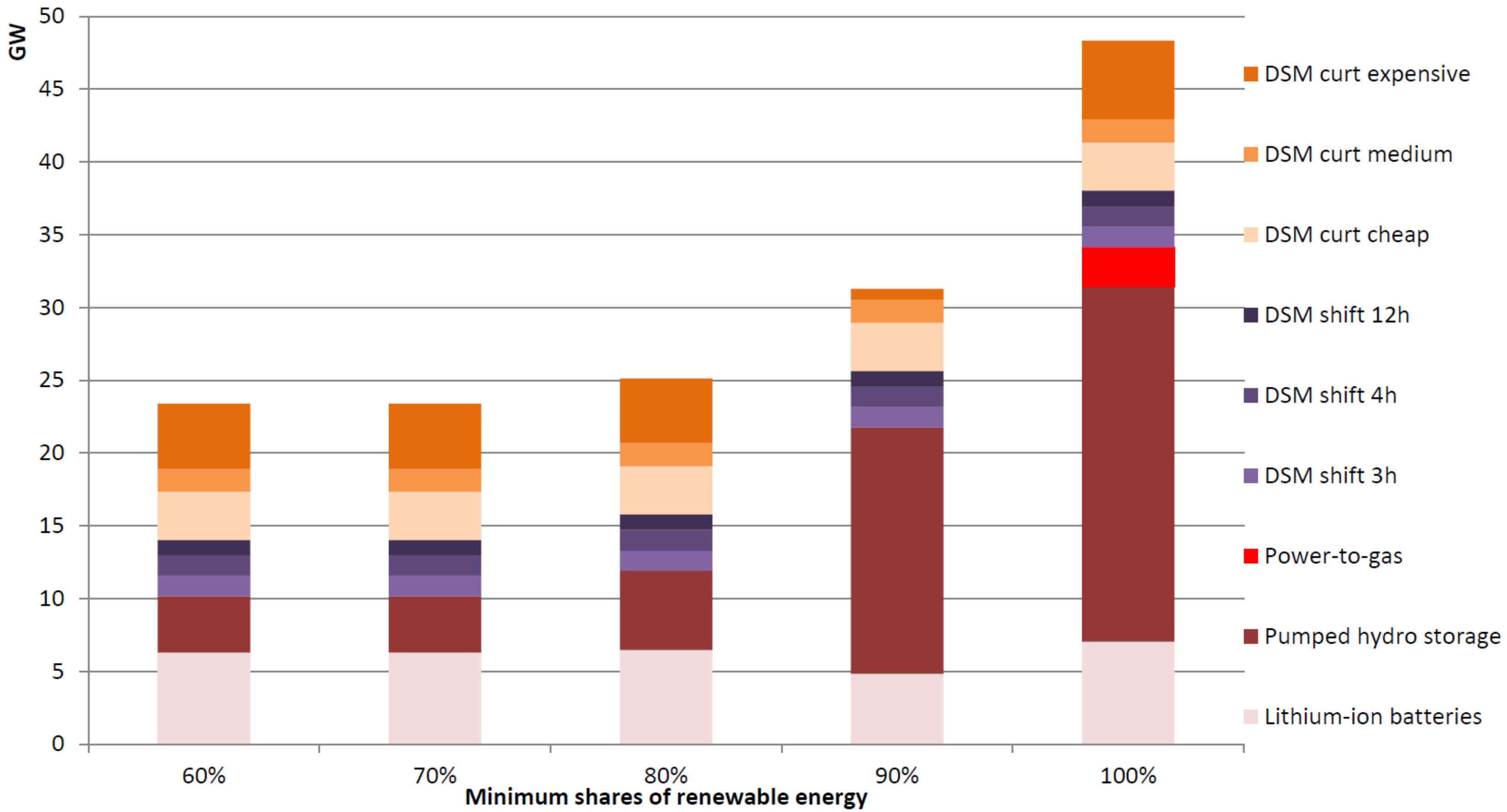
25. September 2019

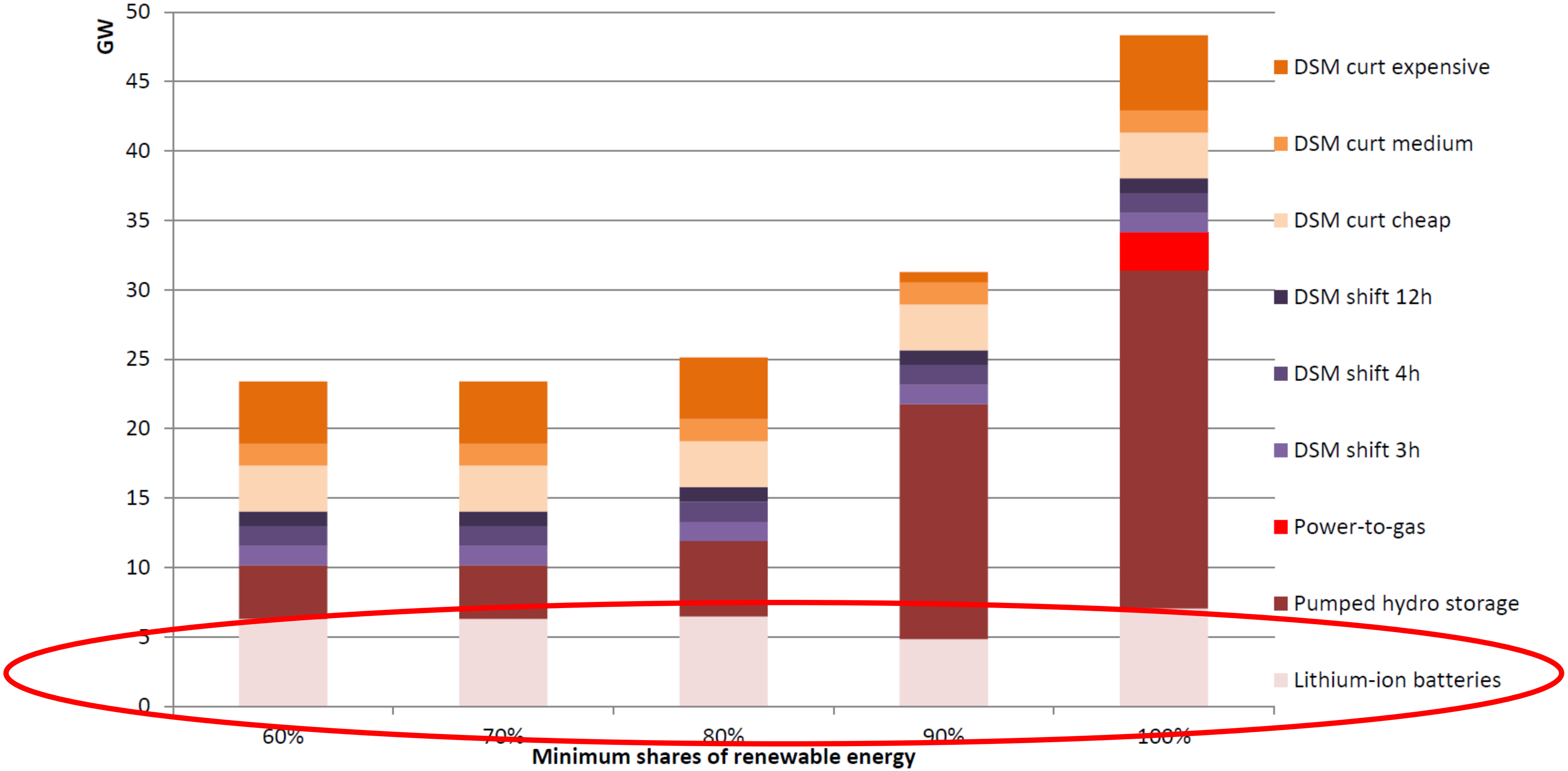
# Storage needs in a long-term greenfield scenario: baseline






Schill & Zerrahn (2018),
*Renewable and Sustainable Energy Reviews*,
https://doi.org/10.1016/j.rser.2017.05.205

# 2 Storage needs in a long-term greenfield scenario: baseline

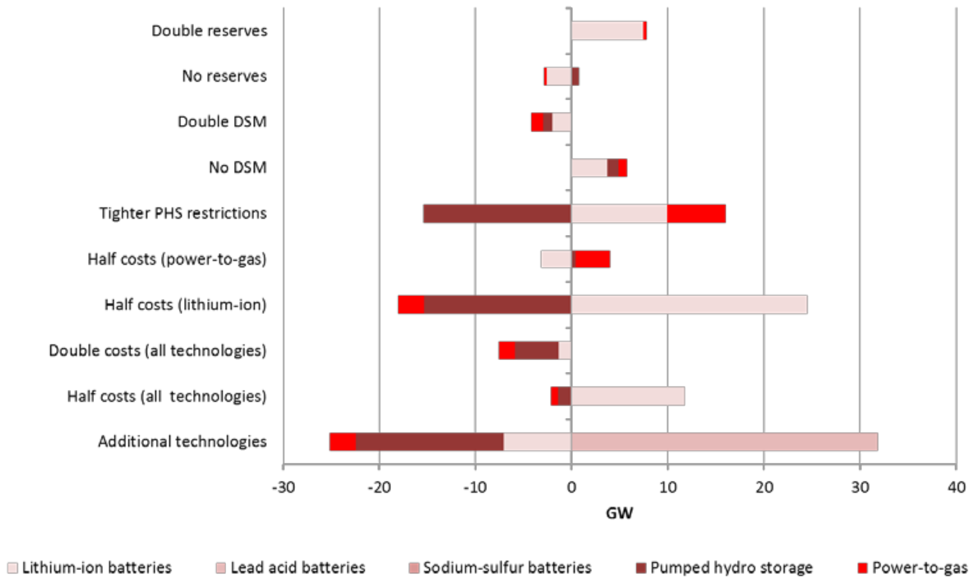



→ Batteries relatively stable between 5 and 7 GW (8 to 22 GWh)

→ Medium-term storage substantially gains importance toward 100% RES

Schill & Zerrahn (2018), *Renewable and Sustainable Energy Reviews*, https://doi.org/10.1016/j.rser.2017.05.205

# 2 Storage power: sensitivities in 100% RES scenarios




**Sensitivities on storage costs, DSM, and reserves**

→ Battery deployment depends on…



Schill & Zerrahn (2018), *Renewable and Sustainable Energy Reviews*, https://doi.org/10.1016/j.rser.2017.05.205

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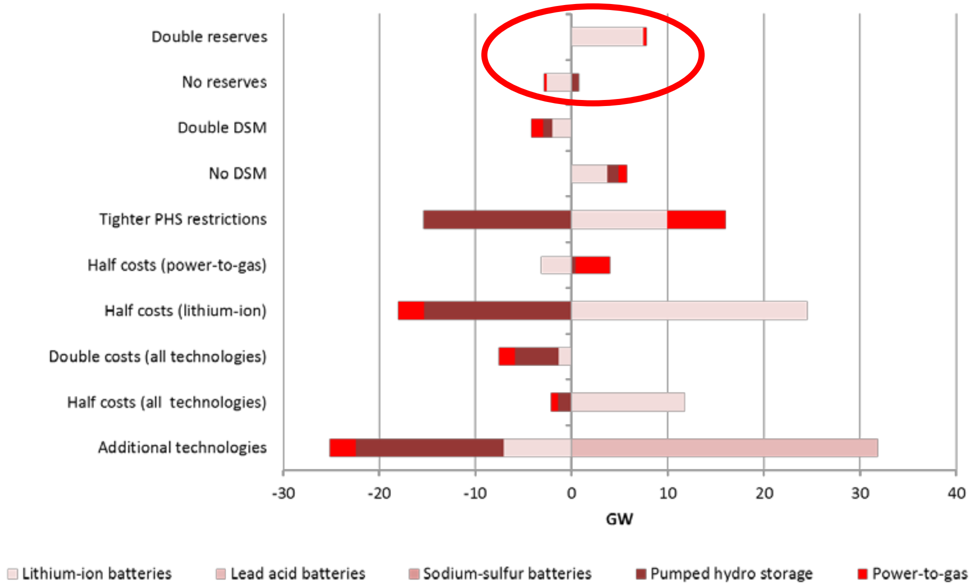


**Sensitivities on storage costs, DSM, and reserves**

→ Battery deployment depends on…

… demand for balancing reserves



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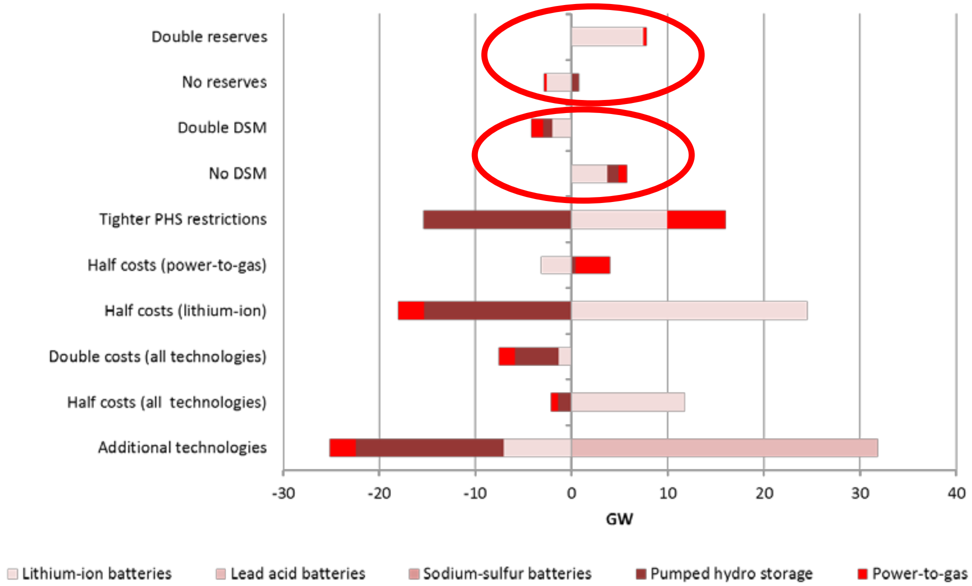


**Sensitivities on storage costs, DSM, and reserves**

→ Battery deployment depends on…

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… availability of demand-side flexibility



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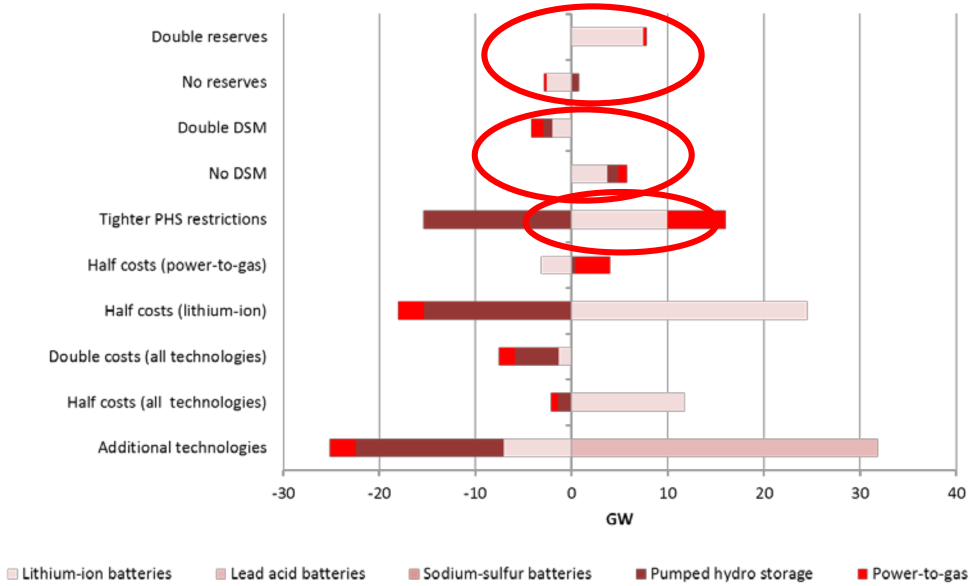


**Sensitivities on storage costs, DSM, and reserves**

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… availability of demand-side flexibility

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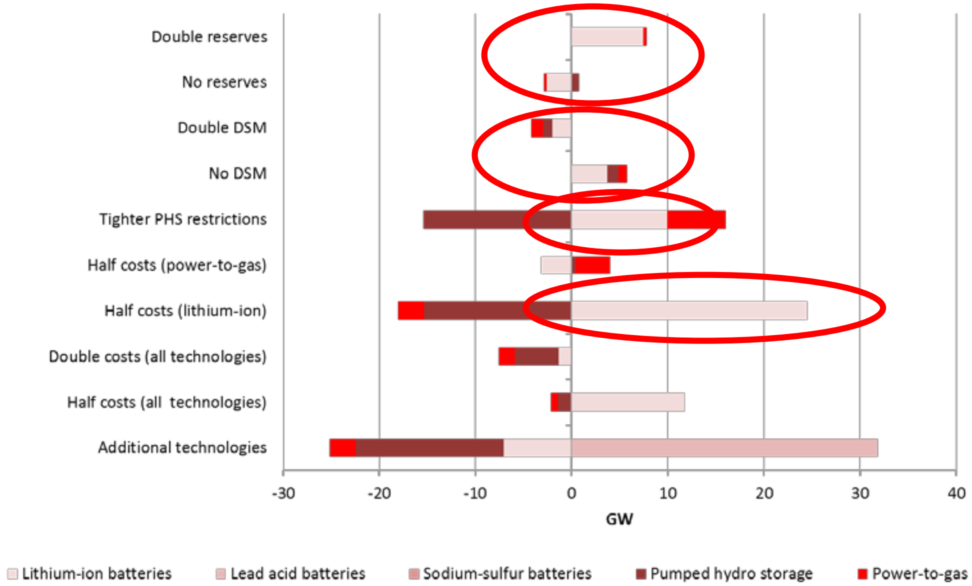


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→ Battery deployment depends on…

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… availability of pumped hydro
… costs of batteries



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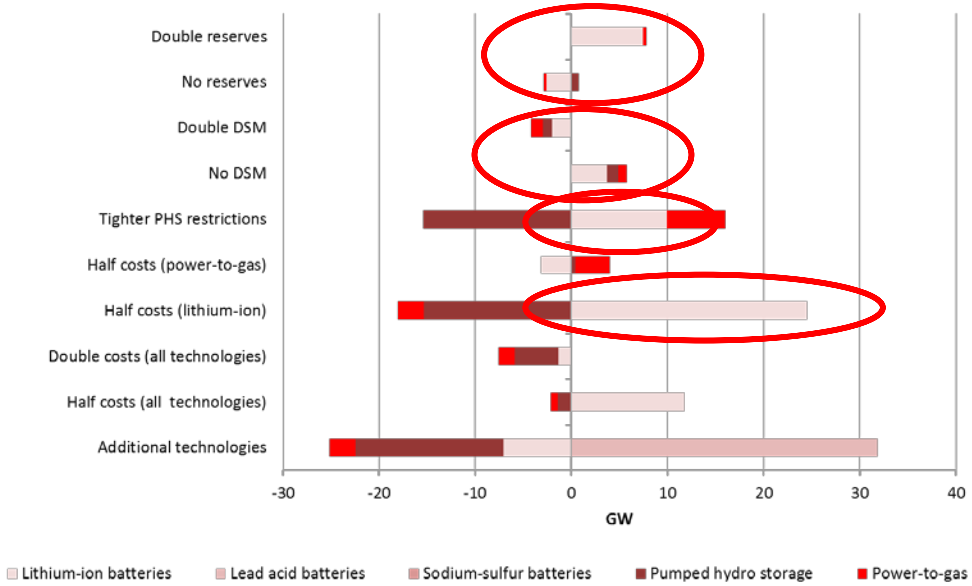


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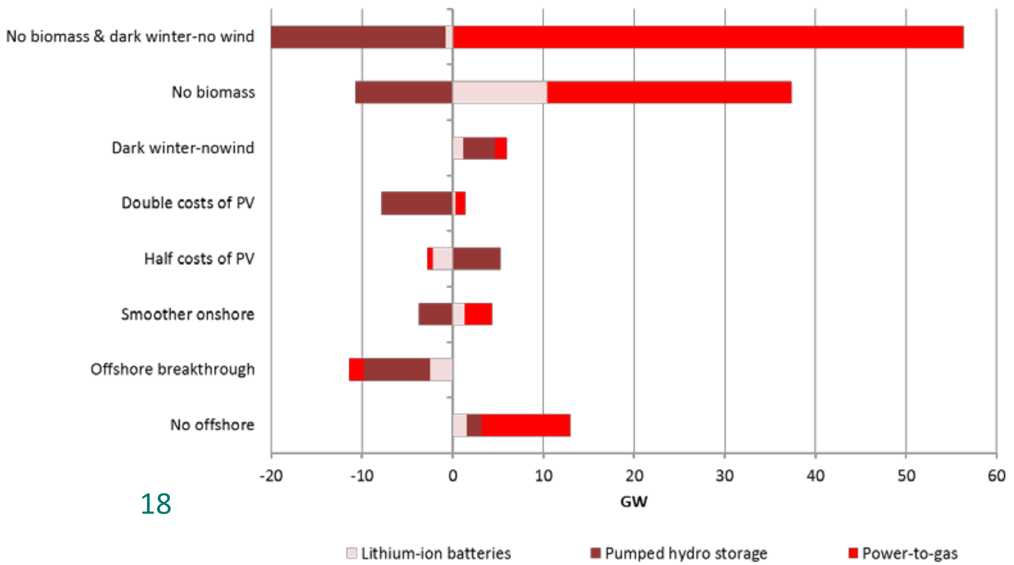


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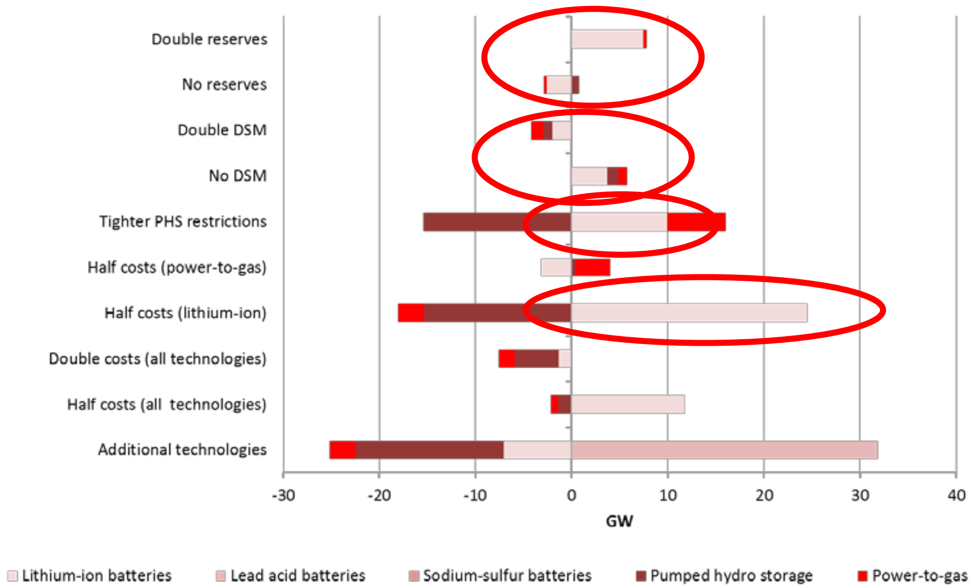


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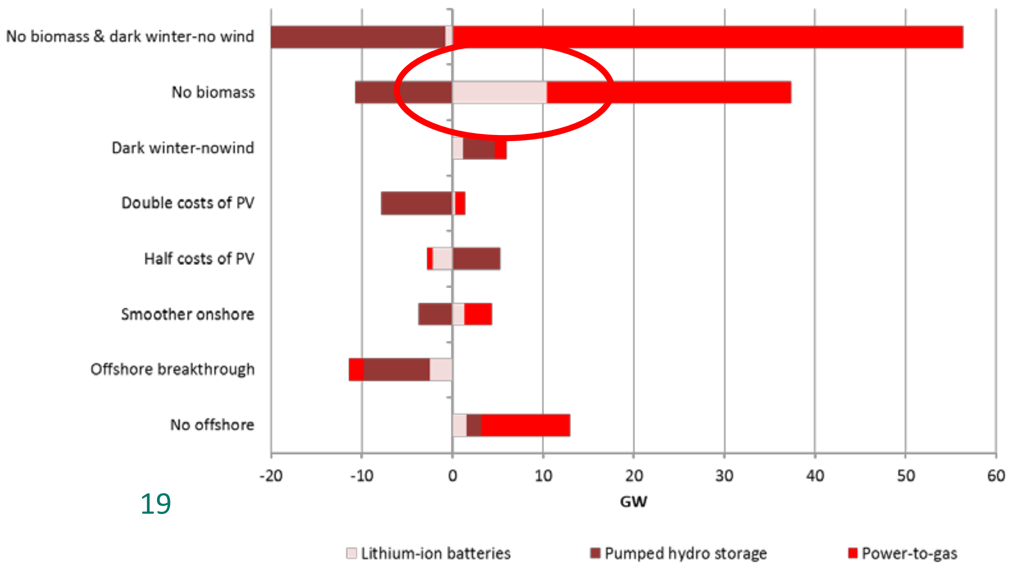


**Sensitivities on renewable costs and availabilities**

→ Battery deployment depends on…

… availability of flexible power generation from biomass

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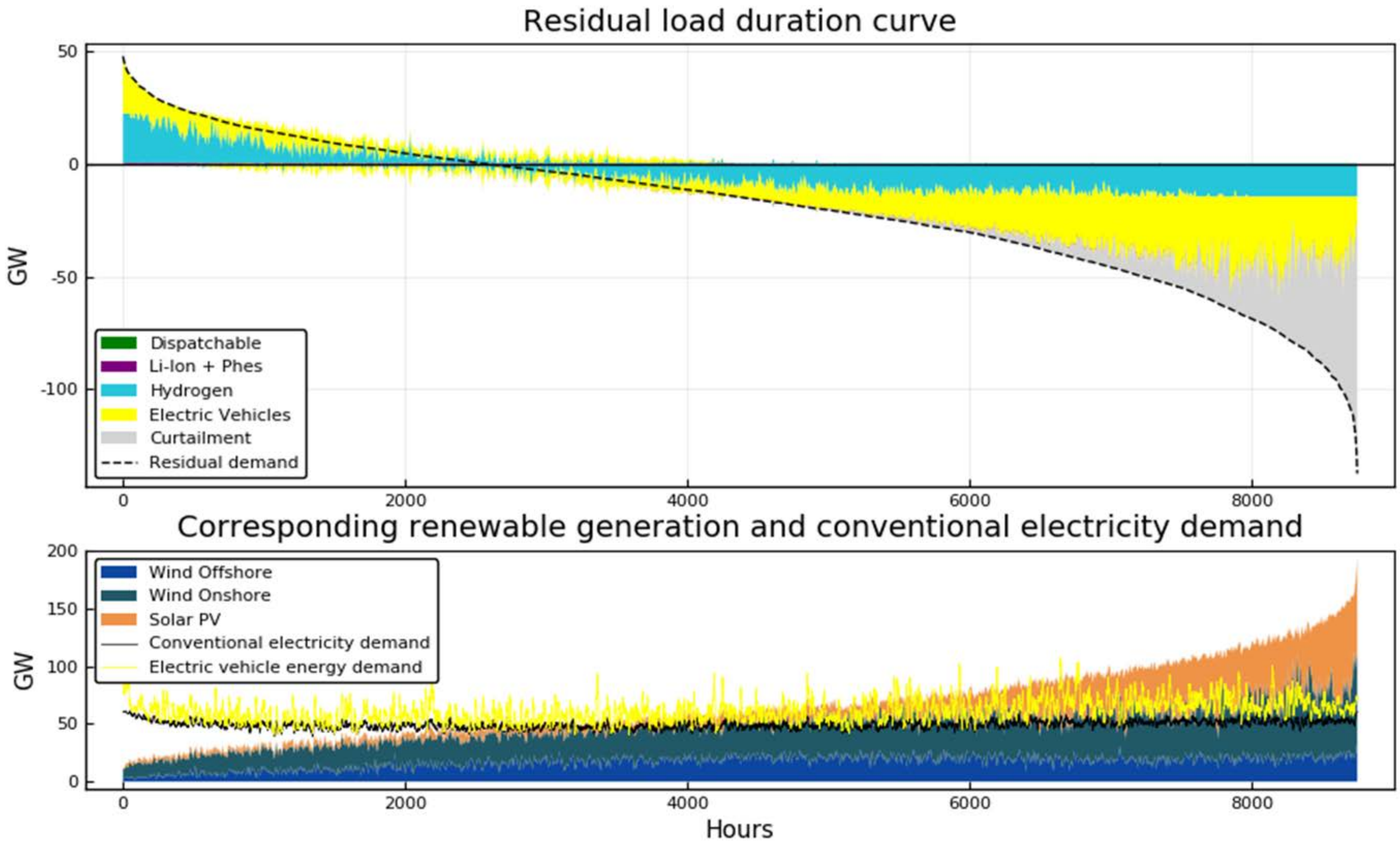
# Ongoing research: interactions of electrical storage with electric vehicles




→ 100% RES: BEVs with V2G could take up surplus energy and supply peak load

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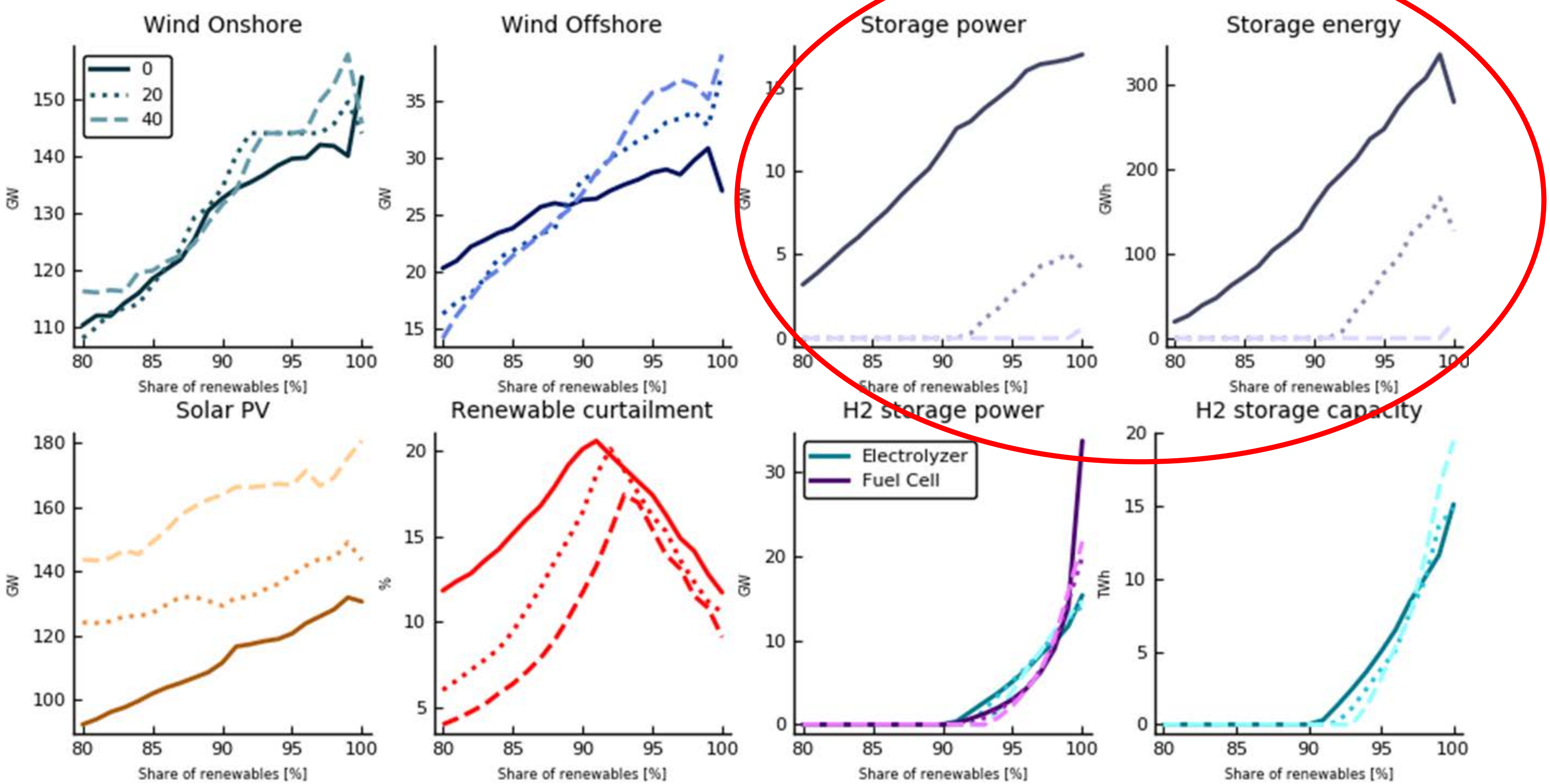


→ 40 mio electric vehicles: nearly perfect substitution of short-term storage

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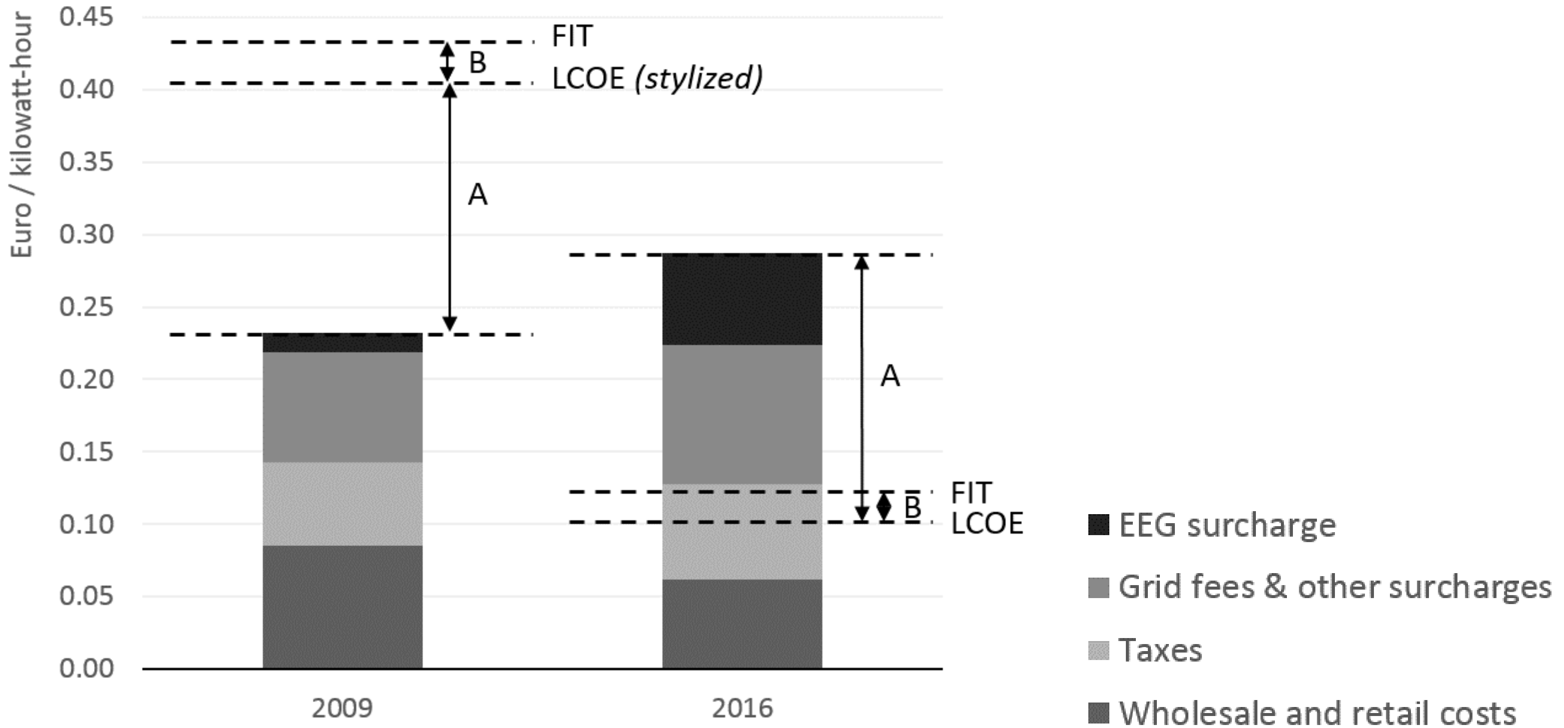
# Household perspective, medium-term

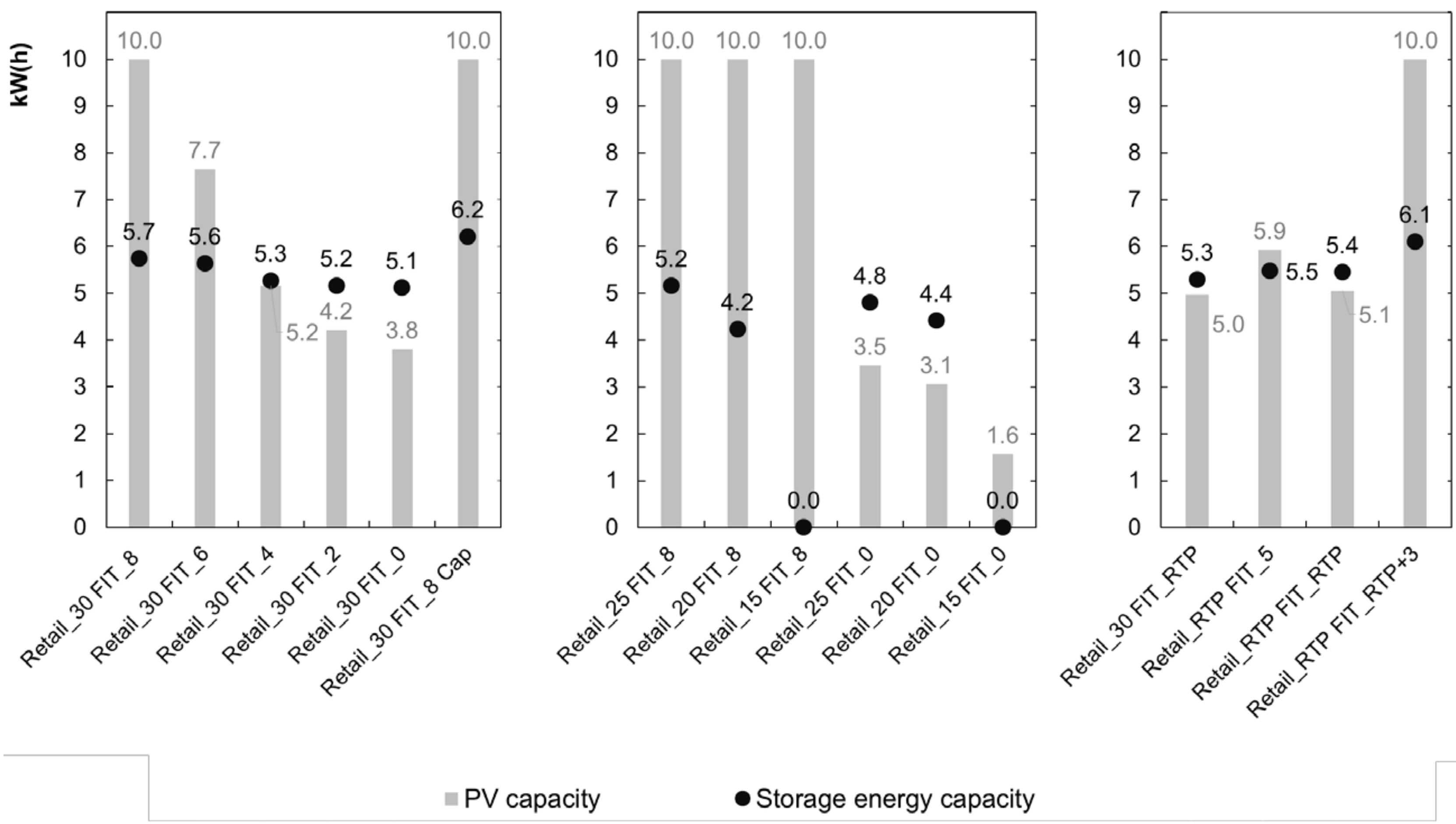
# 3 Solar prosumage with batteries

- Batteries used to increase self-consumption of decentral PV
- Driven by difference between retail prices and FIT → not by system needs
- 2018: ~120,000 units, ~900 MWh




Source: Schill et al., *EEEP* 2017, https://doi.org/10.5547/2160-5890.6.1.wsch

# Model-based analysis: effects of tariff design on prosumage investment

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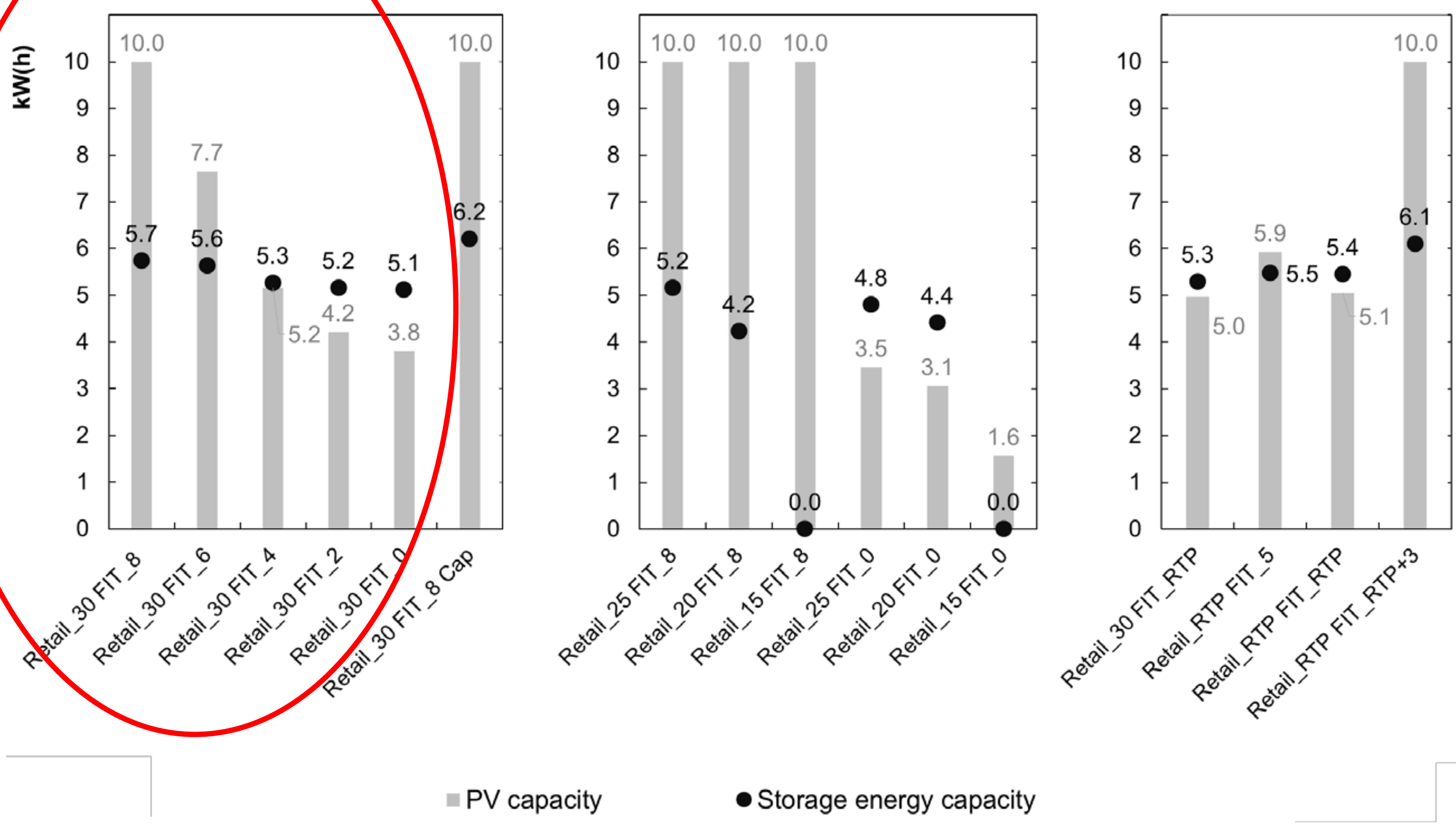


→ Lower feed-in tariffs have a large impact on PV installations, but not so much on storage sizing

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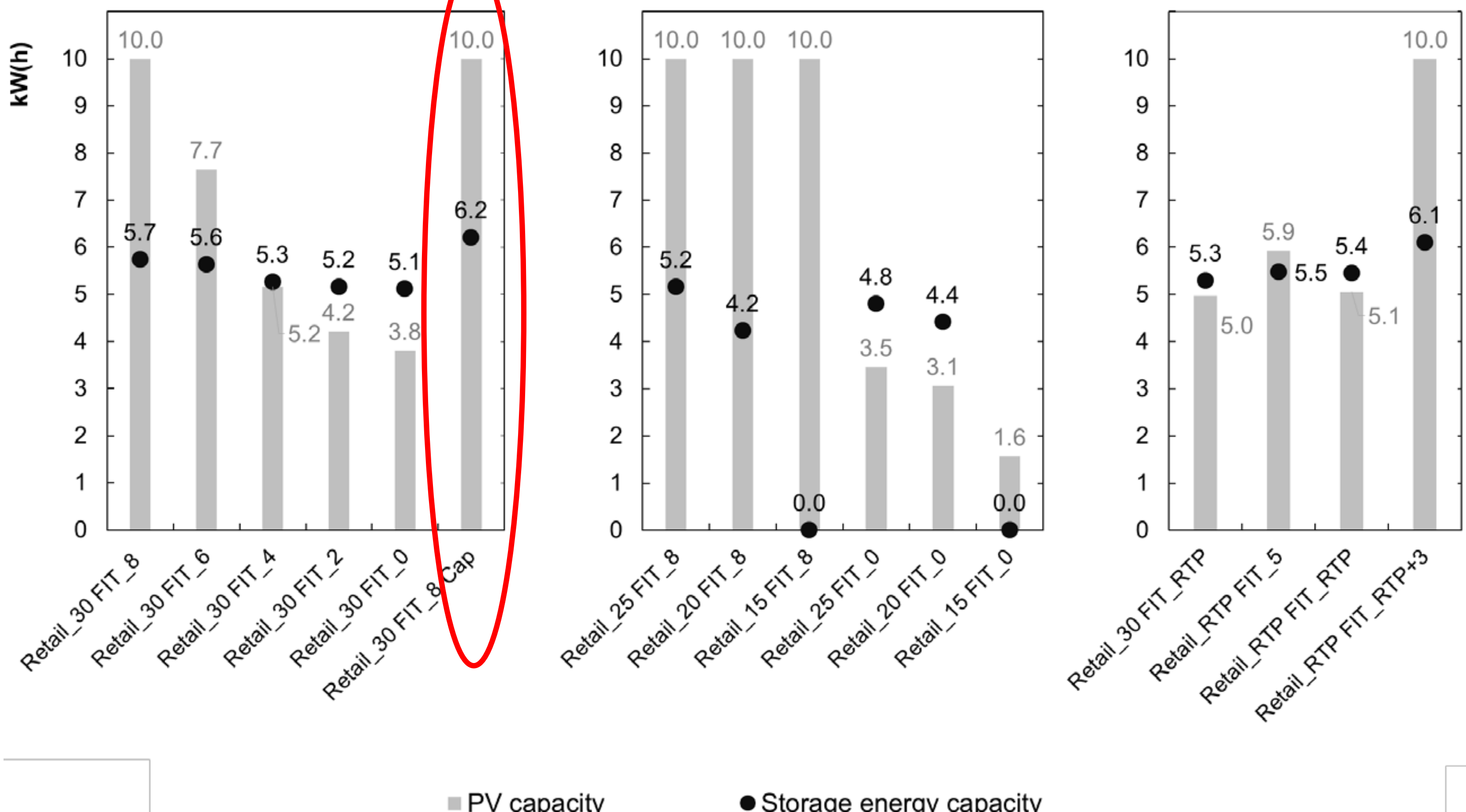


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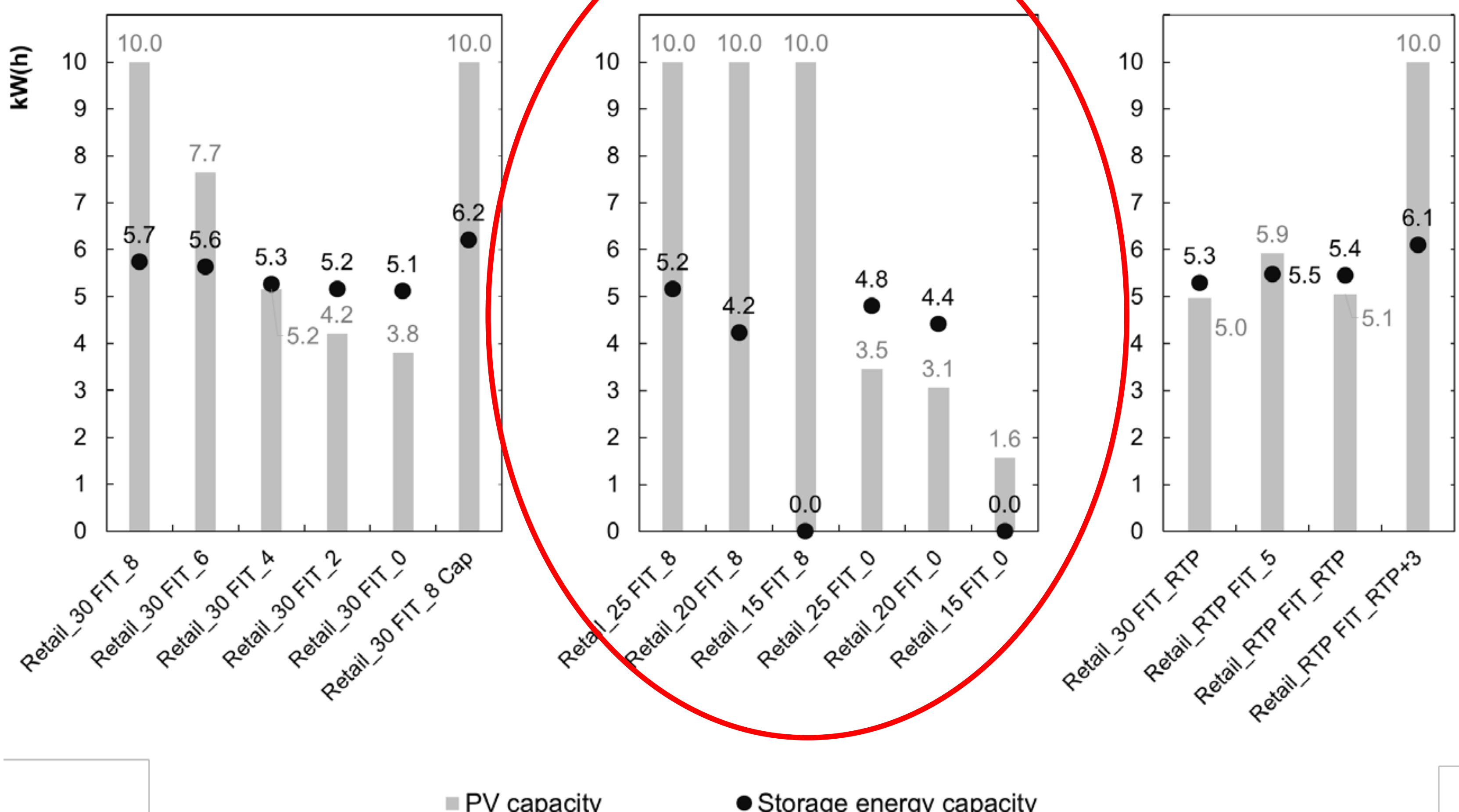


→ Lower feed-in tariffs have a large impact on PV installations, but not so much on storage sizing

→ Small effect of 50% feed-in cap

→ Higher fixed retail tariff parts have a strong effect on storage

Source: Günther et al. 2019, https://arxiv.org/abs/1907.09855

## Competitiveness of batteries has increased in several market segments


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# Conclusions: challenges & perspectives of batteries in the *Energiewende*

Competitiveness of batteries has increased in several market segments

Further perspectives depend on:

- Development of battery costs
- Costs and availability of competing flexibility options
- Regulatory framework
- Prosumage batteries: tariff design


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Important challenge:

- Realize flexibility potential of decentral batteries

Thank you for your attention.

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# BACKUP

# Pros and cons of prosumage depend on perspective

| Arguments in favor of prosumage |
| --- |
| • Consumer preferences<br>• Lower/more stable electricity costs<br>• Participation/acceptance of energy transformation<br>• Activation of private capital<br>• Distribution grid relief |

Schill et al., EEEP 2017, https://doi.org//10.5547/2160-5890.6.1.wsch, and
Lowitzsch (Ed.): Energy Transtition: Financing Consumer Co-Ownership in Renewables, Palgrave Macmillan, DOI 10.1007/978-3-319-93518-8

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**Arguments with ambiguous conclusions**

- Transmission grid relief
- Flexibility
- Driver for sector coupling
- Energy efficiency vs. rebound effect
- Local and macroeconomics benefits, increased competition
- Political economy, path dependency, and policy coordination
- Data protection and security

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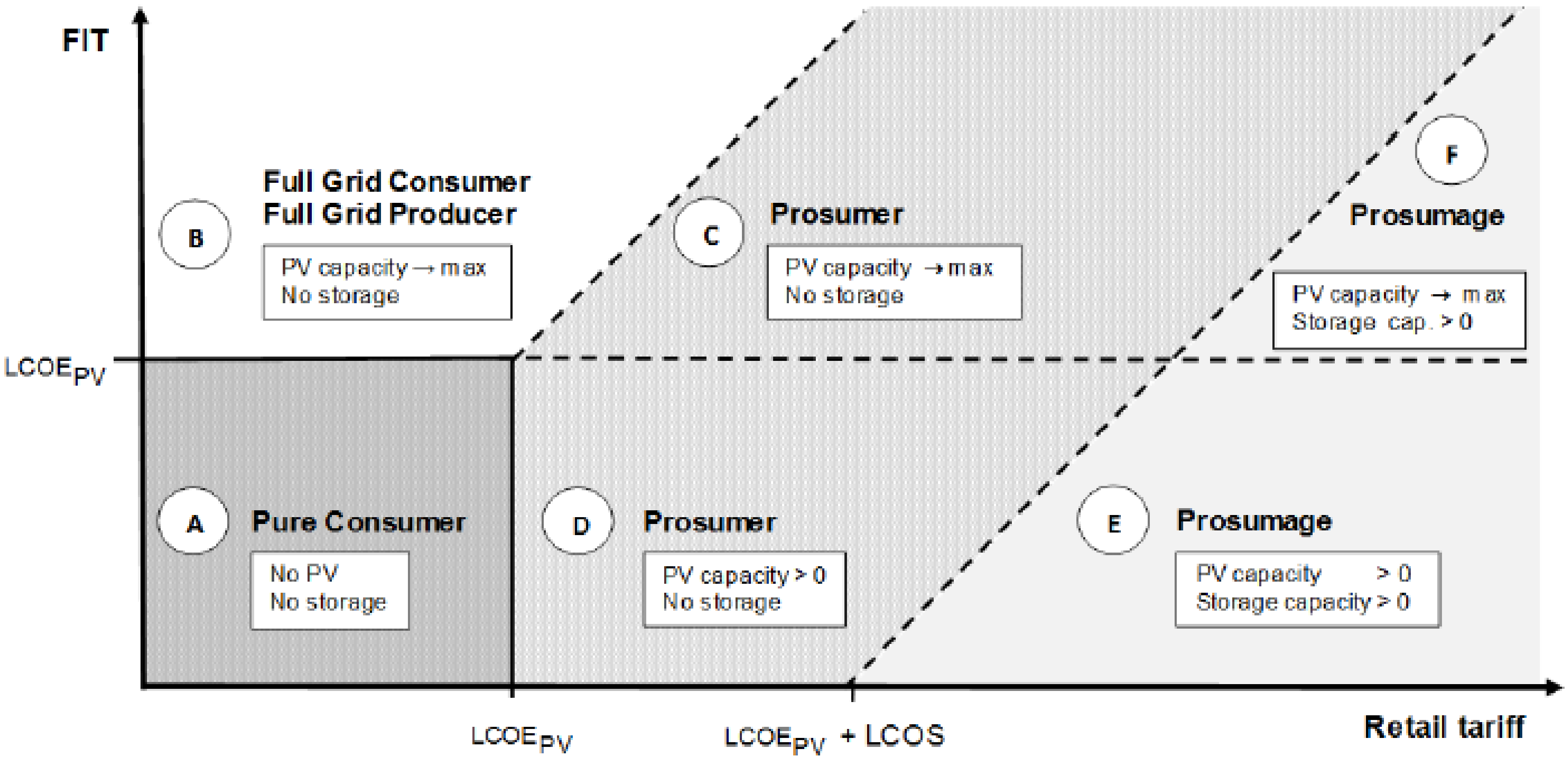
→ Depends on consumer behaviour and communication / control technology

Schill et al., EEEP 2017, https://doi.org//10.5547/2160-5890.6.1.wsch, and Lowitzsch (Ed.): Energy Transtition: Financing Consumer Co-Ownership in Renewables, Palgrave Macmillan, DOI 10.1007/978-3-319-93518-8

# Incentives depend on retail and feed-in tariffs

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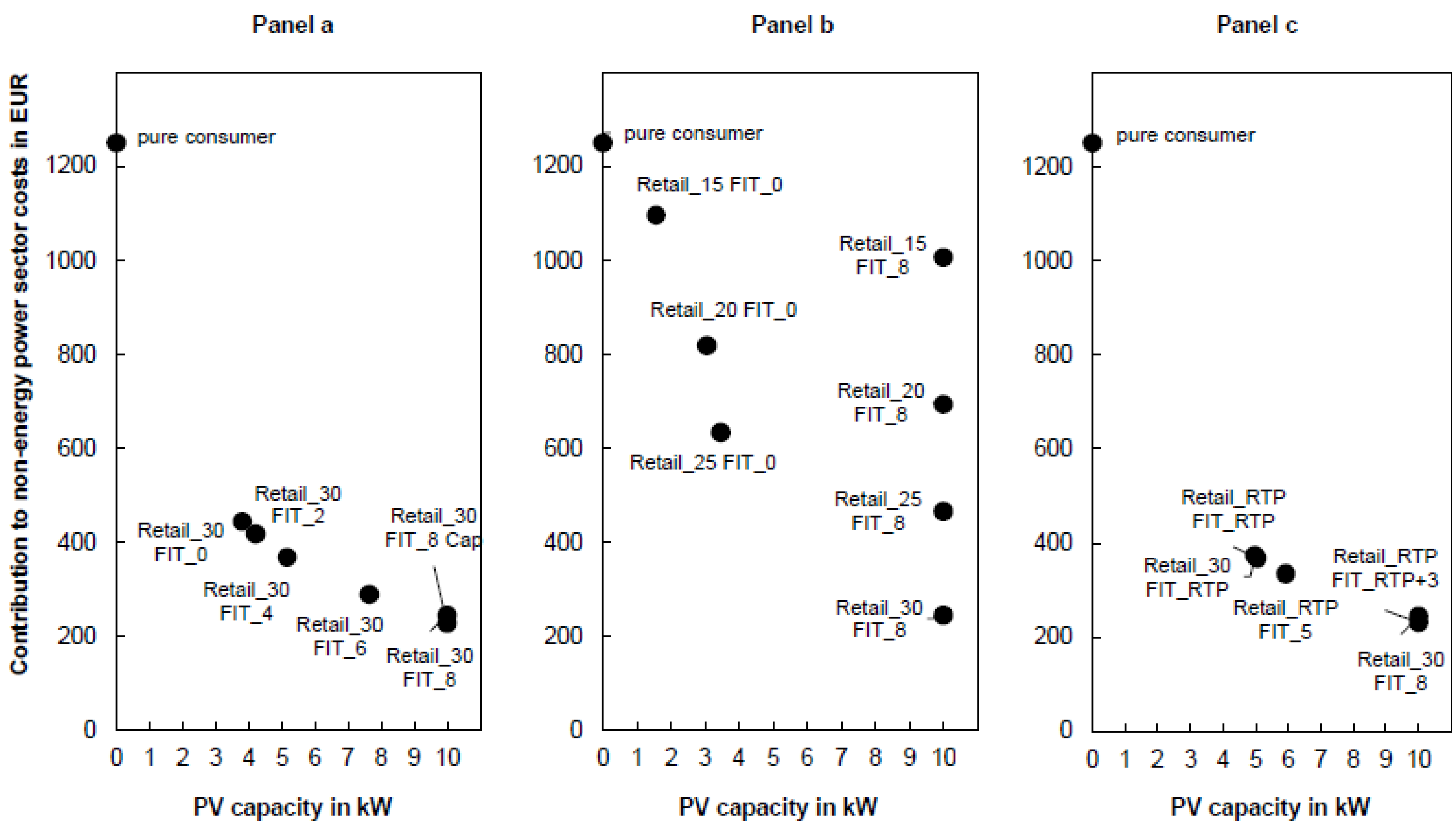
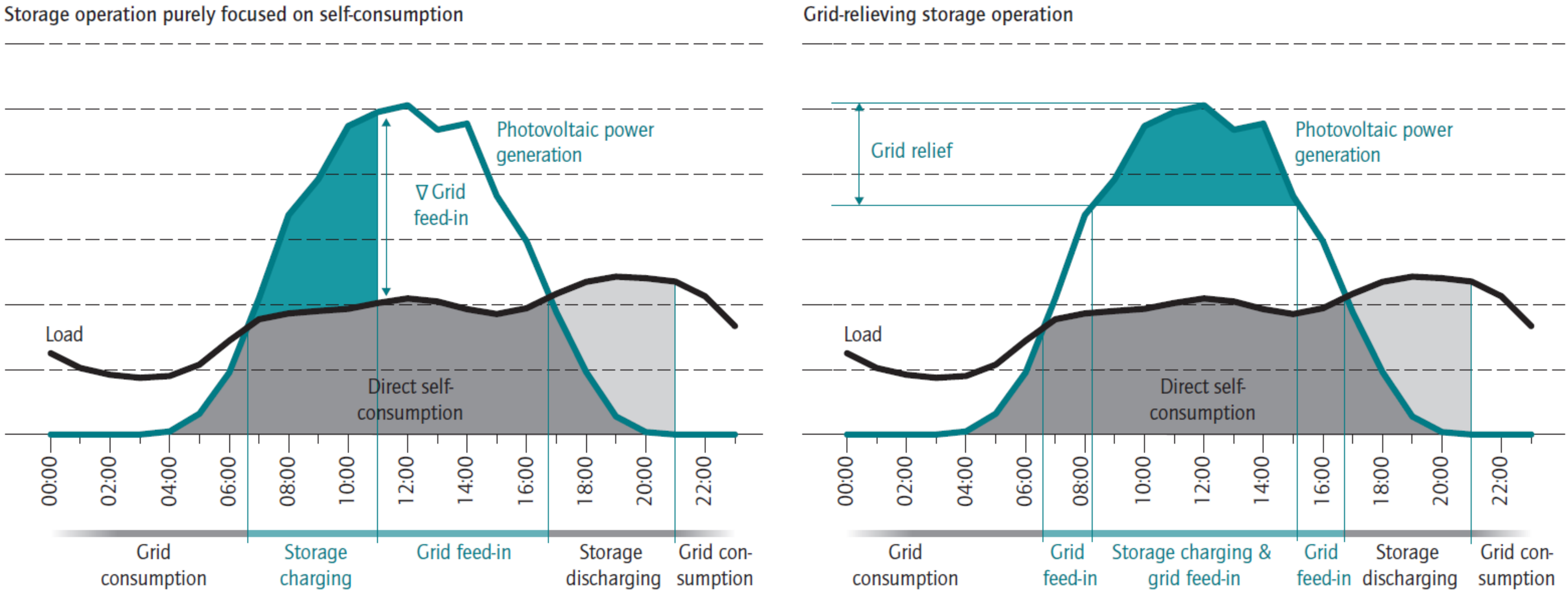



Source: Günther et al. 2019, arXiv:1907.09855v1

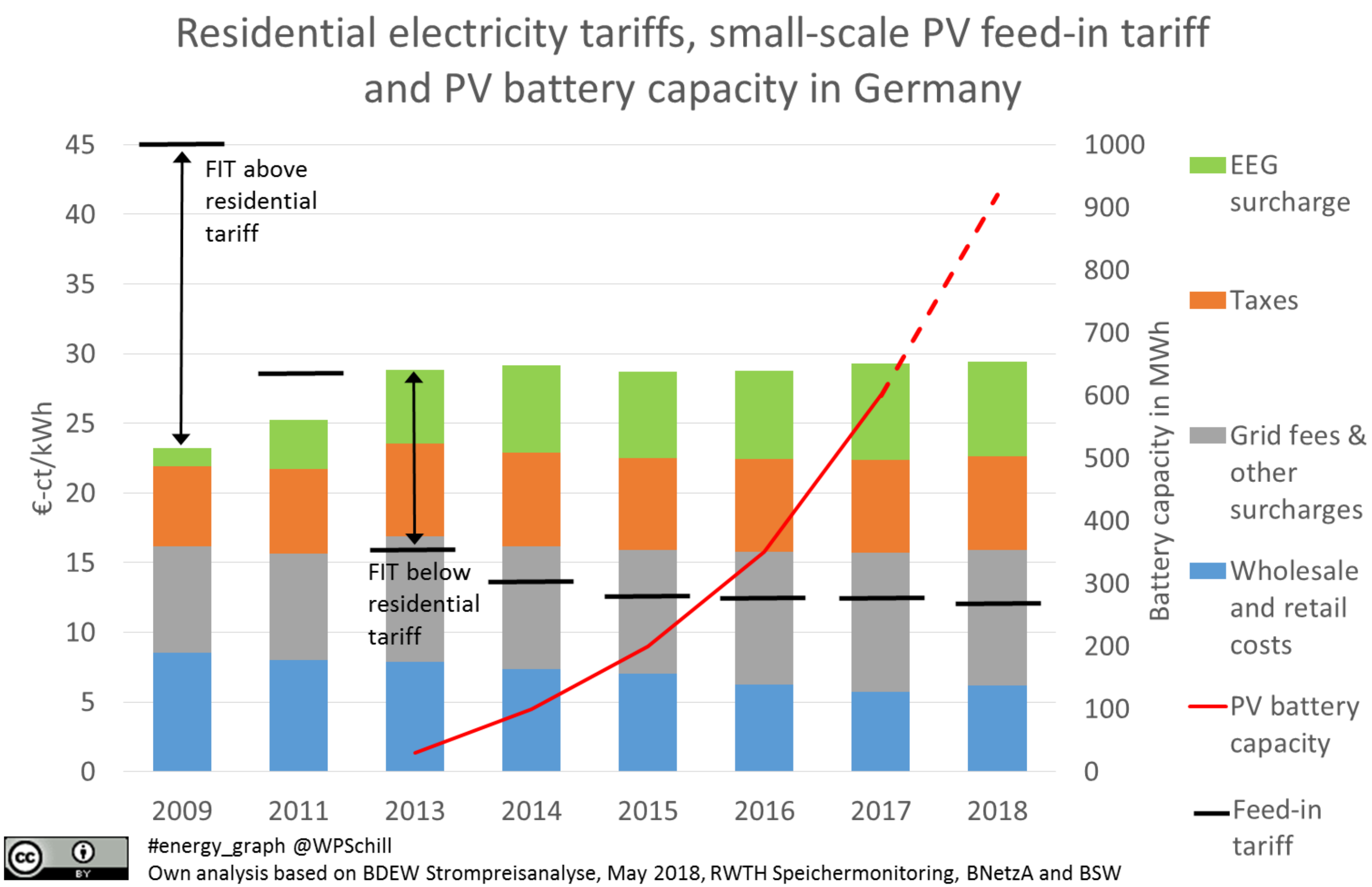
→ Trade-off between contribution to non-energy system costs and PV capacity

# Benefits of prosumage: distribution grid relief




Source: Schill et al., *DIW Economic Bulletin* 12/13 2017, https://www.diw.de/documents/publikationen/73/diw_01.c.555384.de/diw_econ_bull_2017-12-1.pdf

# Uptake of PV batteries since 2013




→ By 2017, around 85.000 decentral PV batteries, total ~600 MWh

→ Also triggered by KfW support program 275



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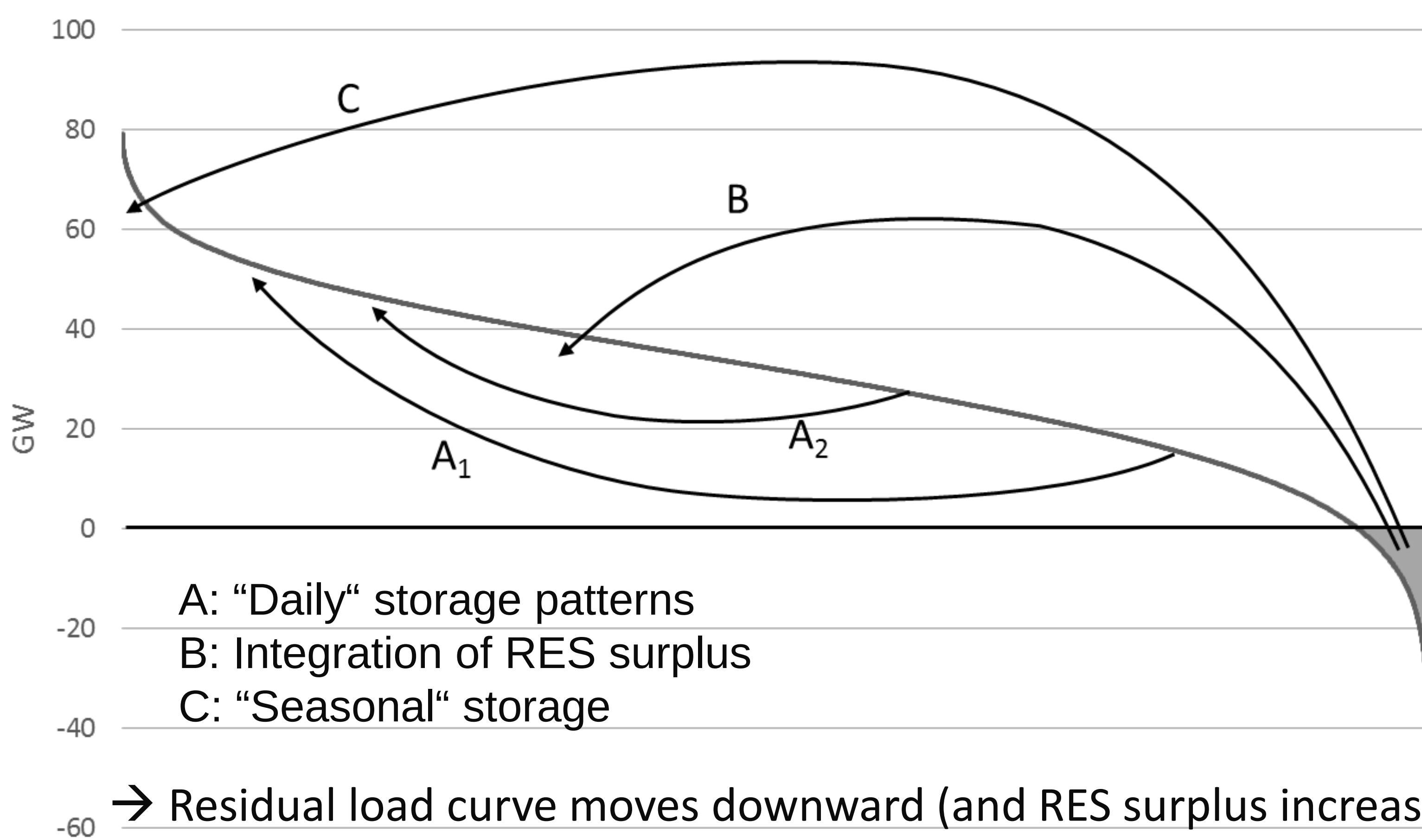
# Modes of storage operation, illustrated with a residual load-duration curve




Based on Schill (2013), *Vierteljahrshefte zur Wirtschaftsforschung*, https://doi.org/10.3790/vjh.82.3.61

→ Residual load curve moves downward (and RES surplus increases) with more renewables and less flexible dispatchable generators

→ RES surplus not necessarily to be integrated by electrical storage!