DIW BERLIN

Strommarkttreffen „Prosumer & Abgaben/Umlagen“

Prosumage of solar electricity: pros, cons, and the system perspective

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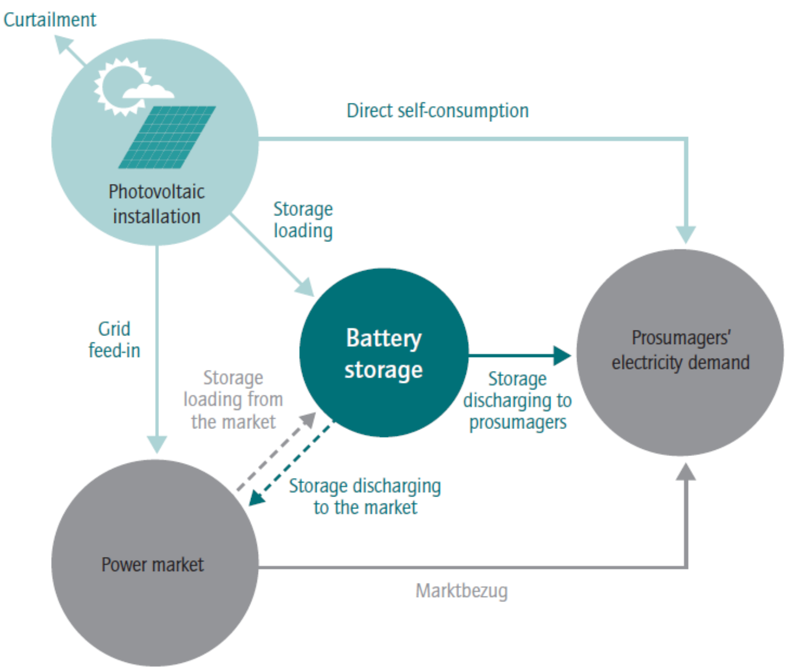
PRO-SUM-AGE

- **PRO**duction of renewable electricity (PV)
- Con**SUM**ption of self-generated electricity
- Stor**AGE** (batteries) to temporally align supply and demand



Source: own illustration

Prosumagers…

- produce their own renewable (PV) electricity at times,
- draw electricity from the grid at other times,
- feed electricity to the grid at other times,
- and may use their storage to shift grid feed-in or grid demand in time

We aim to contribute

- Qualitative discussion of prosumage from an economic perspective
- Description of German situation
- Quantitative illustration of selected system effects

... depend on the perspective

- Prosumagers and consumers
- Incumbent industry, new industry, service providers
- Electricity system perspective, system operators

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences • Participation and acceptance of energy transformation • Lower and less volatile electricity costs • Activation of private capital • Flexibility, sector coupling, and energy efficiency • Distribution grid relief • Transmission grid relief • Increased competition • Local benefits • Political economy and new institutional arguments	• Efficiency losses • Distributional impacts • Rebound effects • Policy coordination and path dependency • Concerns about data protection and remote control

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences	• Efficiency losses
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• Flexibility, sector coupling, and energy efficiency	• Concerns about data protection and remote control
• Distribution grid relief	
• Transmission grid relief	
• Increased competition	
• Local benefits	
• Political economy and new institutional arguments	

Consumer preferences

- Preferences for local renewable energy solutions or autarky (IEA 2014)
- Some empirical support for Germany (Gährs et al 2015, Oberst, Madlener 2015)
- Majority or niche?

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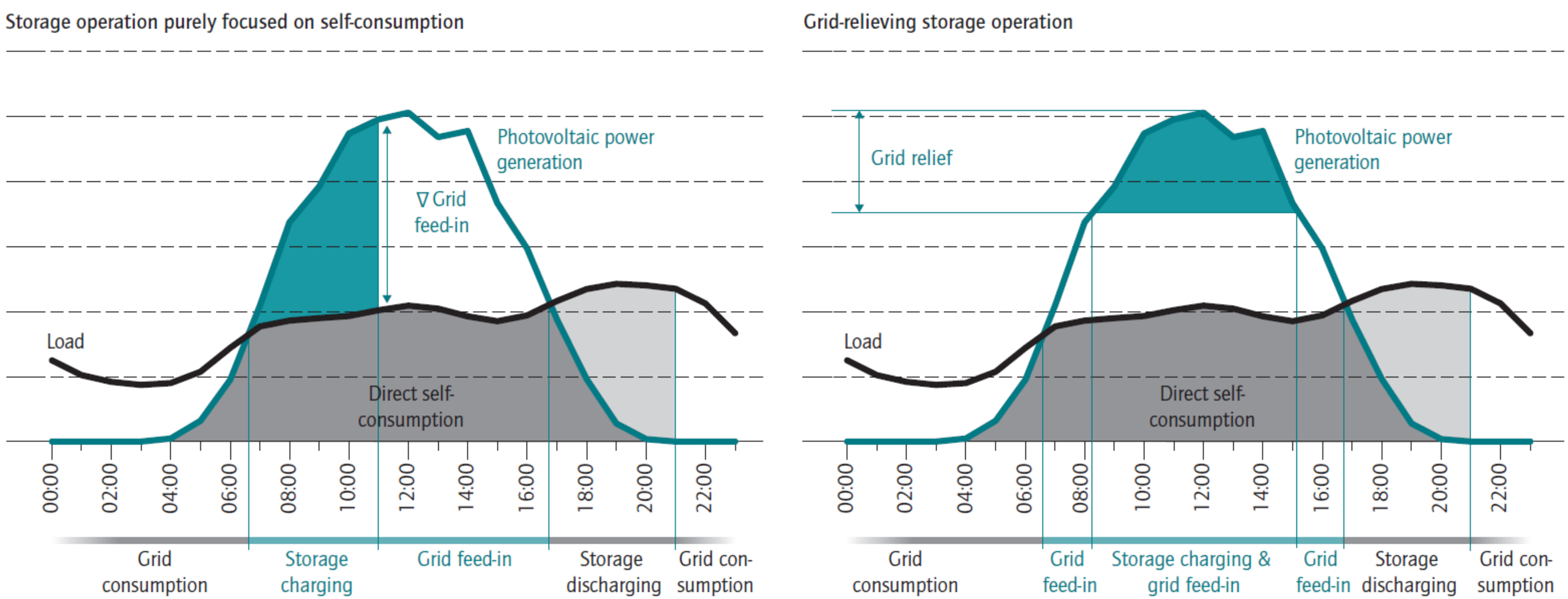
Participation and acceptance of energy transformation

- Preference to actively participate (Gährs et al 2015)
- Mitigate conflicts of "central" infrastructure (SPE 2015, 2016, Krekel, Zerrahn 2017)
- Realization of PV potential (?)

2 Pros

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences • Participation and acceptance of energy transformation • Lower and less volatile electricity costs • Activation of private capital • Flexibility, sector coupling, and energy efficiency • **Distribution grid relief** • Transmission grid relief • Increased competition • Local benefits • Political economy and new institutional arguments	• Efficiency losses • Distributional impacts • Rebound effects • Policy coordination and path dependency • Concerns about data protection and remote control



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Arguments in favor of prosumage	Arguments against prosumage
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Efficiency losses (compared to a centrally optimized power system)

- Suboptimal investments
  - Less spatial balancing, redundant infrastructure
  - Sub-optimal siting and dimensioning of PV and storage systems (Borenstein 2015)
- Suboptimal dispatch

Arguments in favor of prosumage	Arguments against prosumage
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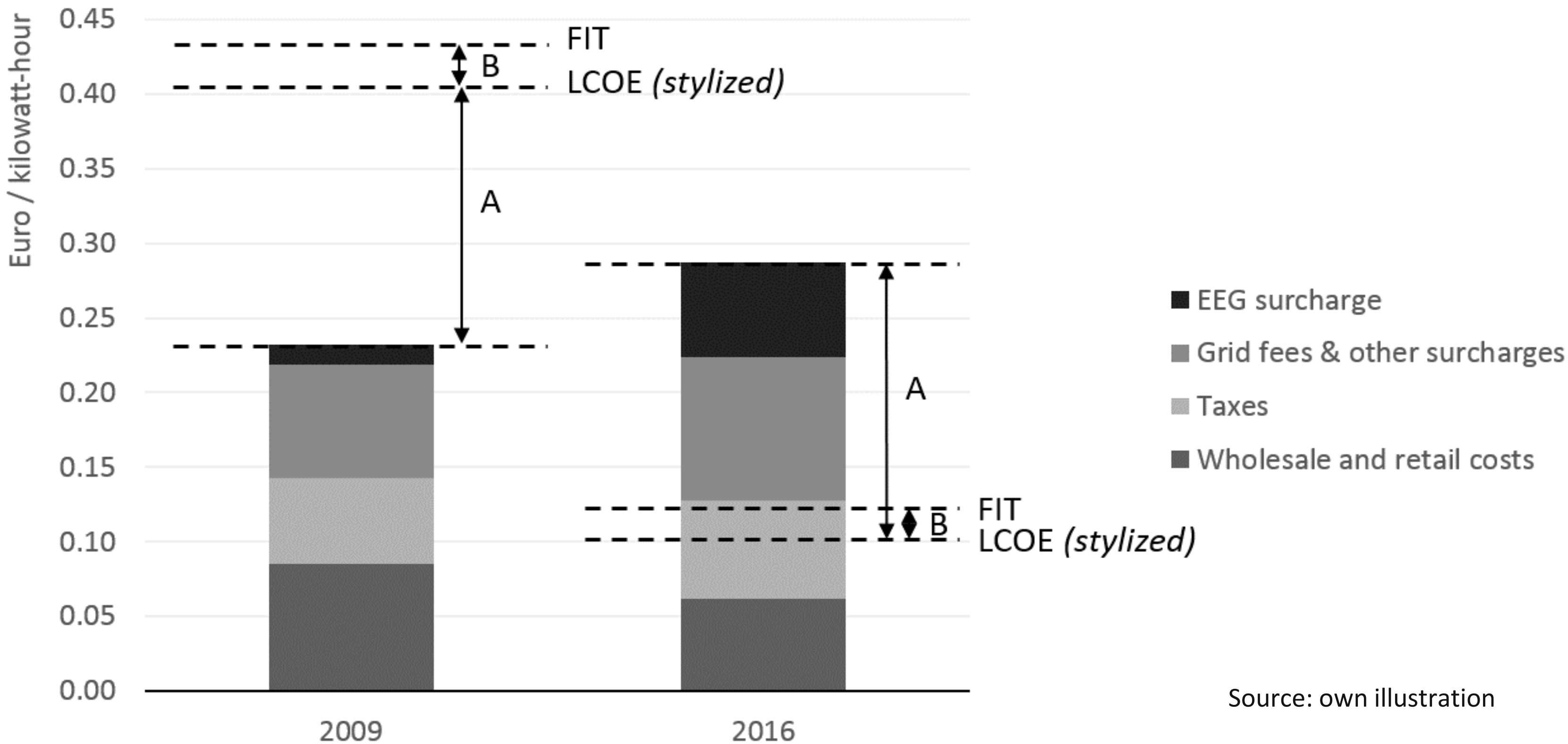
Distributional impacts

- Who can do prosumage?
- Regressive effect of volumetric grid charges and surcharges (Borenstein 2015)
- “Utility death spiral“ (Mayr et al 2015, Parag and Sovacool 2016)
- Relevance? (Prognos 2016, Agora 2017)

Indirect prosumage support in Germany

- Volumetric grid charges and EEG surcharge
  - 40% surcharge on self generated electricity in EEG 2017 for PV > 10 kW
- Strong decline of FIT compared to household tariff (“Socket parity“)



Source: own illustration

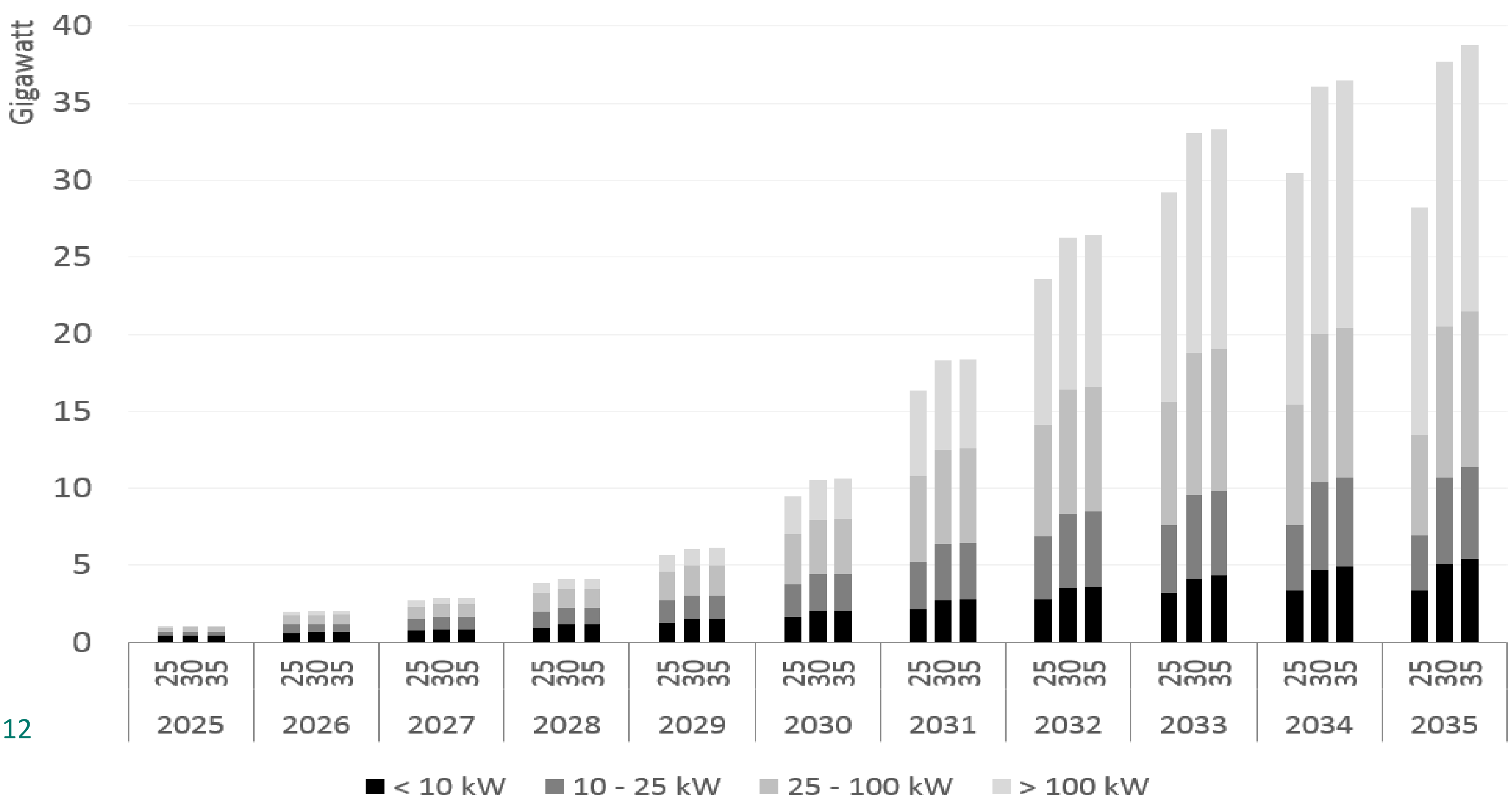
Direct prosumage support in Germany

- “KfW program 275“
  - 2013-2015: 25 million Euro
  - 2016-2018: 10 million Euro per year
  - Subsidized loan
- Support incentivizes system-friendly design
  - Maximum grid feed-in of the PV system at 50% of installed capacity
  - Communication interface requirements

Deployment in Germany

- 2015: Every second small-scale PV system installed with battery
- Jan 2016: ~34,000 prosumage systems, cumulative capacity 200 MWh (RWTH 2016)

→ Large additional potential when large PV capacities drop out of support scheme



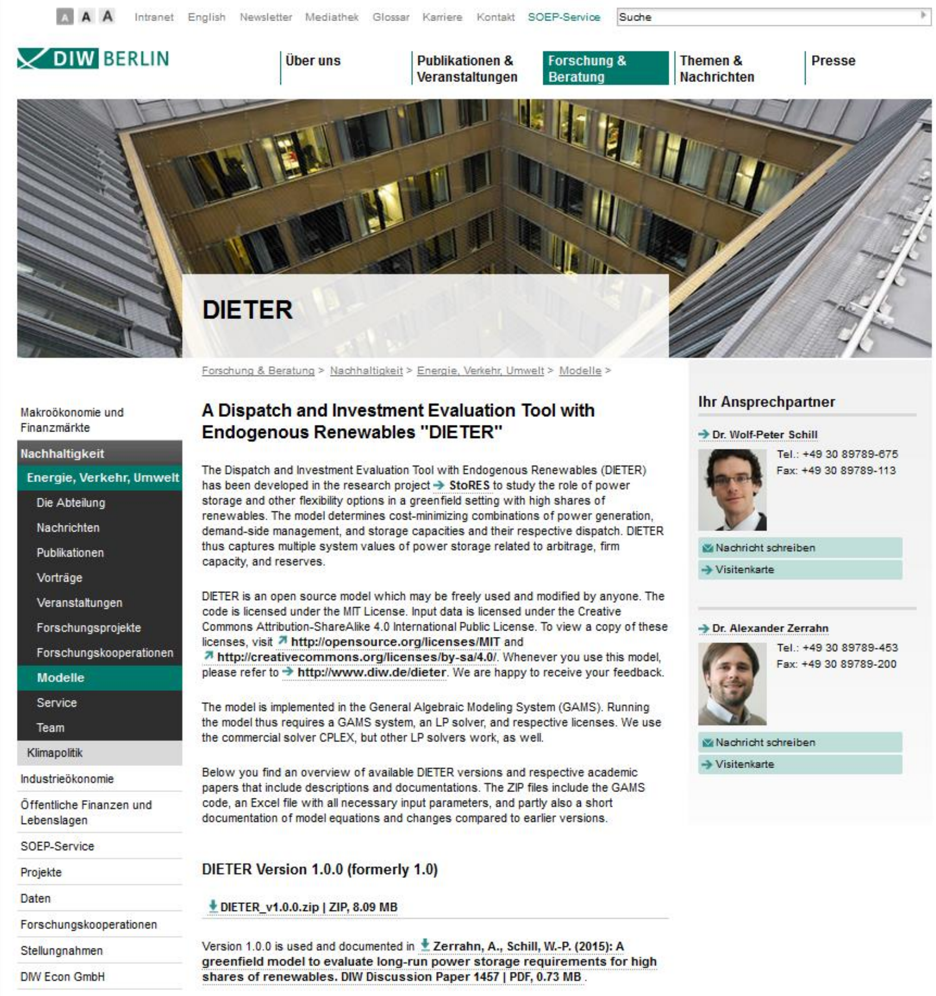
Source: own illustration based on Open Power System Data, http://open-power-system-data.org, Data Package Renewable power plants, version 2016-10-21

DIETER

- Open-source electricity system model
- Cost minimization over dispatch and investment
- Hourly resolution, full year
- Loosely calibrated to German data

DIETER's website

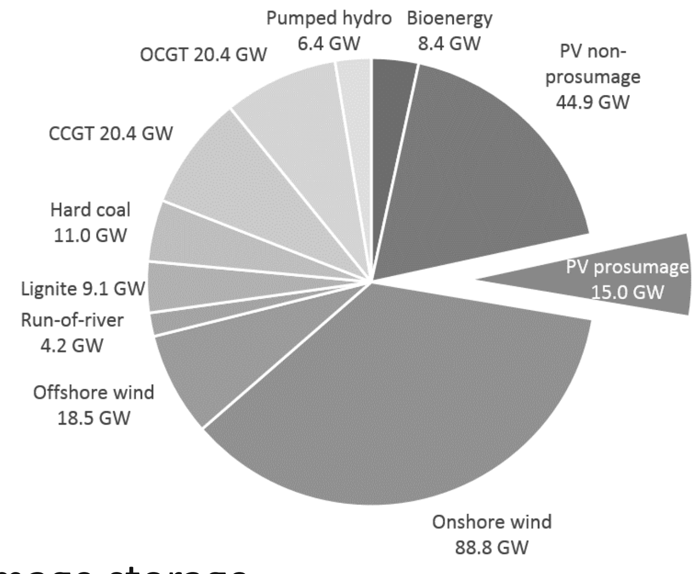
- www.diw.de/dieter
- Code under MIT license



DIETER: augmented prosumage version

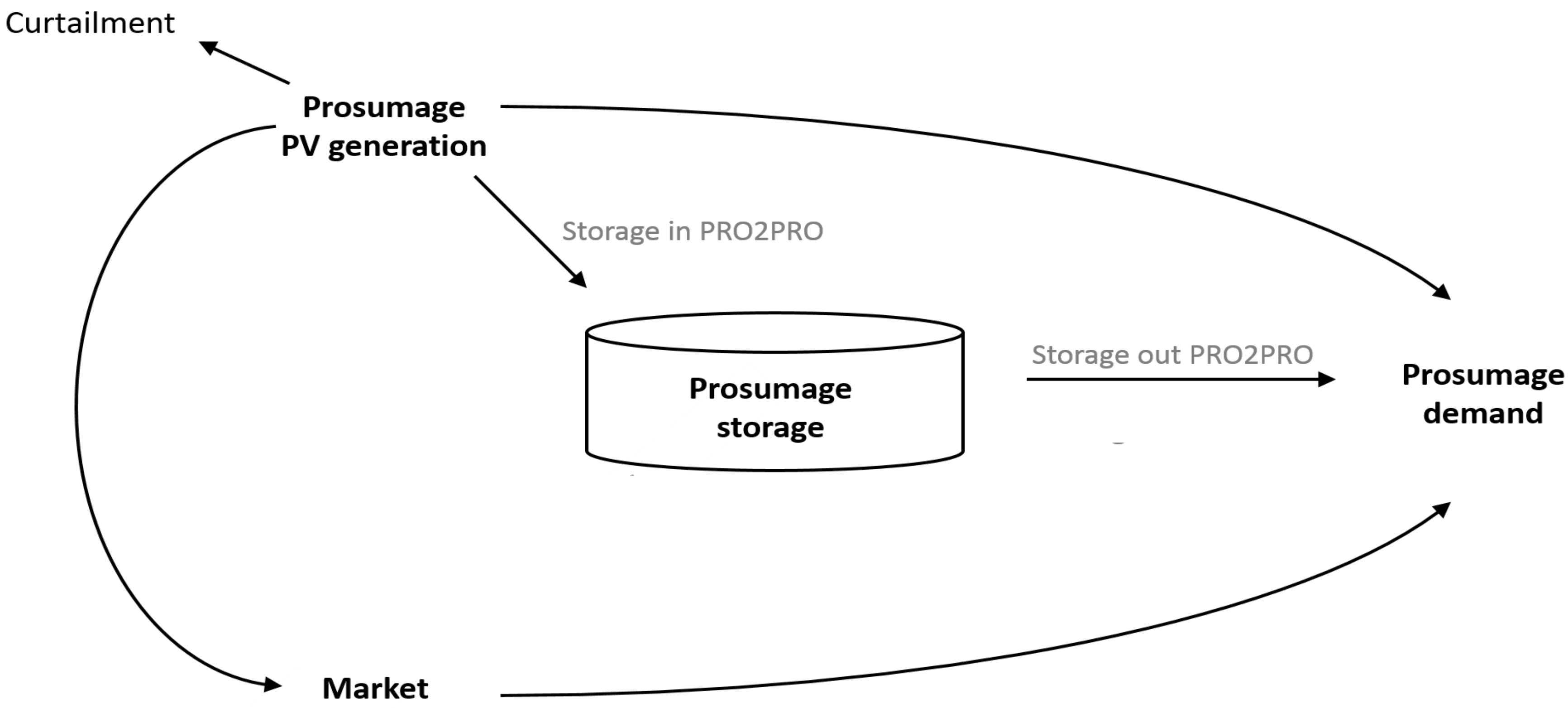
Implicit assumption of optimal behavior from system perspective

- No separate objective for households
- Varying minimum self-consumption restiction
- Prosumagers face wholesale prices (Discussion Paper, *EEEP* article)
- Additional calculations: storage operation purely focused on self-consumption (DIW Wochenbericht / DIW Economic Bulletin)



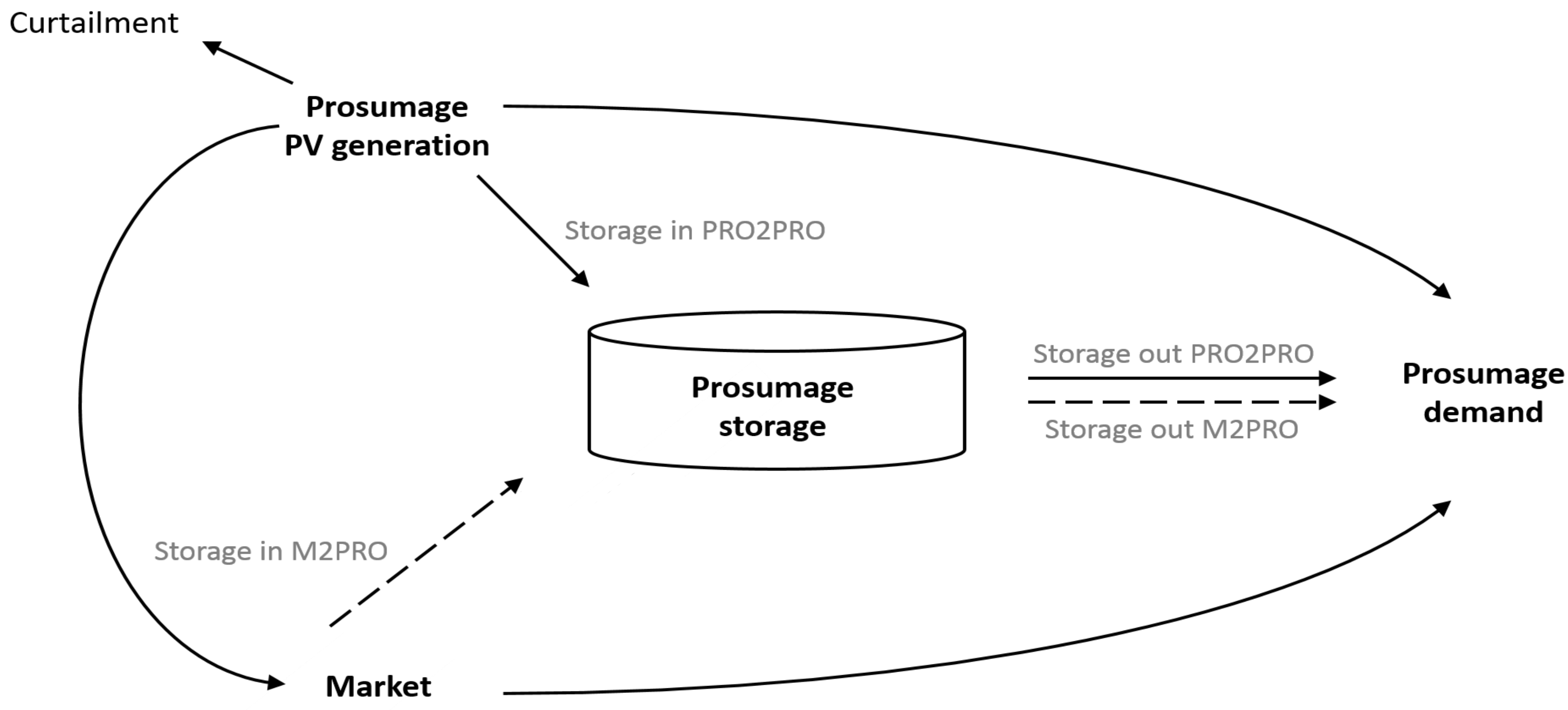
Brownfield data for 2035 (NEP scenario B1)

- 66% renewables in electricity consumption
- 25% of demand attributed to prosumage segment
- 2.6 million prosumage systems with 5.9 kWp each
- Endogenous investment only in central and prosumage storage



(i) ***Pure prosumage*** **-** No interaction of prosumage storage with market

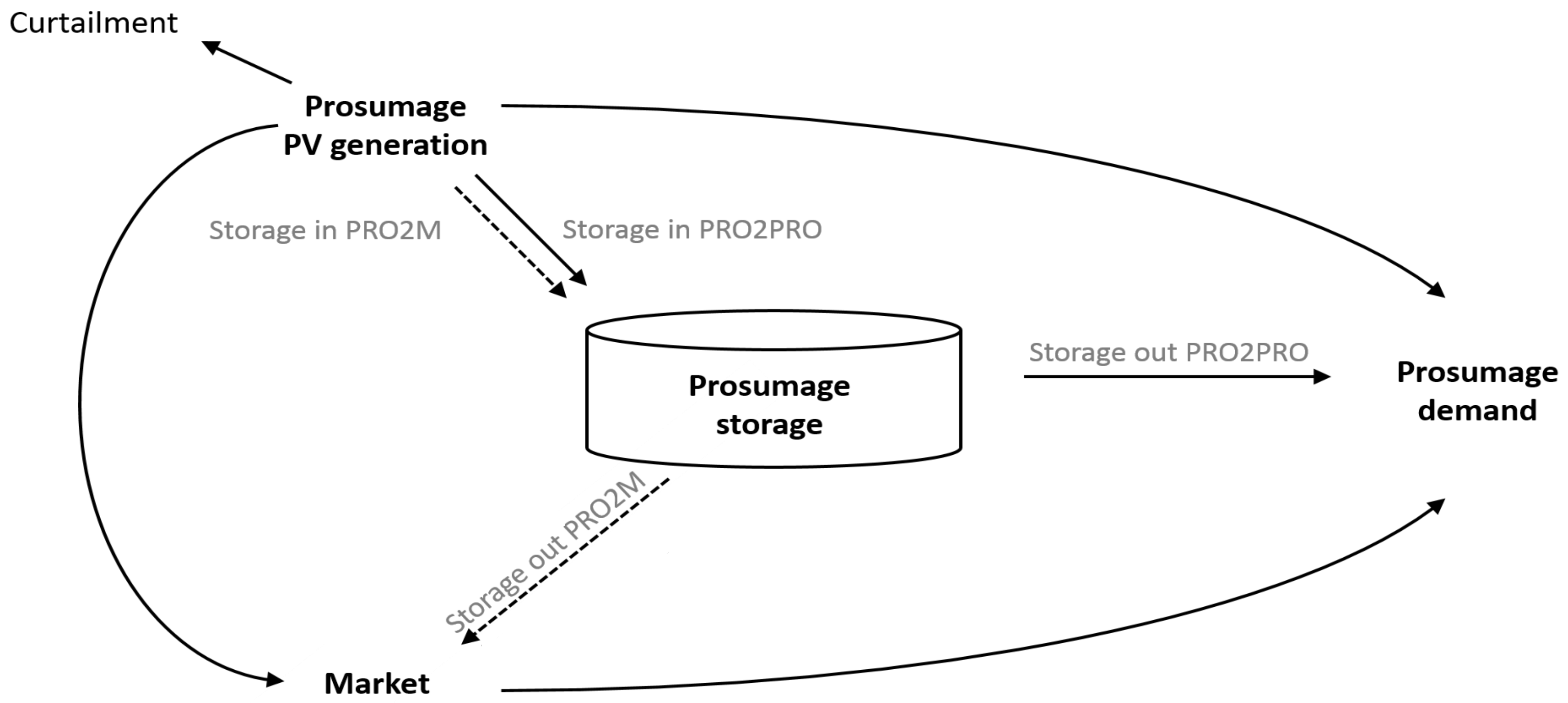
DIETER: scenarios



(i) ***Pure prosumage*** **-** No interaction of prosumage storage with market

(ii) ***Grid consumption smoothing*** - Only prosumage storage loading from market

DIETER: scenarios

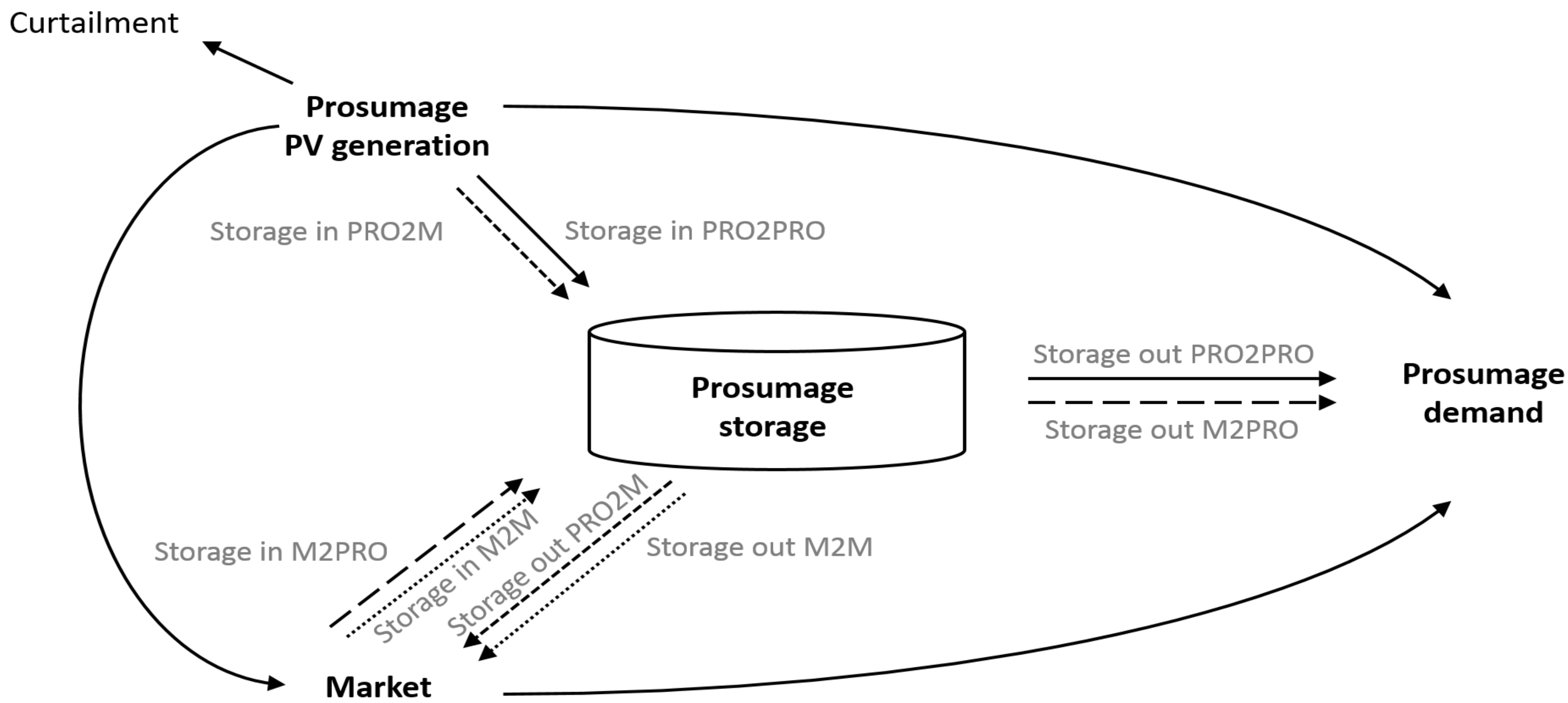


(i) ***Pure prosumage*** **-** No interaction of prosumage storage with market

(ii) ***Grid consumption smoothing*** - Only prosumage storage loading from market

(iii) ***PV profiling*** - Only prosumage storage discharging to market

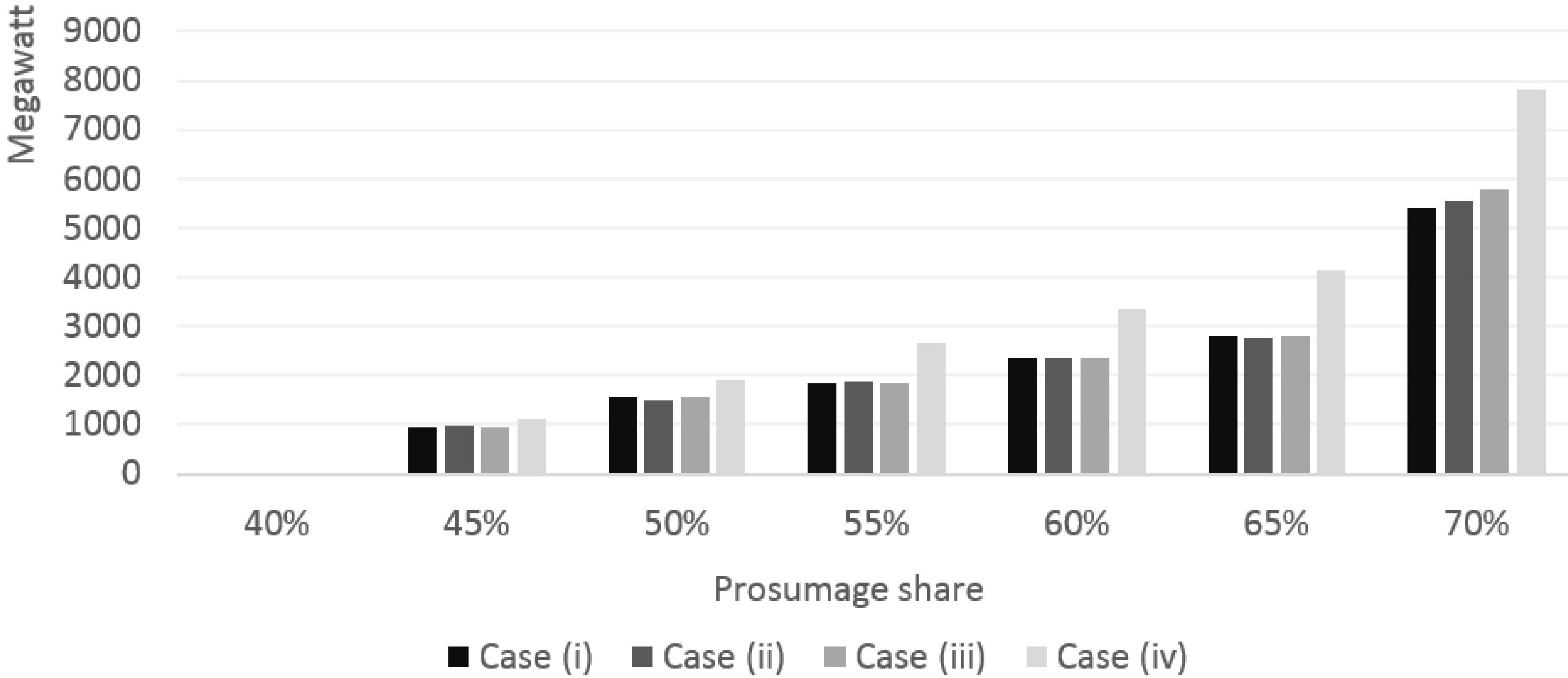
4 DIETER: scenarios



- *(i)* ***Pure prosumage*** **-** No interaction of prosumage storage with market
- *(ii)* ***Grid consumption smoothing*** - Only prosumage storage loading from market
- *(iii)* ***PV profiling*** - Only prosumage storage discharging to market
- *(iv)* ***Full interaction*** - No restrictions on interaction of prosumage storage with market

4

Storage deployment compared to baseline



- Moderate increase of prosumage storage capacities up to 65% self-consumption
- Substantially greater storage capacities in case (iv) with full market interaction

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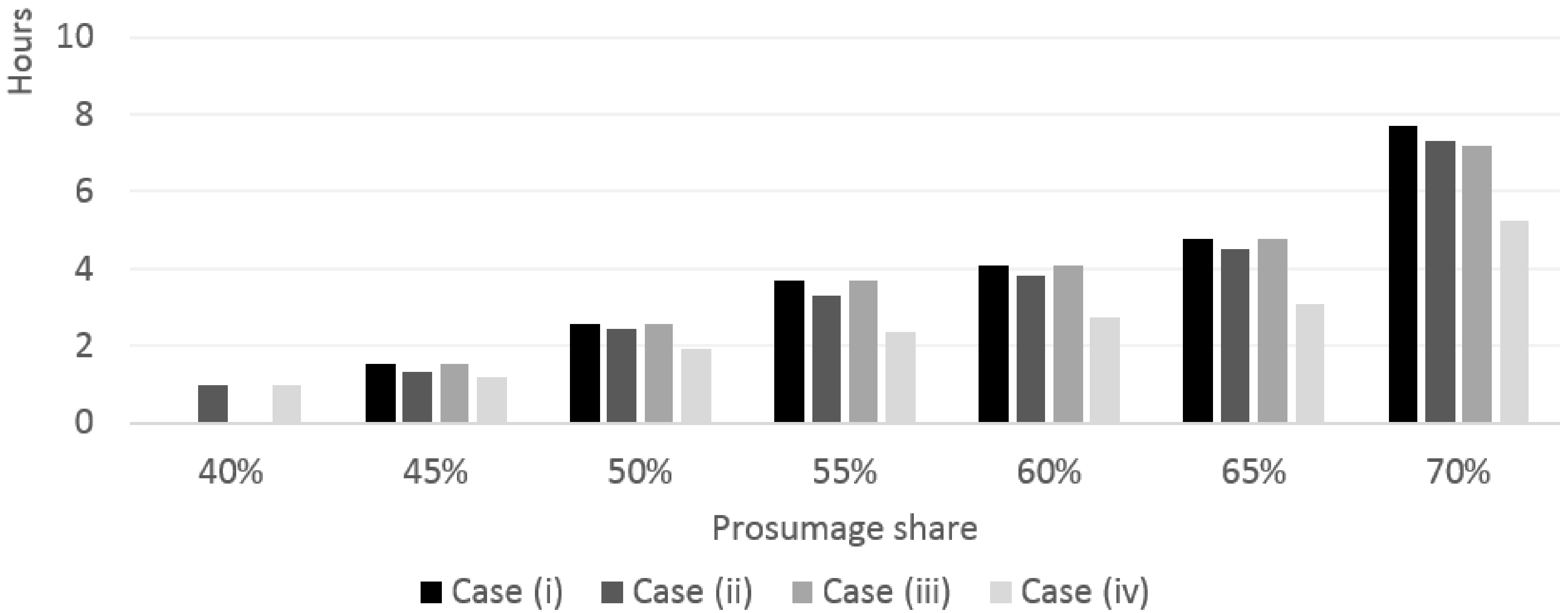
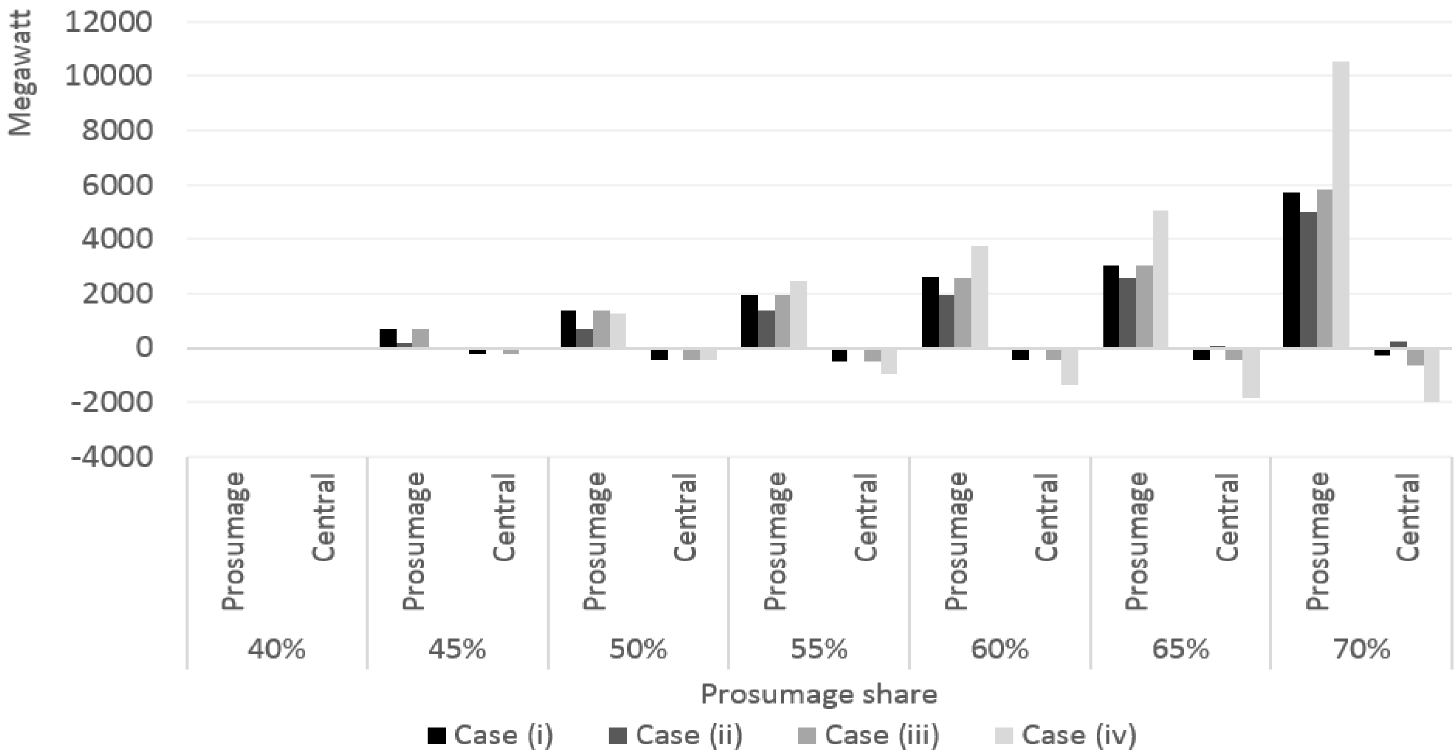
E/P ratios of prosumage storage



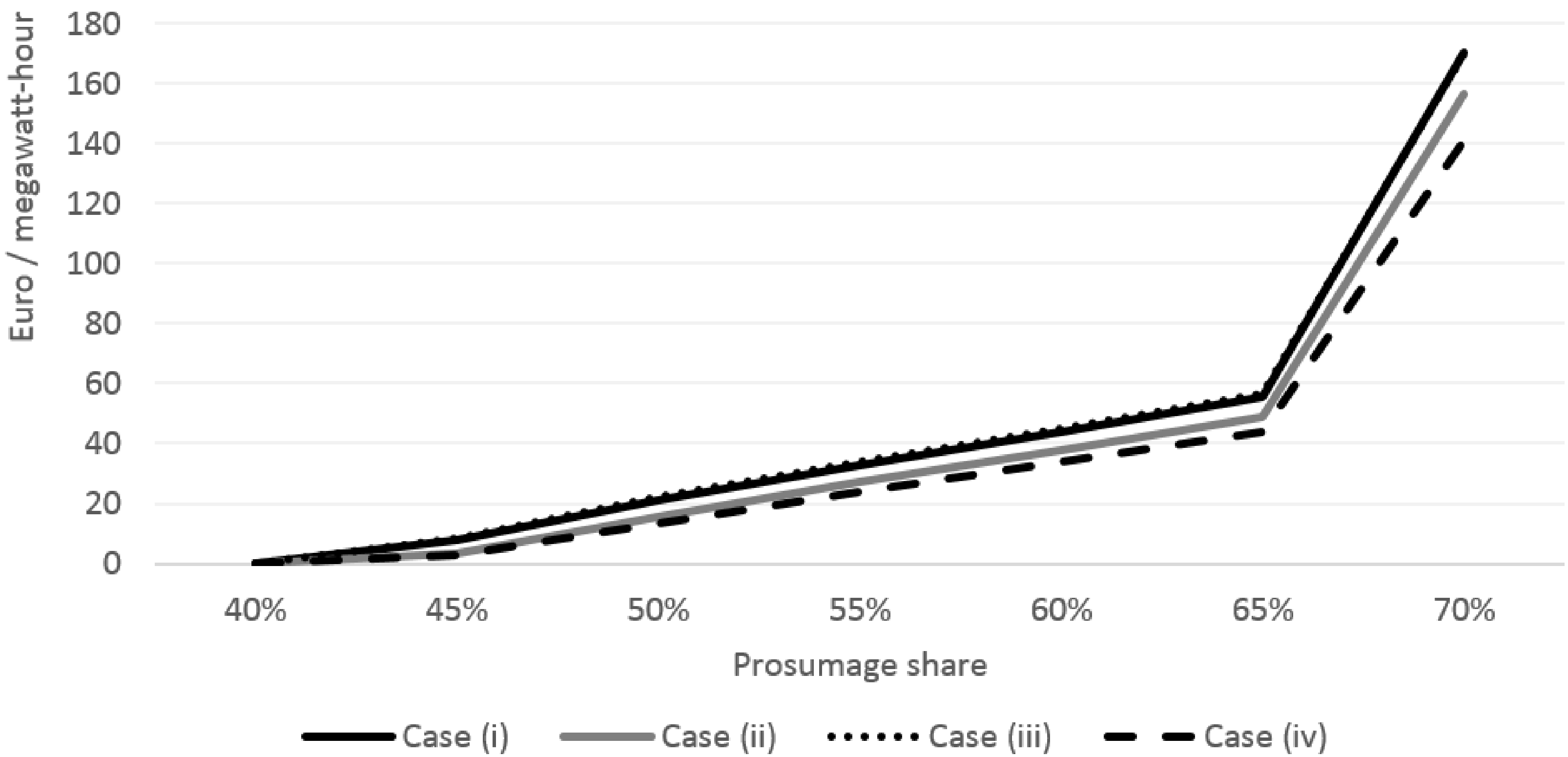
- E/P ratios increase in prosumage requirements
- Lower E/P ratios in Case (iv) driven by higher storage power capacities; energy virtually constant

4 Prosumage and central storage in a sensitivity w/o given storage capacities



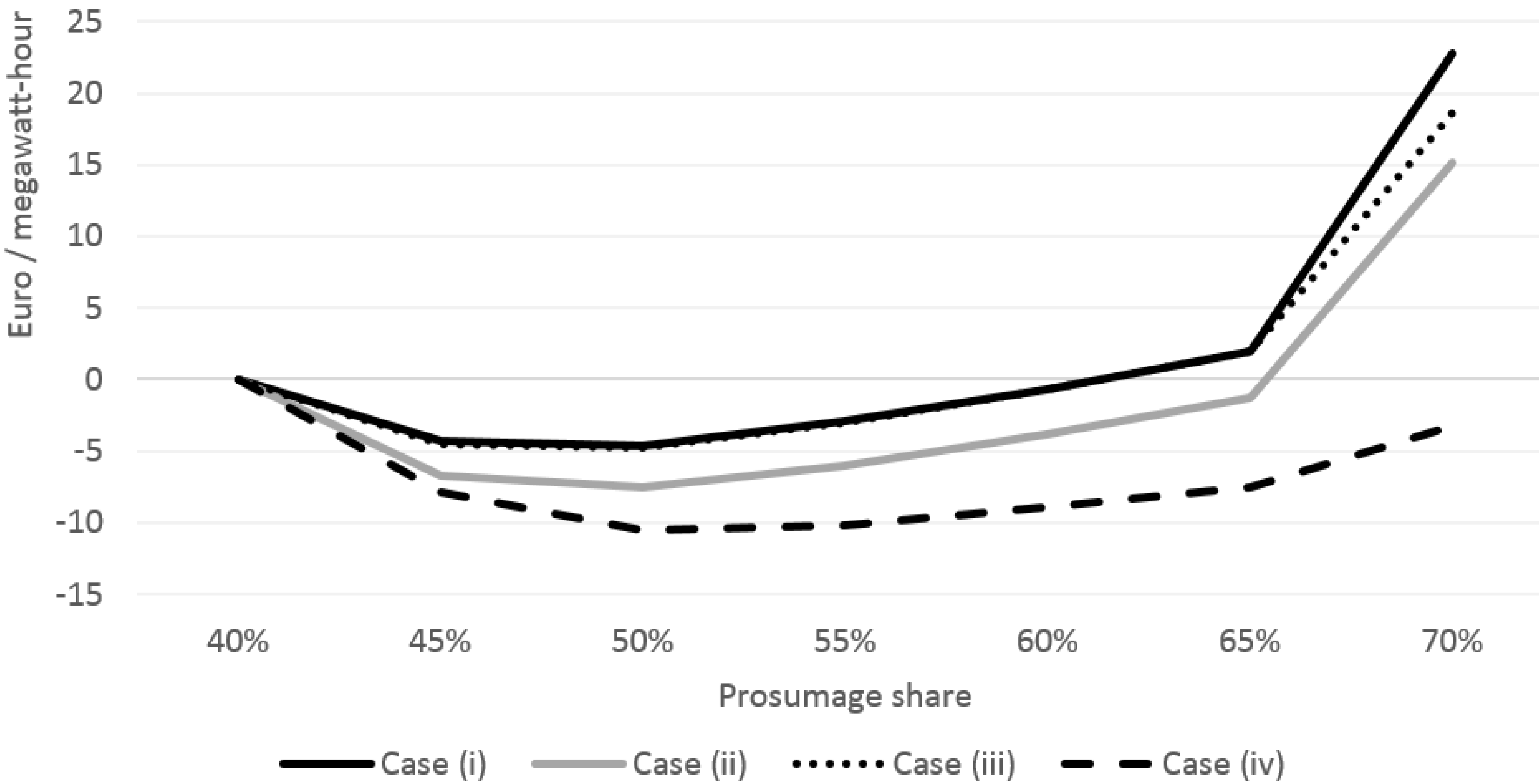
- Substantial substitution only under full market interaction

4 Average additional cost per additional MWh self-consumption compared to baseline



- Lower cost increases in case of additional market interactions
- Absolute cost increase: 103 – 135 million Euro (Case (iv), 55%); 0.1-0.2% of total system costs

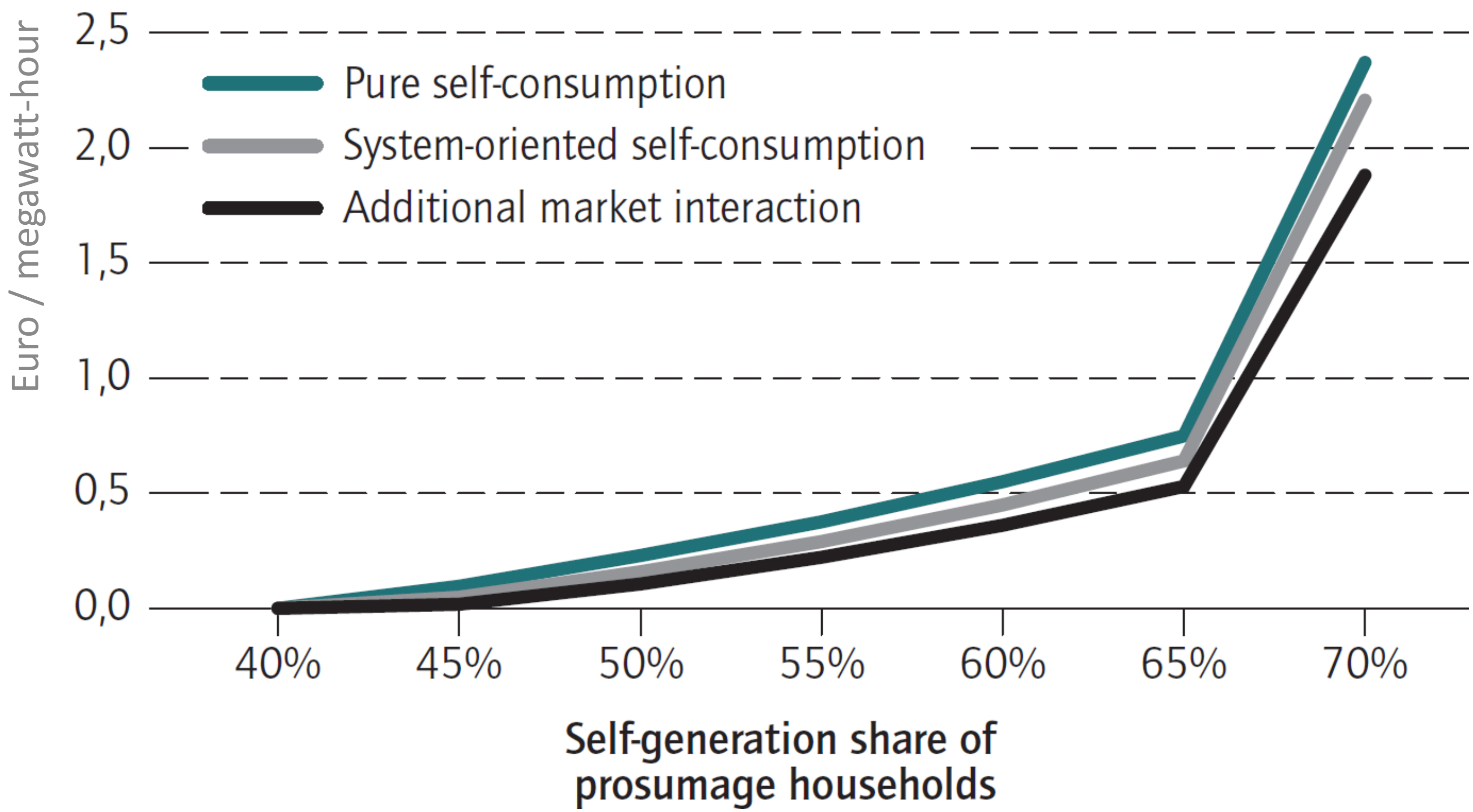
4 Dispatch effect (w/o storage investments)



- Positive value of additional flexibility

4 Additional system costs related to overall electricity demand

Additional calculations in DIW Wochenbericht / DIW Economic Bulletin



- Pure self-consumption (sligthly) worse than former Case (i)

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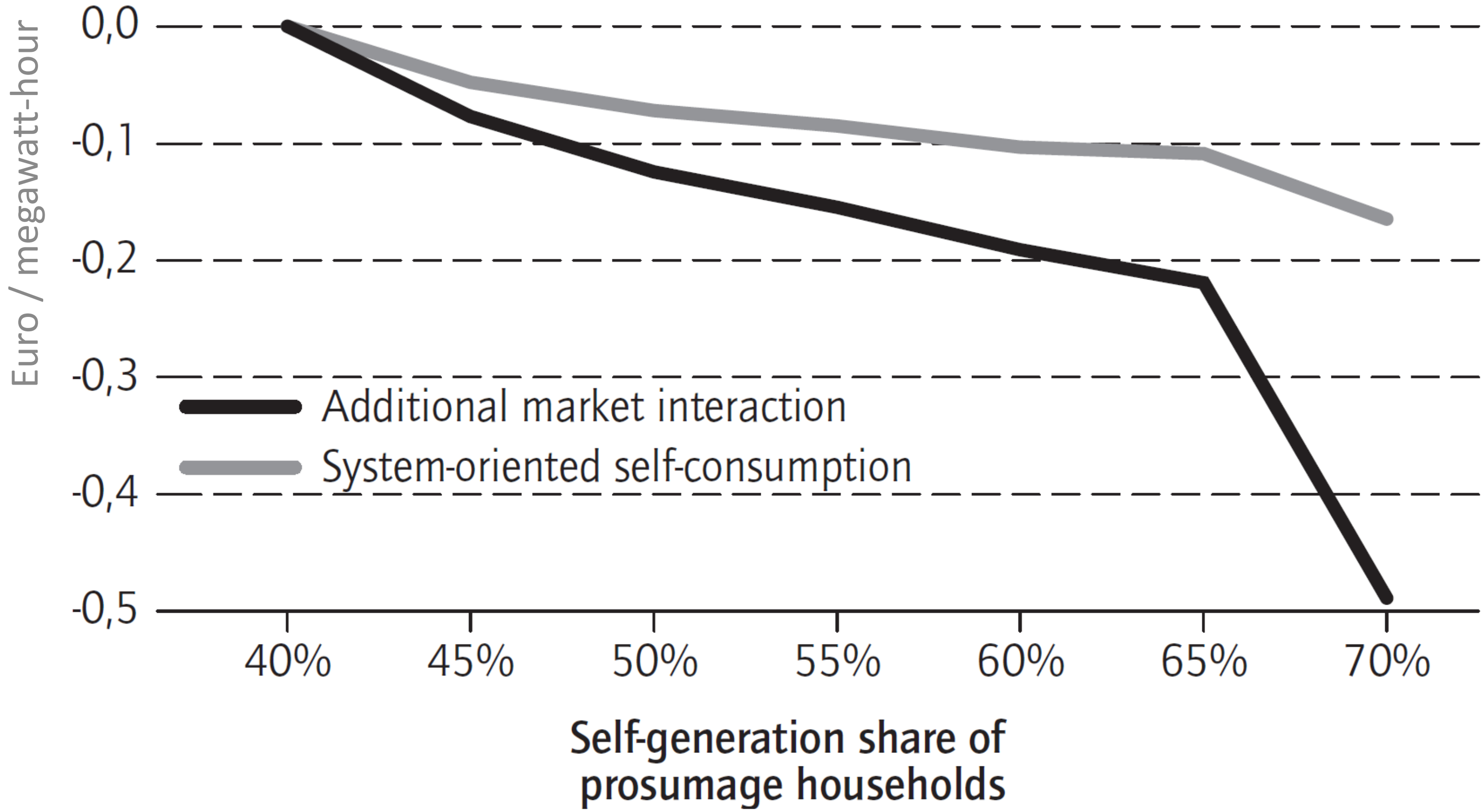
System cost reduction compared to pure self-consumption related to overall electricity demand

Additional calculations in DIW Wochenbericht / DIW Economic Bulletin



- System cost-decreasing effect of additional market interactions even larger

5

Conclusions

Still a niche – but potentially rising importance of prosumage in the future

- Large PV capacities in Germany exit support scheme before end of technical lifetime

Prosumage - range of pros and cons

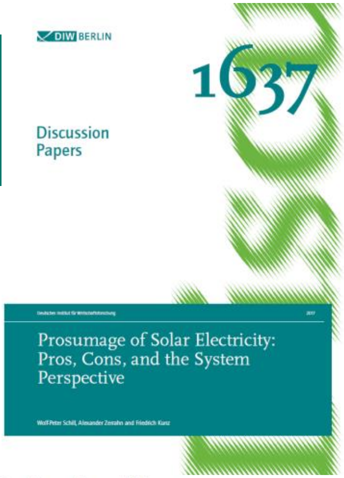
- Weight of arguments
- Future research to quantify effects

Model illustration shows importance of system-friendly behavior

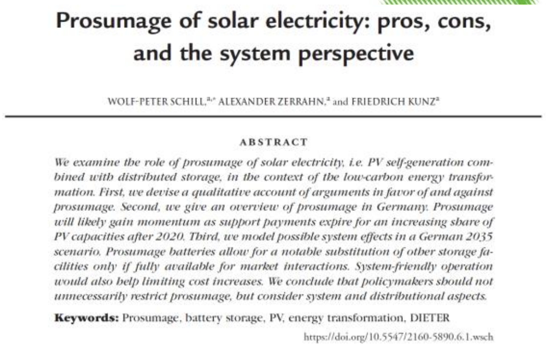
- Regulation should aim at making the flexibility potential available to the system
- Prosumagers should receive appropriate price signals (directly or indirectly)

5 More...

- DIW Discussion Paper 1637,
  www.diw.de/documents/publikationen/73/diw_01.c.552031.de/dp1637.pdf



- *Economics of Energy & Environmental Policy* 6(1), 7-31,
  https://doi.org/10.5547/2160-5890.6.1.wsch


Prosumage of solar electricity: pros, cons, and the system perspective

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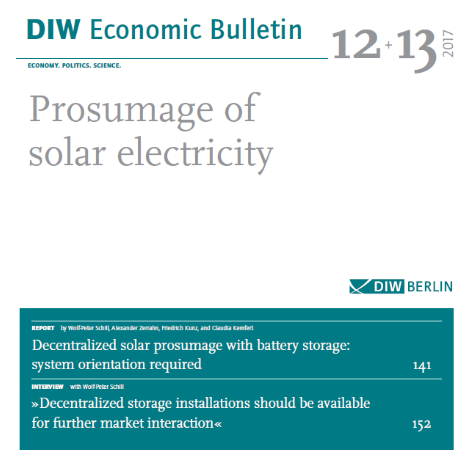
ABSTRACT

We examine the role of prosumage of solar electricity, i.e. PV self-generation combined with distributed storage, in the context of the low-carbon energy transformation. First, we devise a qualitative account of arguments in favor of and against prosumage. Second, we give an overview of prosumage in Germany. Prosumage will likely gain momentum as support payments expire for an increasing share of PV capacities after 2020. Third, we model possible system effects in a German 2035 scenario. Prosumage batteries allow for a notable substitution of other storage facilities only if fully available for market interactions. System-friendly operation would also help limiting cost increases. We conclude that policymakers should not unnecessarily restrict prosumage, but consider system and distributional aspects.

Keywords: Prosumage, battery storage, PV, energy transformation, DIETER

https://doi.org/10.5547/2160-5890.6.1.wsch

- DIW Wochenbericht 12/2017 / DIW Economic Bulletin 12+13/2017,
  http://diw.de/documents/publikationen/73/diw_01.c.554835.de/17-12-1.pdf /
  http://diw.de/documents/publikationen/73/diw_01.c.555384.de/diw_econ_bull_2017-12-1.pdf



- DIETER code, data, and model description
  www.diw.de/dieter

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