DIW BERLIN

6th European Energy Forum

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

Wolf-Peter Schill, Alexander Zerrahn, Friedrich Kunz

Paris, May 22, 2017

1 Background of this talk

Our recent article in EEEP (2017)

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

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

WOLF-PETER SCHILL,[a,*] ALEXANDER ZERRAHN,[a] and FRIEDRICH KUNZ[a]

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

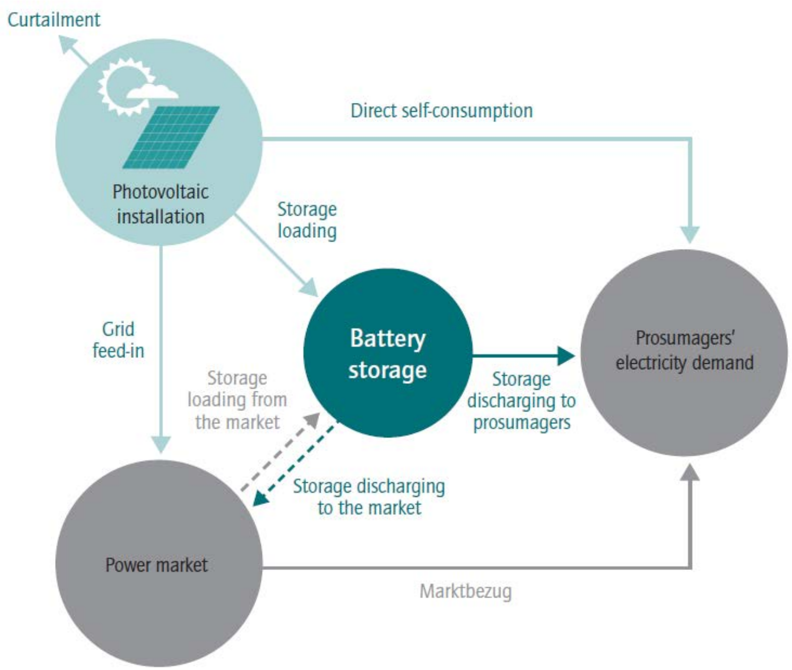
https://doi.org/10.5547/2160-5890.6.1.wsch

How it may contribute to this seminar

- Prosumage as a potentially important driver of change in the electricity sector
- Qualitative reasoning: what drives individuals (and some policy makers) to go for prosumage?

How we define 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 make use of battery storage

Pros and cons depend on the perspective

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

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences	• Efficiency losses
• Participation and acceptance of energy transformation	• Distributional impacts
• Lower and less volatile electricity costs	• Rebound effects
• Activation of private capital	• Policy coordination and path dependency
• 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	

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences	• Efficiency losses
• Participation and acceptance of energy transformation	• Distributional impacts
• Lower and less volatile electricity costs	• Rebound effects
• Activation of private capital	• Policy coordination and path dependency
• 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 self-generation (IEA 2014)
- Some empirical support for Germany (Gährs et al 2015, Oberst, Madlener 2015)
- Findings relevant for majority of consumers or for small niche?

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

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 roof-top PV potential

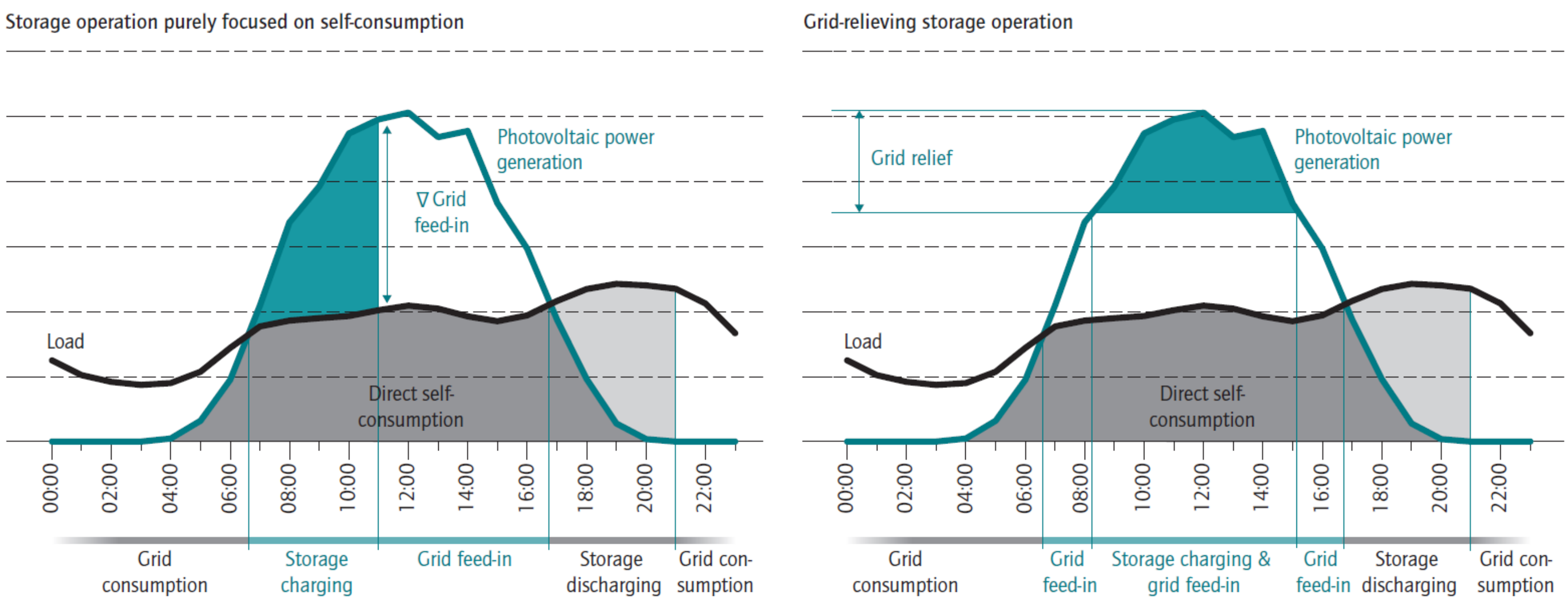
Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences • Participation and acceptance of energy transformation • **Lower and less volatile electricity costs** • Activation of private capital • Flexibility, sector coupling, and energy efficiency • Distribution grid relief • 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

Lower and less volatile electricity costs

- Only valid from a consumer (prosumager) perspective
- Only true for self-generated share of electricity

2 Pros

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences	• Efficiency losses
• Participation and acceptance of energy transformation	• Distributional impacts
• Lower and less volatile electricity costs	• Rebound effects
• Activation of private capital	• Policy coordination and path dependency
• 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	



Source: own illustration

Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences	• Efficiency losses
• Participation and acceptance of energy transformation	• Distributional impacts
• Lower and less volatile electricity costs	• Rebound effects
• Activation of private capital	• Policy coordination and path dependency
• 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	

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

2 Cons

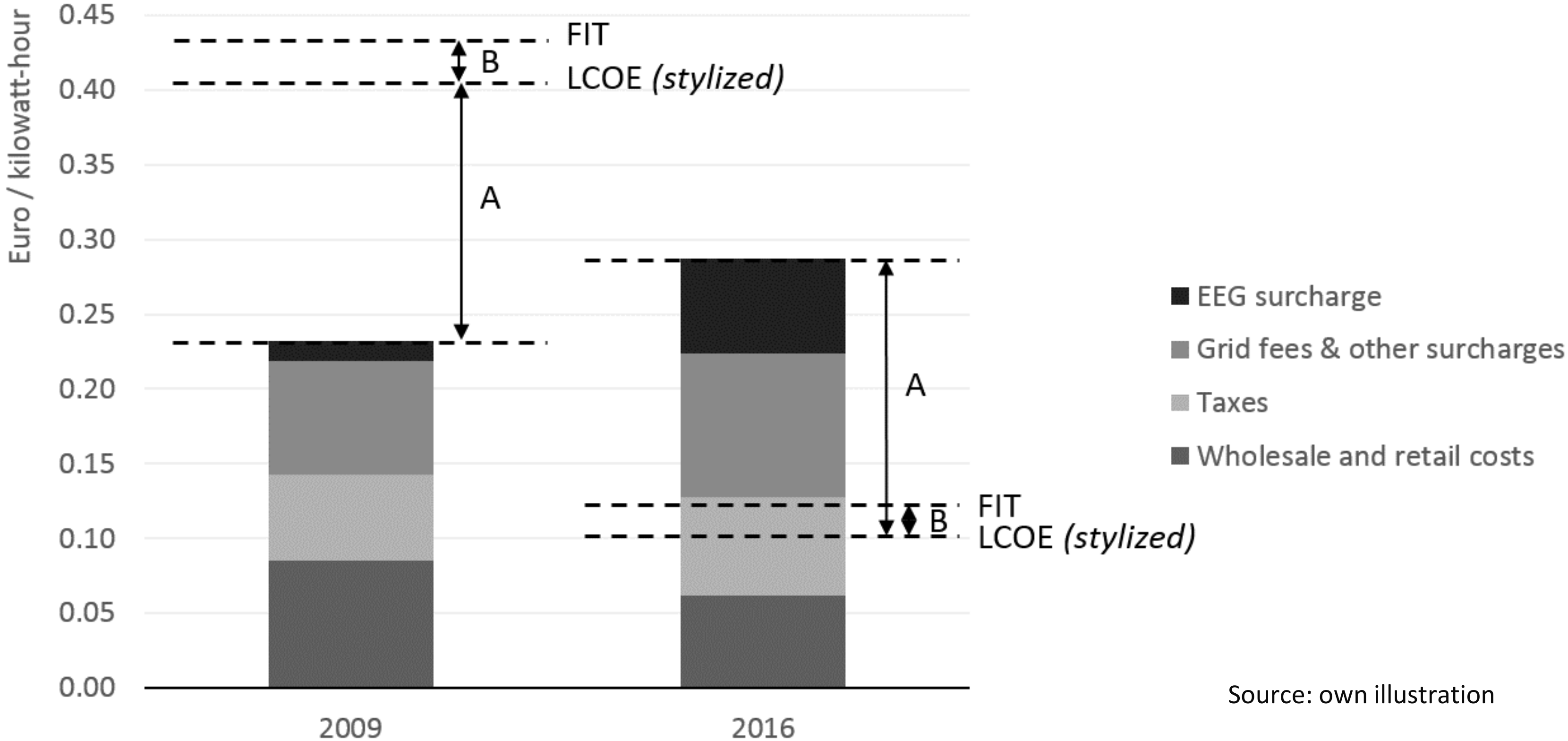
Arguments in favor of prosumage	Arguments against prosumage
• Consumer preferences • Participation and acceptance of energy transformation • Lower and less volatile electricity costs • Activation of private capital • Flexibility, sector coupling, and energy efficiency • Distribution grid relief • Transmission 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

Distributional impacts

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

Indirect prosumage support in Germany: FITs, LCOEs and household tariffs

- Volumetric grid charges and EEG surcharge – but not on self-generation
  - (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

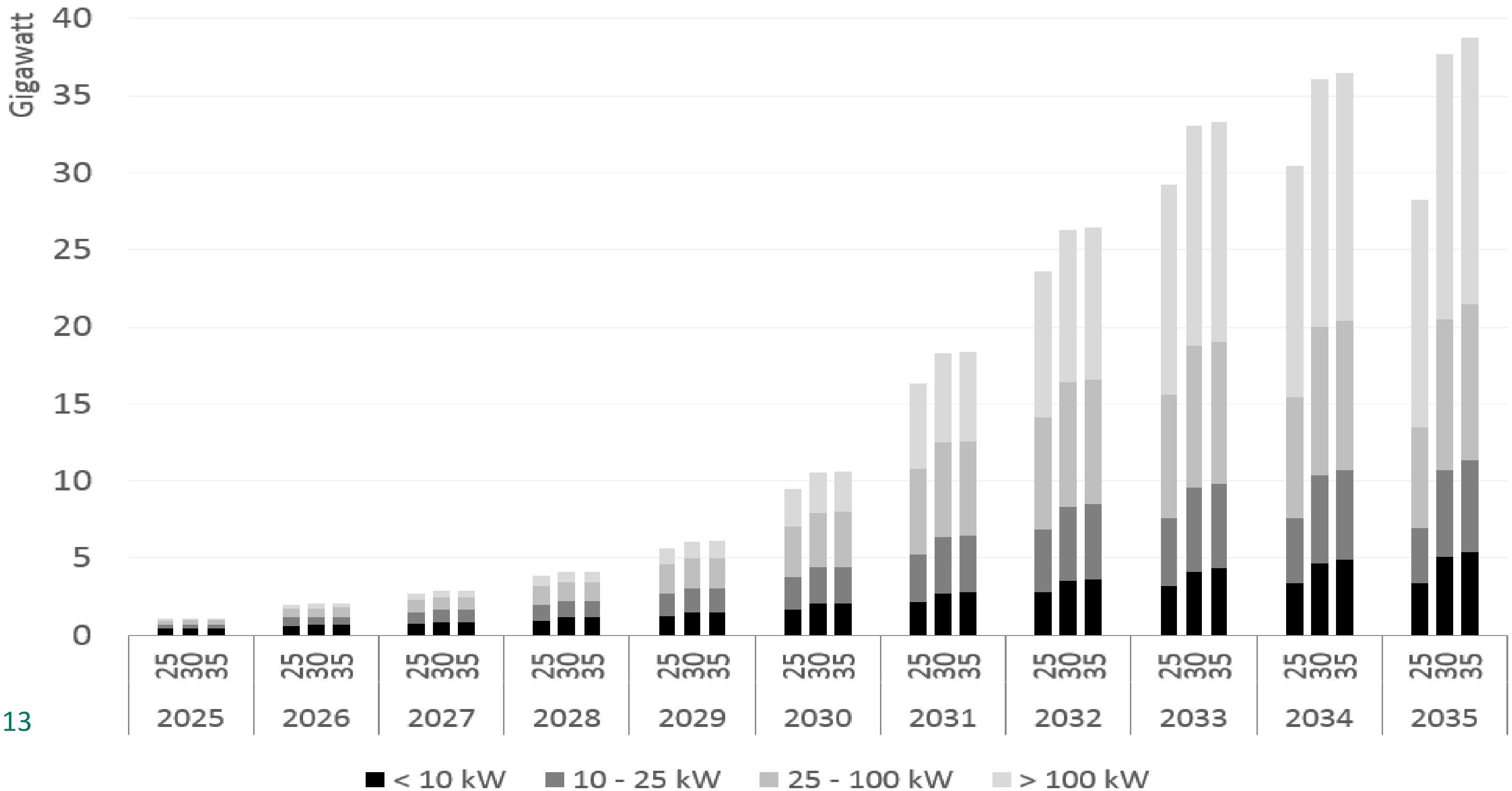
Direct prosumage support in Germany

- “KfW program 275“
    - 2013-2015: 25 million Euro
    - 2016-2018: 30 million Euro
    - Subsidized loan and investments grant
- Support program incentivizes system-friendly design of installations
    - Grid feed-in of PV system capped to 50% of installed capacity
    - Communication interface requirements

Deployment in Germany

- 2015: Every second small-scale PV system installed with battery
- Jan 2016: ~34,000 systems (~200 MWh), today > 50,000

→ Large additional potential when 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

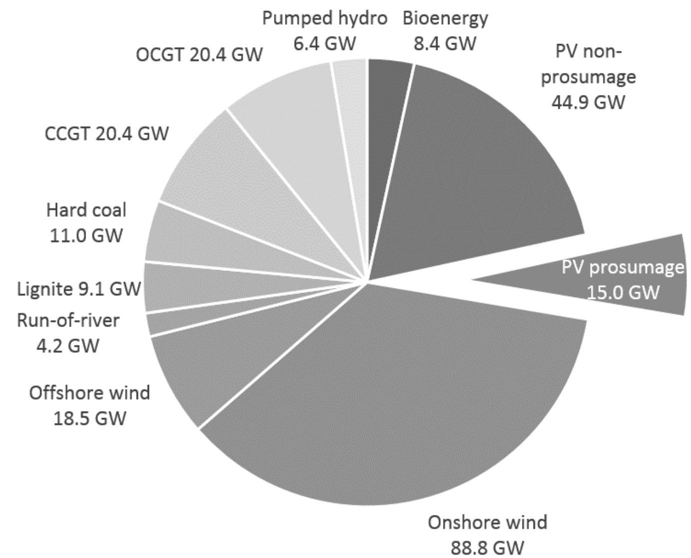
4 A model-based illustration of system effects

Implicit assumption of optimal behavior from system perspective

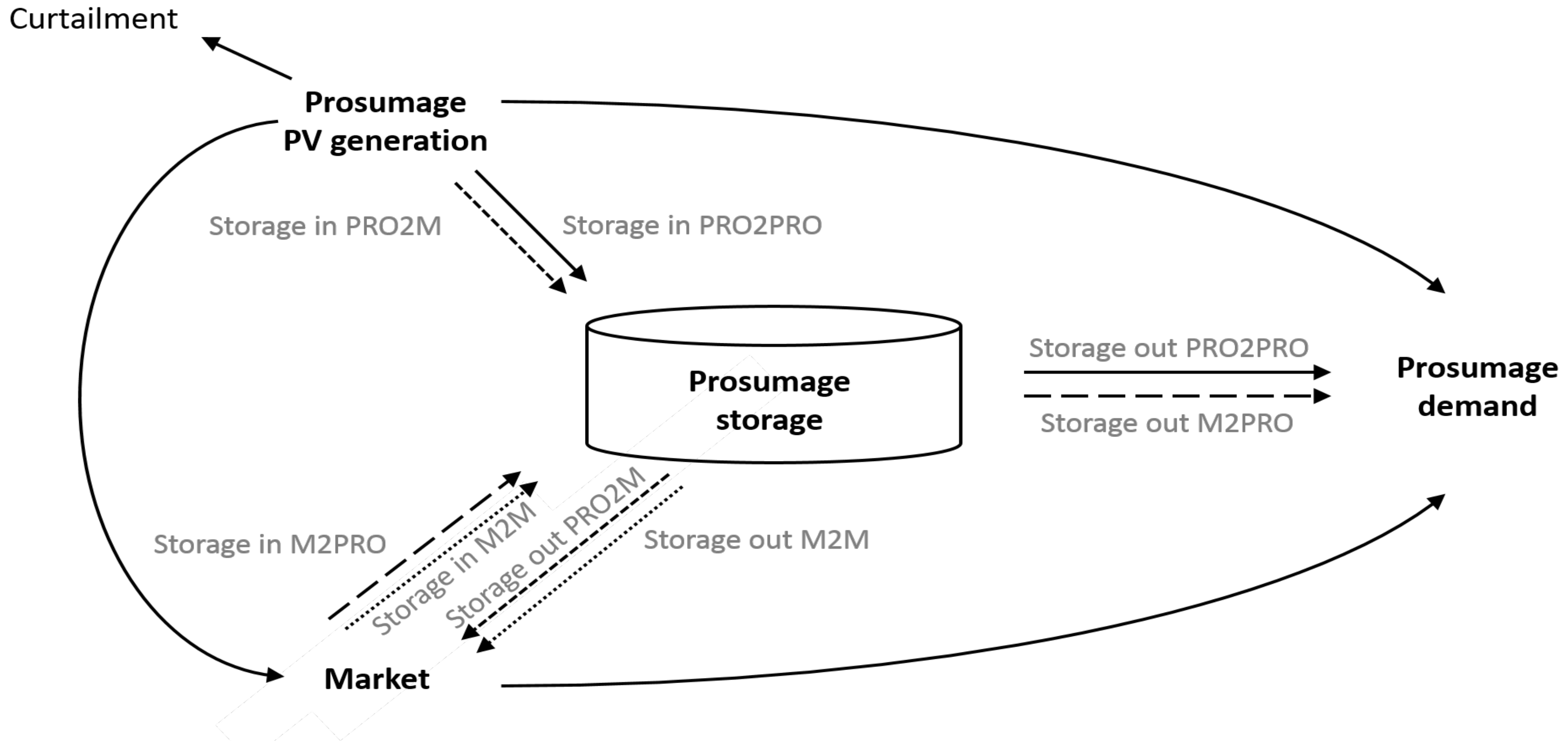
- No separate objective for households
- Varying minimum self-consumption restiction
- Prosumagers face wholesale prices (*EEEP* article)
- Additional calculations: storage operation purely focused on self-consumption (*DIW Wochenbericht / DIW Economic Bulletin*)

German scenario 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



DIETER: scenarios



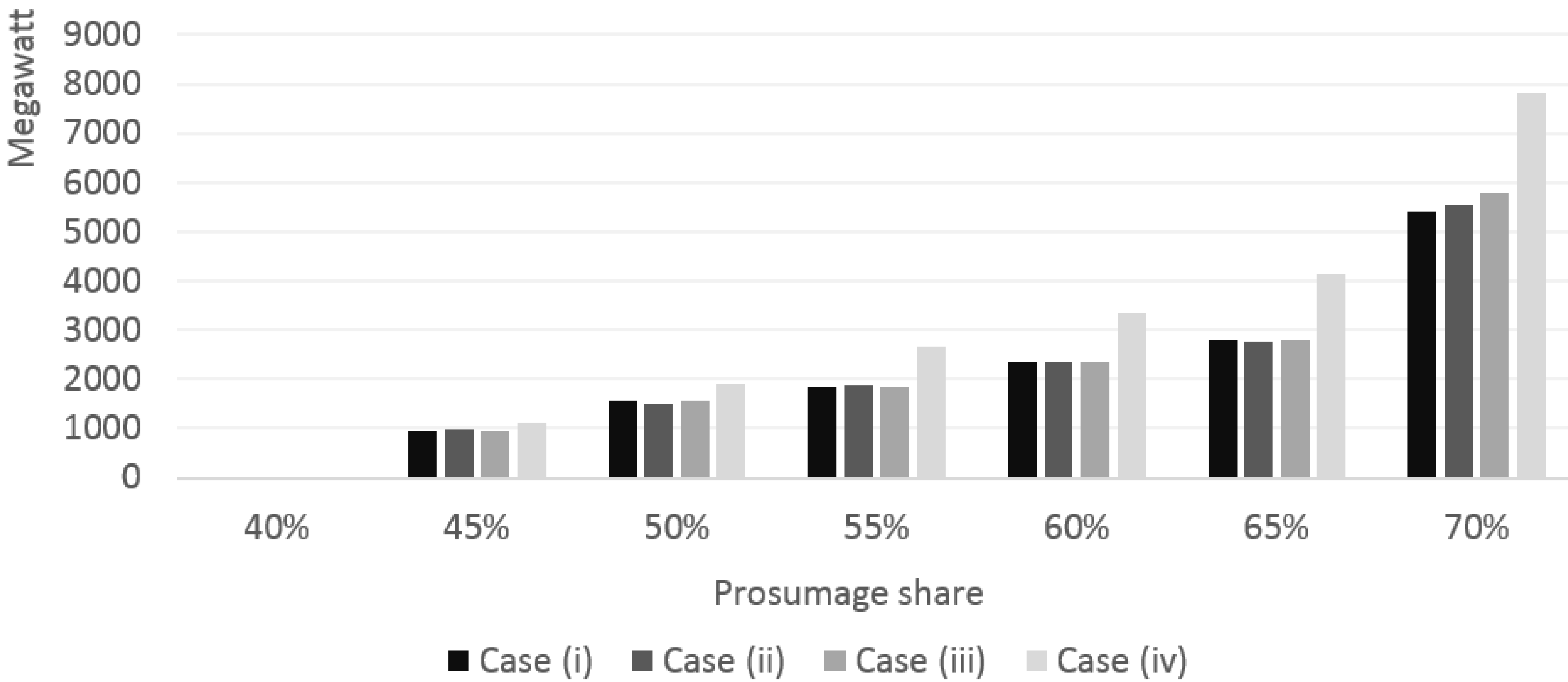
(i) ***Pure prosumage*** **-** No interaction of prosumage storage with market

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

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

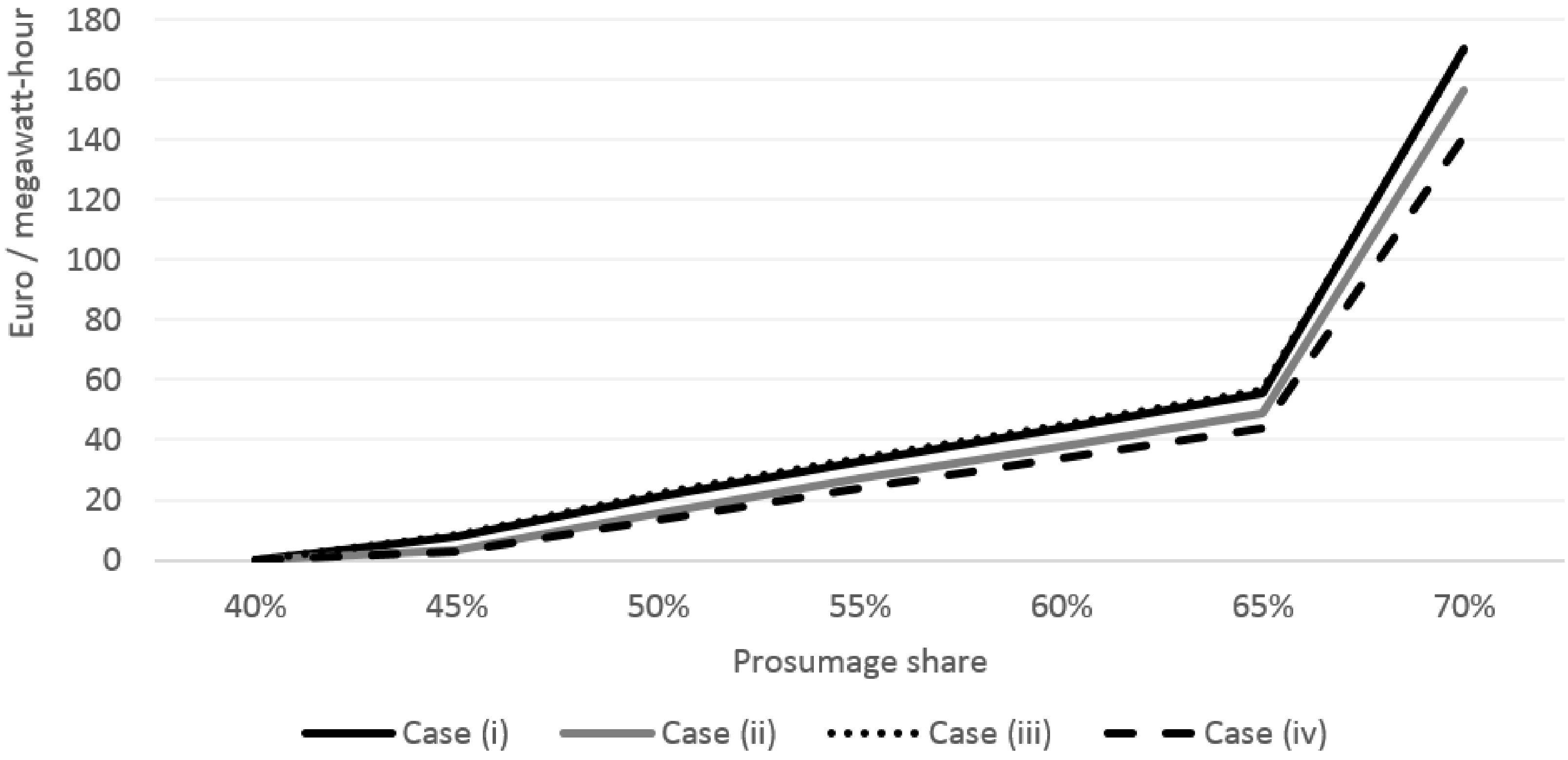
(iv) ***Full interaction*** - No restrictions on interaction of prosumage storage with market

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
- Energy capacity (MWh) does not change between cases

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

Prosumage is still a niche in Germany – but growing

- Ongoing (?) trends in battery costs, household tariffs and renewable support
- Large PV capacities drop out of support scheme before end of technical lifetime
- Not clear how regulatory framework evolves

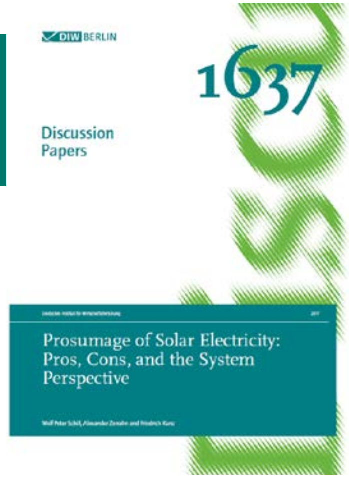
Range of pros and cons

- Weight of arguments
- Further research to quantify effects

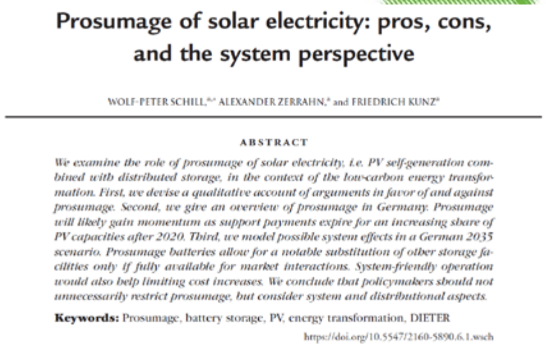
Model illustration shows importance of system-friendly behavior

- 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



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

WOLF-PETER SCHILL, ALEXANDER ZERRAHN, and FRIEDRICH KUNZ

ABSTRACT

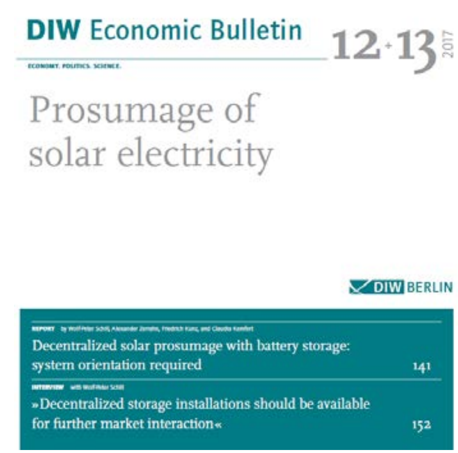
We examine the role of prosumage of solar electricity, i.e. PV self-generation combined with distributed storage, in the context of the low-carbon energy transformation. First, we devise a qualitative account of arguments in favor of and against prosumage. Second, we give an overview of prosumage in 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

- *Economics of Energy & Environmental Policy* 6(1), 7-31,
  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

Thank you for listening

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

Contact
Wolf-Peter Schill
wschill@diw.de

References

- Anda, M. and J. Temmen (2014). “Smart metering for residential energy efficiency: The use of community based social marketing for behavioural change and smart grid introduction.” *Renewable Energy* 67: 119-127. http://dx.doi.org/10.1016/j.renene.2013.11.020
- BNetzA (2014). *Szenariorahmen 2025. Genehmigung*. Bundesnetzagentur [German federal regulatory authority]. Bonn, 19.12.2014.
- Borenstein, S. (2015). “The private net benefits of residential solar PV: the role of electricity tariffs, tax incentives and rebates.“ *NBER Working Paper* 21342. www.nber.org/papers/w21342
- Gährs, S., K Mehler, M. Bost and B. Hirschl (2015). „Acceptance of Ancillary Services and Willingness to Invest in PV-storage-systems.“ *Energy Procedia* 73: 29 – 36. http://dx.doi.org/10.1016/j.egypro.2015.07.554
- IEA (2014). *Residential prosumers – drivers and policy options (RE-PROSUMERS)*. IEA-RETD. September 2014 (Revised version of June 2014). http://iea-retd.org/wp-content/uploads/2014/09/RE-PROSUMERS_IEA-RETD_2014.pdf
- Krekel, C., and A. Zerrahn (2017). „Does the presence of wind turbines have externalities for people in their surroundings? Evidence from well-being data.“ Journal of Environmental Economics and Management (forthcoming).
- Luthander, R., J. Widén, D. Nilsson and J. Palm (2015). “Photovoltaic self-consumption in buildings: A review.” *Applied Energy* 142: 80-94. http://dx.doi.org/10.1016/j.apenergy.2014.12.028
- Mayr, D., E. Schmid, H. Trollip, M. Zeyringer and J. Schmidt. “The impact of residential photovoltaic power on electricity sales revenues in Cape Town, South Africa.” *Utilities Policy* 36 (2015): 10-23. http://dx.doi.org/10.1016/j.jup.2015.08.001
- Michaels, L. and Y. Parag (2016). „Motivations and barriers to integrating ‘prosuming’ services into the future decentralized electricity grid: Findings from Israel.” *Energy Research & Social Science* 21: 70 – 83. http://dx.doi.org/10.1016/j.erss.2016.06.023

References

- Oberst, C.A., and R. Madlener (2015). “Prosumer Preferences Regarding the Adoption of Micro-Generation Technologies: Empirical Evidence for German Homeowners.” *FCN Working Paper* 22/2014. https://www.fcn.eonerc.rwth-aachen.de/global/show_document.asp?id=aaaaaaaaaaoqwnx
- Parag, Y. and Sovacool, B.K. (2016): “Electricity market design for the prosumer era.” *Nature Energy* 1, article number 16032. http://dx.doi.org/10.1038/nenergy.2016.32
- Prognos (2016). *Eigenversorgung aus Solaranlagen. Das Potenzial für Photovoltaik-Speicher-Systeme in Ein- und Zweifamilienhäusern, Landwirtschaft sowie im Lebensmittelhandel. Analyse im Auftrag von Agora Energiewende*. Berlin, October 2016.
- RWTH (2016). *Wissenschaftliches Mess- und Evaluierungsprogramm Solarstromspeicher. Jahresbericht 2016*. ISEA, RWTH Aachen.
- *Open Power System Data, http://open-power-system-data.org, Data Package Renewable power plants, version 2016-10-21*
- SPE (2015). *Renewable Self-Consumption Cheap and Clean Power at your Doorstep. Policy Paper*. SolarPower Europe, June 2015. http://www.solarpowereurope.org/fileadmin/user_upload/documents/Policy_Papers/Self-consumption_final1507.pdf
- SPE (2016). *Ahead of the Pack. Solar, the new Gateway to the decentralised Energy System*. SolarPower Europe, May 2016.