Battery Ageing • Battery Models • Battery Diagnostics • Battery Pack Design • Electromobility • Stationary Energy Storage • Energy System Analysis

Market and Technology development of PV Battery Systems in Germany

Finanzierungsmodelle für PV-Anlagen im Kontext neuer Förder-mechanismen (DFBEW / OFATE)

31.10.2016, Paris

Kai-Philipp Kairies, Dirk Uwe Sauer

Chair for Electrochemical Energy Conversion and Storage Systems

ISEA Stromrichtertechnik und Elektrische Antriebe | RWTH AACHEN UNIVERSITY

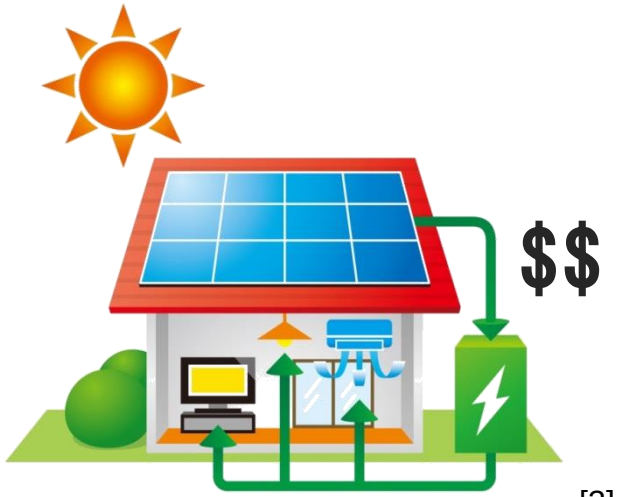
2015: More PV Battery Systems than electric cars in Germany

- **12.363** new electric vehicles registered in Germany

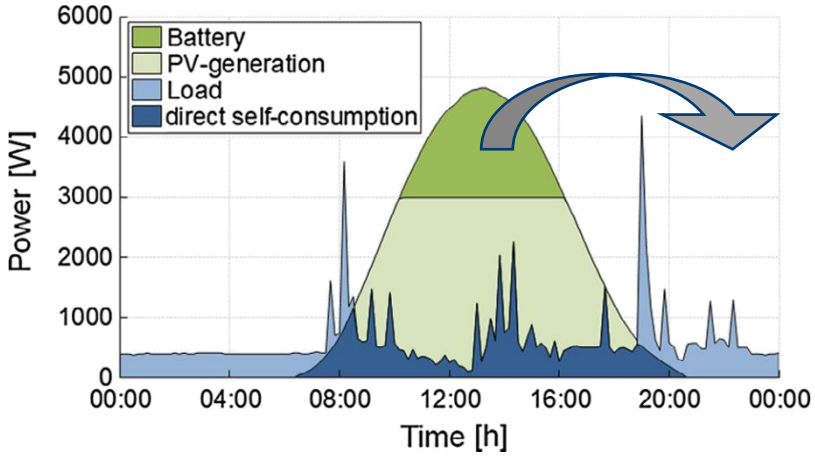
- **~ 20.000** installations of PV Battery Systems

Potentials of PV Battery Systems

- Increase self-consumption
  - Make solar energy available for usage in the evening and at night
  - Lower electricity bill
- Relieve low voltage grids
  - Take up peak energy production at noon
  - Improve grid compatibility

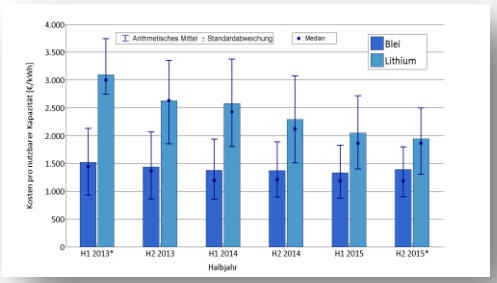


[3]



Agenda

- **Funding for PV Battery Systems**
  - Federal funding (“KfW funding”)
  - Local funding programs



- Current market trends
  - Market size
  - Price development
  - Battery Technologies

Federal funding for PV Battery Systems (1/3)

Nature of support:

- Loans at reduced rates, provided by state owned KfW banking group
- Repayment grant provided by the Federal Ministry of Economics

Bundesministerium für Wirtschaft und Energie

KFW

First funding period

- May 2013 to December 2016
- 50 Million Euro of funding
- 30% of eligible cost
- *More than 19.000 funded storage systems*

Second funding period

- March 2013 to December 2018
- 30 Million Euro of funding
- 25…10% of eligible cost

Federal funding for PV Battery Systems (2/3)

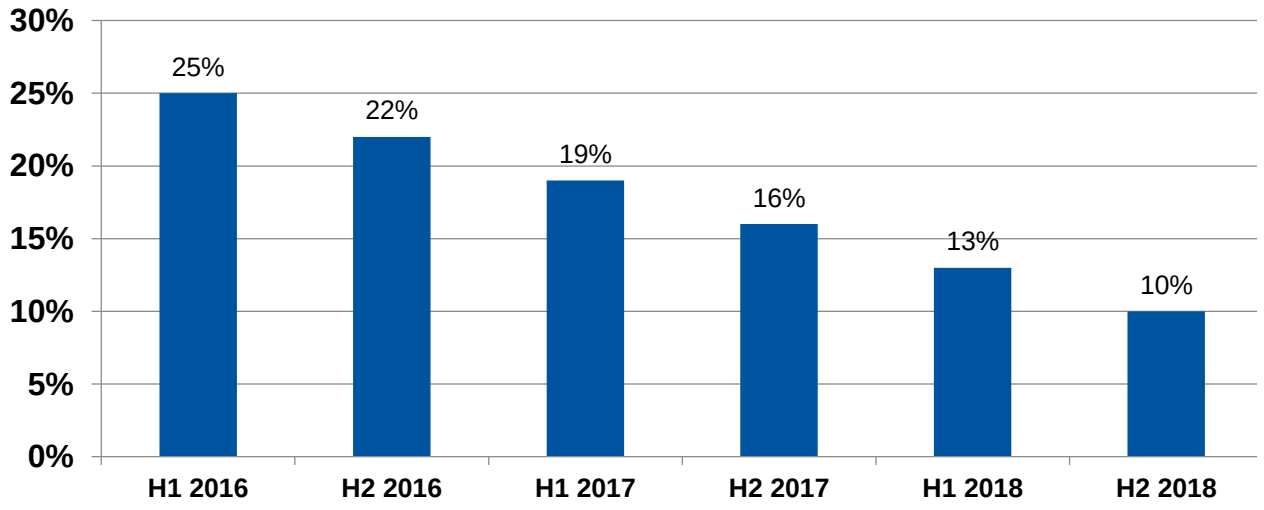
Nature of support:

- Loans at reduced rates, provided by state owned KfW banking group
- Repayment grant provided by the Federal Ministry of Economics

First funding period

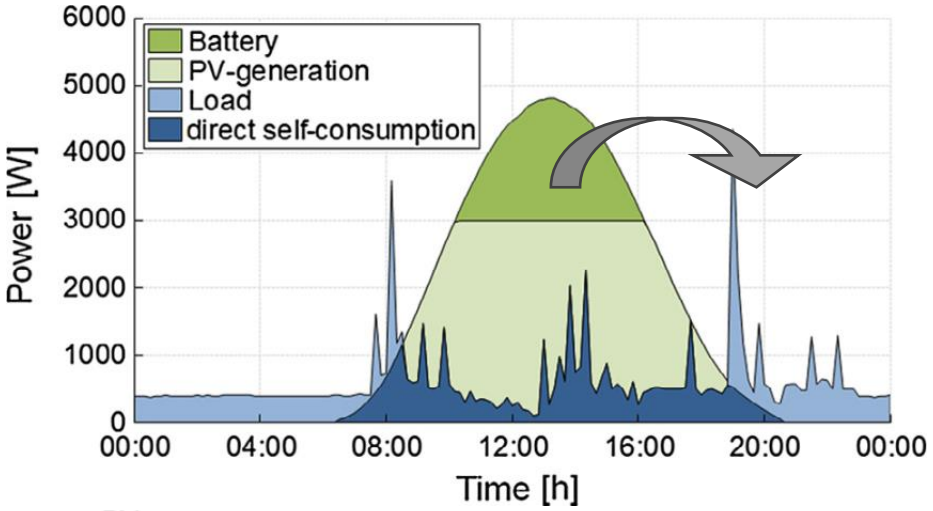
- May 2013 to December 2016
- 50 Million Euro of funding
- 30% of eligible cost
- *More than 19.000 funded storage systems*

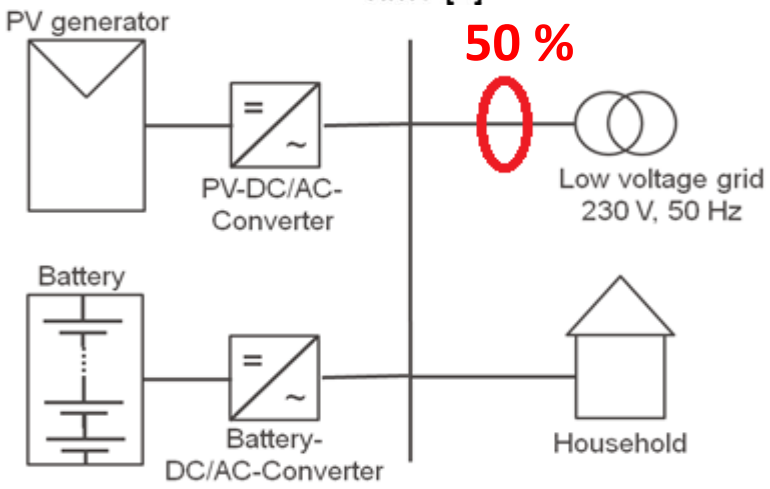
Repayment grant for PV Battery Systems



Federal funding for PV Battery Systems (3/3)

- Systems must offer a **10-year warranty** on the battery
- The maximum feed-in power of the corresponding PV power generator has to be limited to **50%** of its nominal power at the network connection point.
- All funded Systems must register with a scientific monitoring program





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SPEICHER MONITORING

Federal funding for PV Battery Systems: Stop until 2017

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Das T[illegible]uschuss vom Bund ist für dieses Jahr nahezu aus[illegible]opft.
Foto: KfW-Bildarchiv/Rüdiger Nehmzow

Funding stopped until end of 2016

Continuation of program on 01.01.2017

KfW verkündet vorläufigen Stopp der Photovoltaik-Speicherförderung bis Jahresende

30. September 2016 | Speicher und Netze, Topnews

Die Mittel für den Tilgungszuschuss von Seiten des Bundes sind für dieses Jahr nahezu aufgebraucht. Daher musste die KfW nun einen vorläufigen Zusagestopp für das Programm Erneuerbare Energien - Speicher (275) verkünden. Die Grünen und der Bundesverband Solarwirtschaft üben harsche Kritik an der Bundesregierung, die nicht bereit ist trotz der Nachfrage die Mittel für die Förderung von Photovoltaik-Heimspeichern aufzustocken.

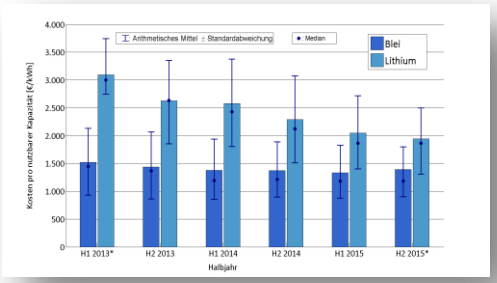
[4]

Local funding schemes are on the rise

- **Saxony**
  - Residential PV Battery Systems
  - Up to 40-50% of invest
  - 50% max PV feed-in
- **Saarland**
  - “Innovative” PV Battery Systems
  - Up to 35…55% of invest
- **Bavaria**
  - Residential PV Battery Systems and power to heat solutions
  - Up to 35…55% of invest
  - 50…30% max PV feed-in
- **North Rhine Westphalia**
  - Batteries with PV > 30 kW (SME)
  - Up to 50% of invest
  - 50% max PV feed-in
- **Thüringen**
  - SME batteries (?)
  - tba

Agenda

- Funding for PV Battery Systems
  - Federal funding (“KfW funding”)
  - Local funding programs

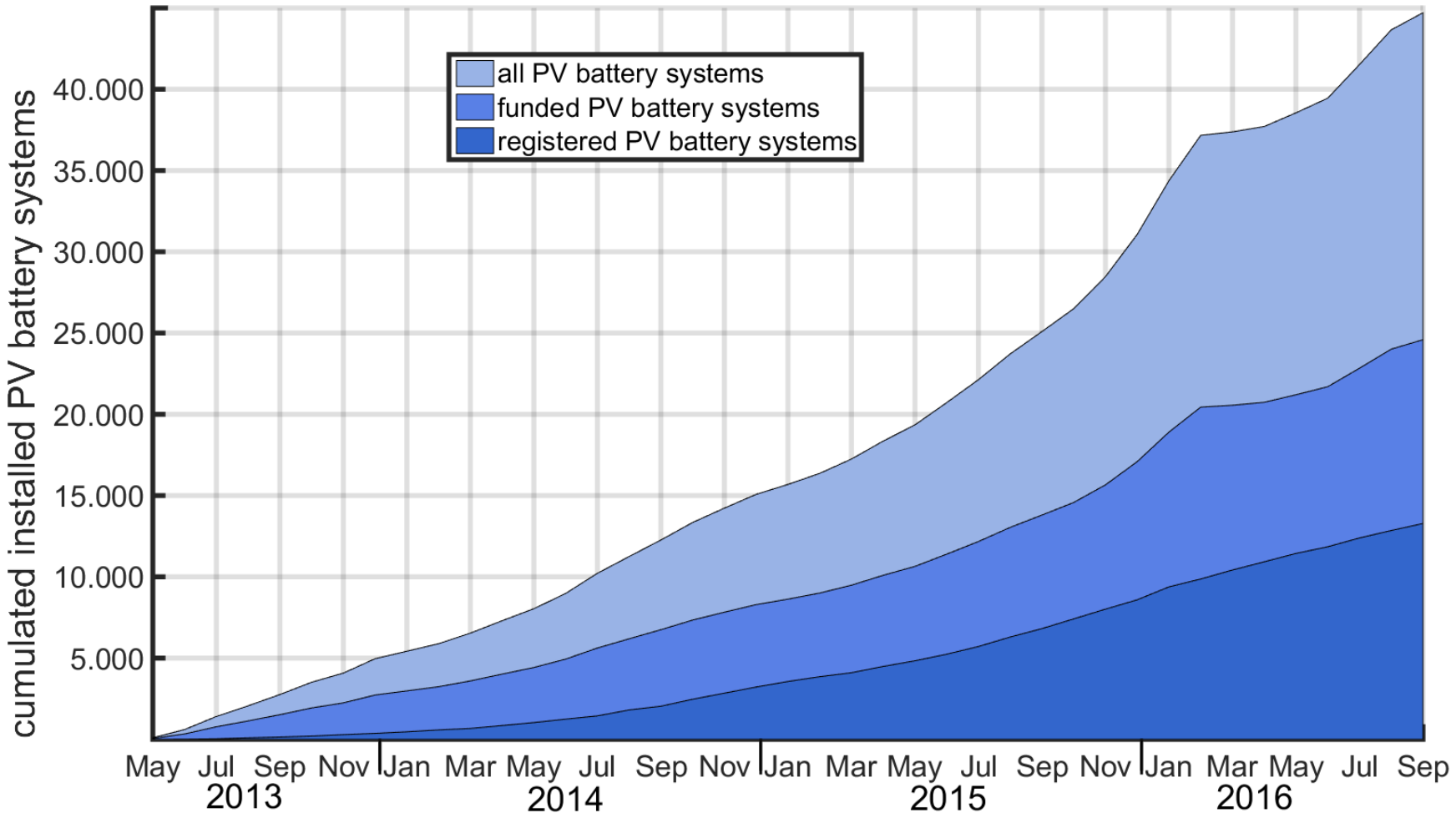


- **Current market trends**
  - Market size
  - Price development
  - Battery Technologies

Publication of annual report 2016

- All results of this presentation can be found in the current annual report of Speichermonitoring
- Among others: List of manufacturers, typical system design measured self-consumption and autarky, …
- PDF version is publicly available: ***www.speichermonitoring.de***

Installations of PV Battery Systems in Germany since 2013



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Chair for Electrochemical Energy Conversion and Storage Systems
ISEA Power Electronics and Electrical Drives
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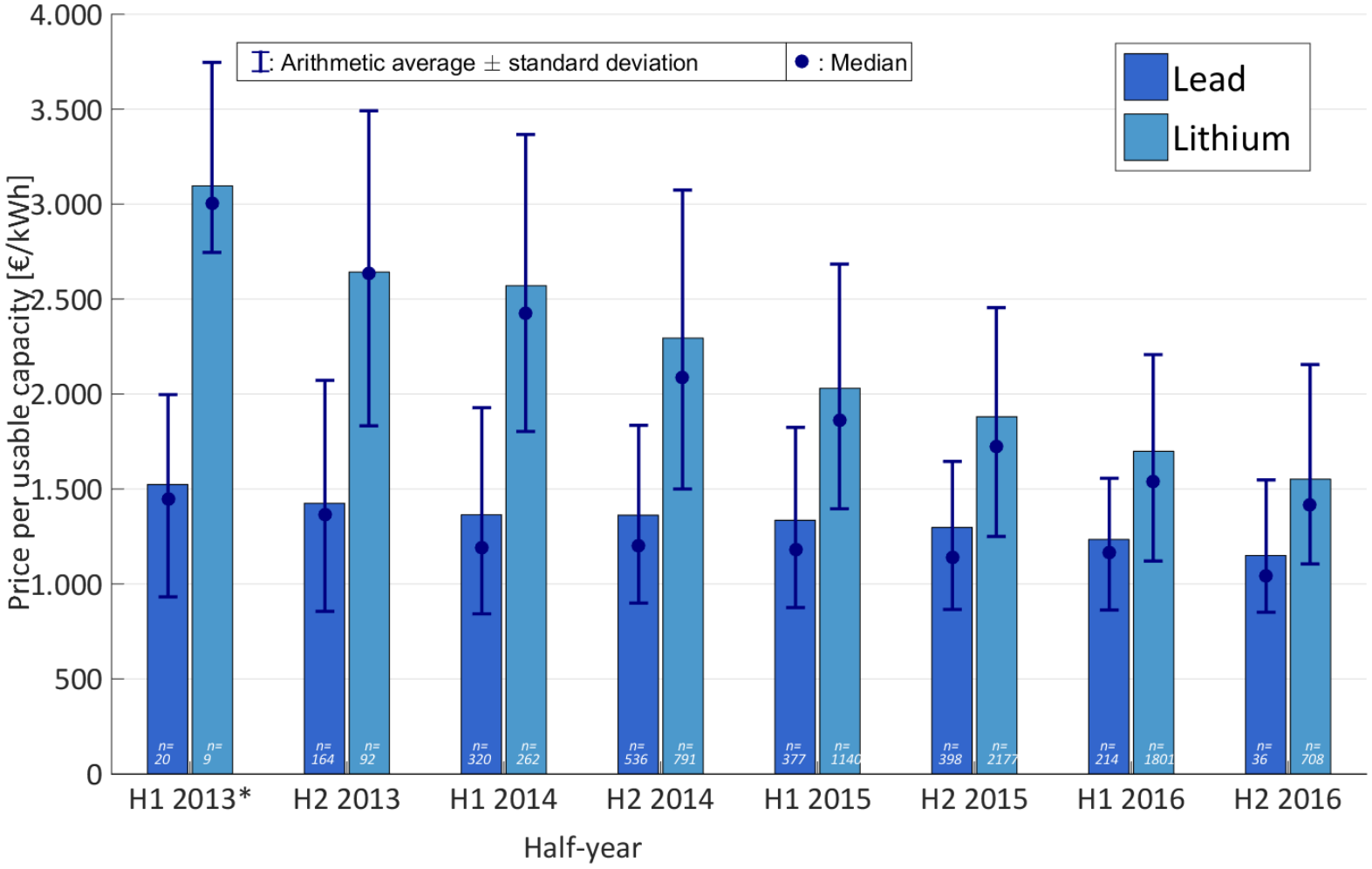
Development of retail-prices (incl. VAT)



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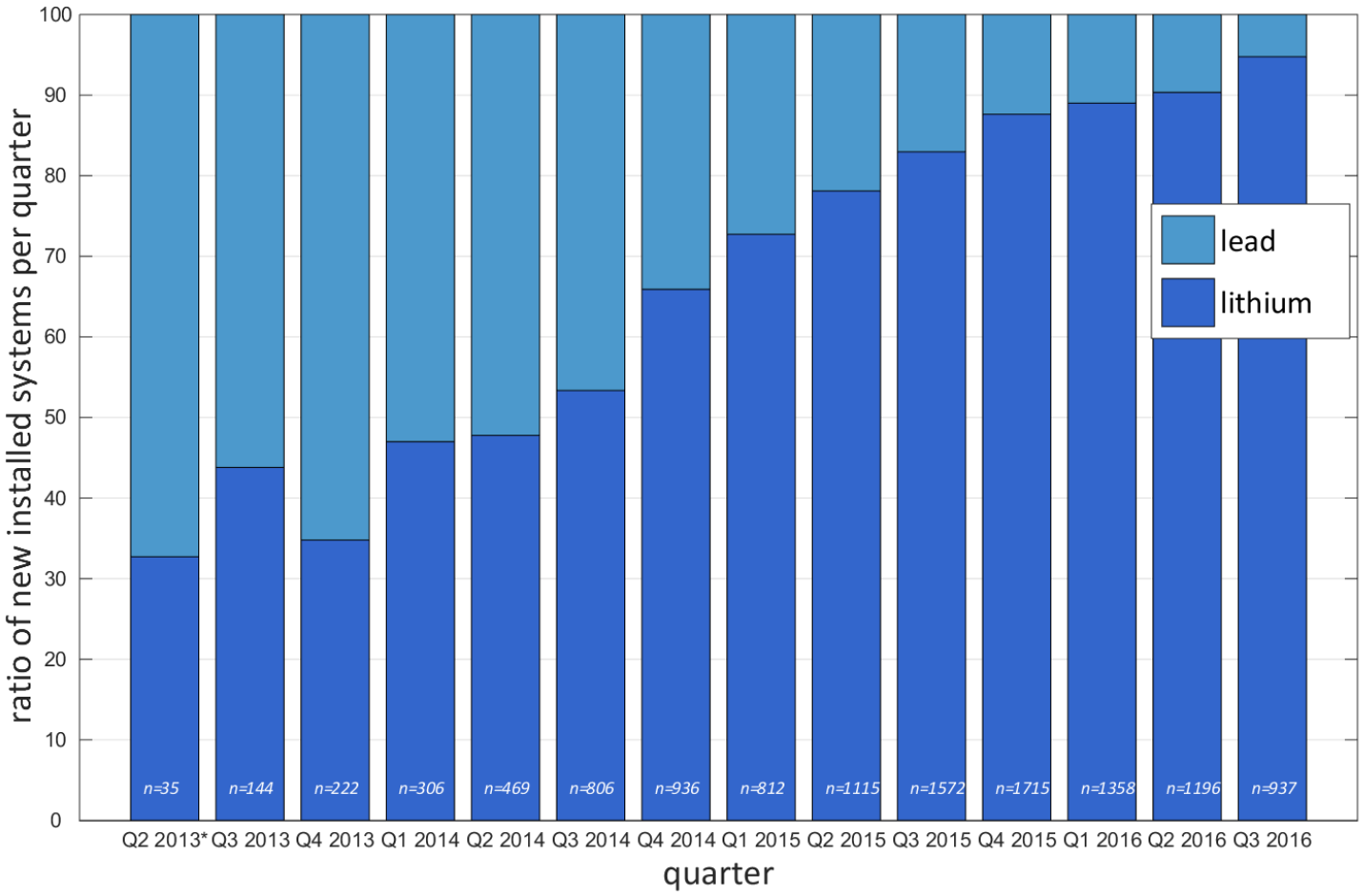
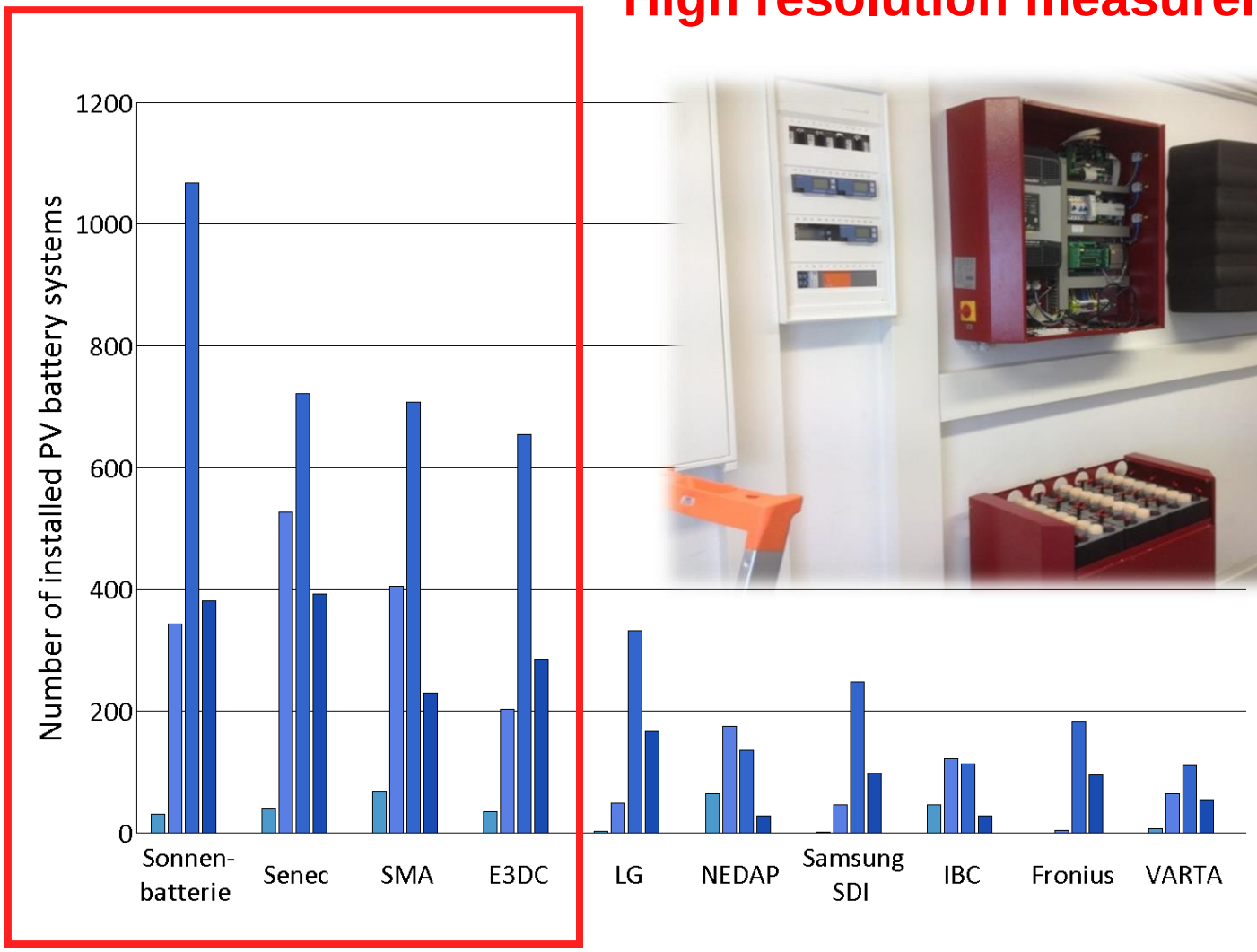
Development of battery technologies



Market shares of Top-10 manufacturers (KfW-funded storage systems only)

High resolution measurements



Summary / Outlook

- PV Battery Systems are a **rapidly growing market**
  - ~ 50% of the new small PV installations expected to be in combination with storage systems
  - Retrofit of old PV installations will start in 2021
- System **quality increased** significantly due to governmental funding and scientific monitoring
  - System efficiency, battery lifetime, safety, operating strategies, …
- **Multi-use** of decentralized storage capacities will play a major role in future energy grids
  - Guidelines need to be adjusted

[3]

Image sources

[1] http://uk.reuters.com/article/us-autoshow-frankfurt-merkel-eu-idUKBRE98B0SZ20130912

[2] http://www.stadtwerke-bamberg.de/energie/erneuerbare-energien/wir-suchen-dachflaechen-fuer-solaranlagen.html

[3] © ayutaroupapa - Fotolia.com

[4] http://www.pv-magazine.de/nachrichten/details/beitrag/kfw-verkndet-vorlufigen-stopp-der-photovoltaik-speicherfrderung-bis-jahresende_100024575/

[4] https://www.solarwatt.de/

[5] https://www.sonnenbatterie.de/de/home

[6] http://www.senec-ies.com/senec.home_lithium

Unless otherwise stated, all used pictures are property of the Institute for Power Electronics and Electrical Drives (ISEA) at Aachen University (RWTH Aachen)

Thank you
for your attention

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We thank

Supported by:

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Backup Slides: Profitability of PV Battery Systems

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Profitability of PV Battery Systems (as manufacturers see it)

[4]

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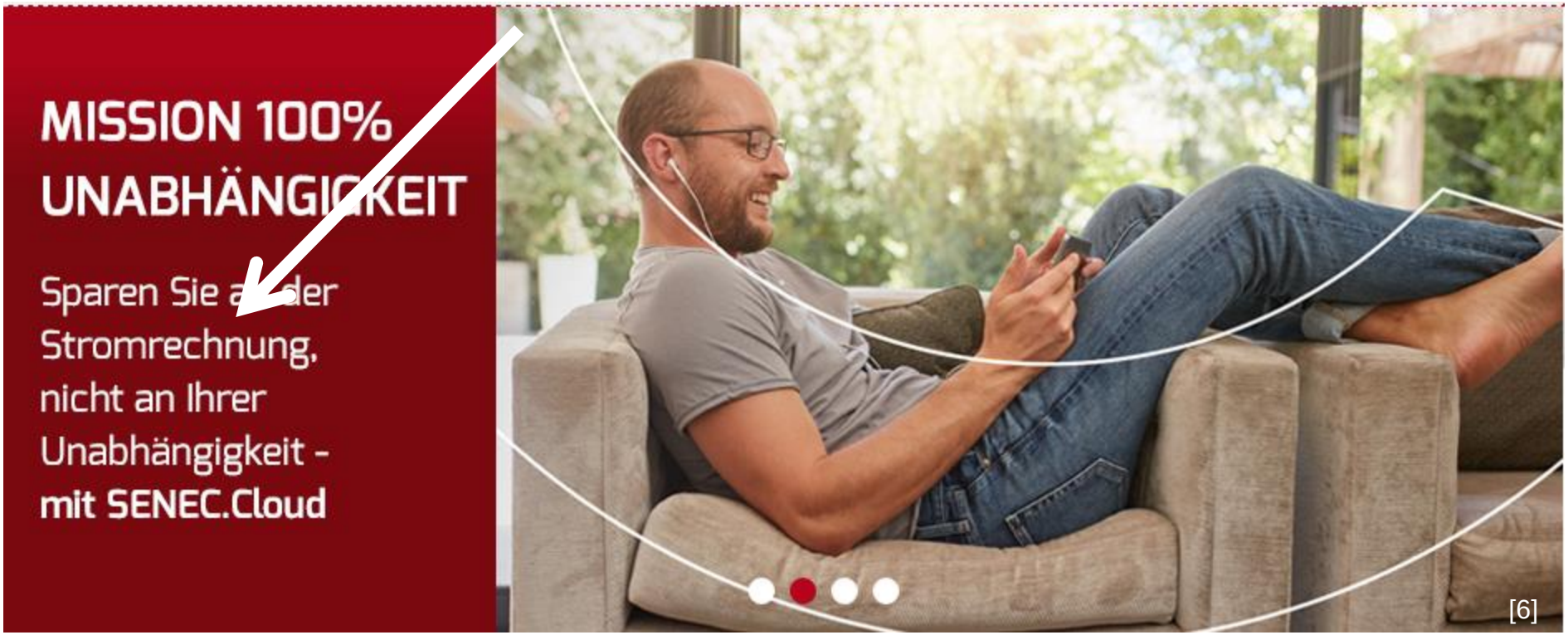
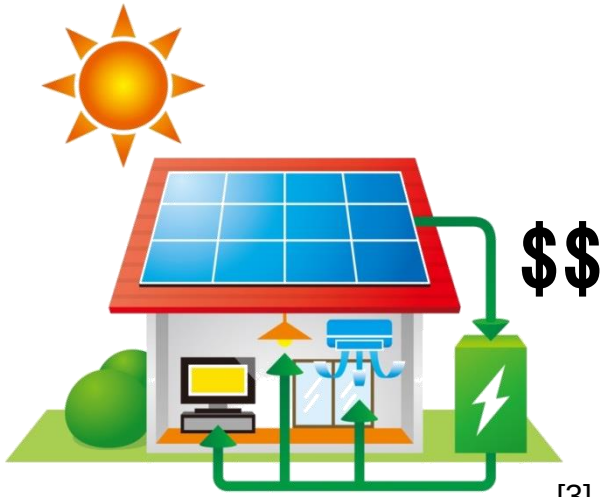
Profitability of PV Battery Systems (as manufacturers see it)



Profitability of PV Battery Systems (status quo)

- Boundary Conditions
  - 800 € / kWh usable capacity
  - 10 years warranty
  - 75…85% efficiency
  - 12 ct/kWh PV generation costs
  - Max. 30 ct/kWh electricity costs
  - 200…250 cycles per year



[3]

- Price for one kilowatt-hour of stored electricity
  - Production + losses :

$$12\,\frac{ct}{kWH} * \frac{1}{85\%} = 14{,}4\,\frac{ct}{kWh}$$

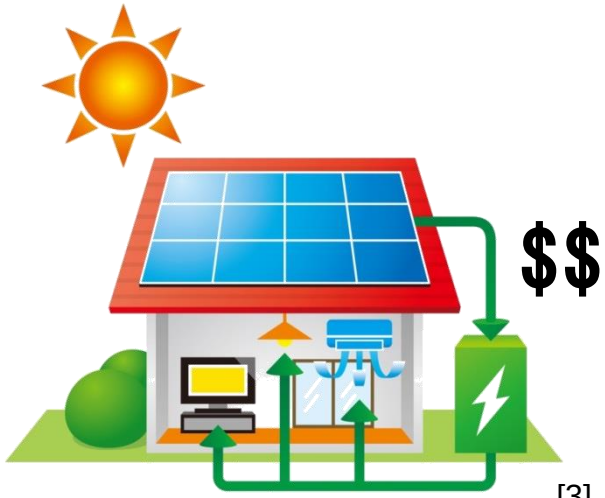
  - Storage:

$$\frac{800\ €}{2500\ full\ cycles} = 32\,\frac{ct}{kWh}$$

- Overall price **> 46 ct/kWh**

Profitability of PV Battery Systems (in 2 years)

- Boundary Conditions
  - **550 € / kWh** usable capacity
  - **15 years warranty**
  - 75…85% efficiency
  - **11 ct/kWh PV generation costs**
  - Max. 30 ct/kWh electricity costs
  - 200…250 cycles per year



[3]

- Price for one kilowatt-hour of stored electricity
  - Production + losses :

$$11\frac{ct}{kWH} * \frac{1}{85\%} = 12{,}9\frac{ct}{kWh}$$

  - Storage:

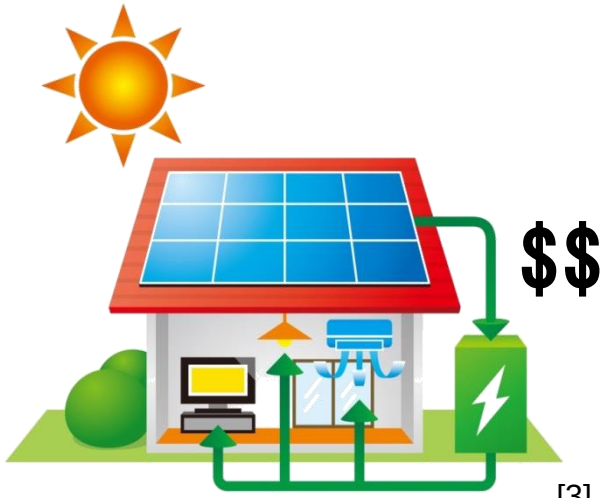
$$\frac{550\ €}{3750\ full\ cycles} = 14{,}7\frac{ct}{kWh}$$

- Overall price **28 ct/kWh**

- Additional margin from grid services ~ 1 ct/kWh

Profitability of PV Battery Systems (in 4 years, no EEG)

- Boundary Conditions
  - **400 € / kWh** usable capacity
  - **15 years warranty**
  - 75…85% efficiency
  - **3 ct/kWh PV generation costs**
  - Max. 30 ct/kWh electricity costs
  - 200…250 cycles per year



[3]

- Price for one kilowatt-hour of stored electricity
  - Production + losses :

$$3\frac{ct}{kWH} * \frac{1}{85\%} = 3{,}53\frac{ct}{kWh}$$

  - Storage:

$$\frac{400\ €}{3750\ full\ cycles} = 10{,}7\frac{ct}{kWh}$$

- Overall price **14,2 ct/kWh**

- Additional margin from grid services ~ 1 ct/kWh

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