Assessment of residential battery systems (RBS): profitability, perceived value proposition, and potential business models

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Residential battery systems (RBS) for enhanced self-sufficiency

Functional principle of RBS

Source: Graebig et al, E3/DC GmbH
"Grid parity" in Germany paves the way for RBS

Guaranteed feed-in tariff for PV and average electricity price for households*

- PV storage market expected to grow from $0.2 bn (2012) to $19 bn (2017)**
- Up to 70% market share in Germany**
- 30% government subsidy for RBS in Germany

* Guaranteed feed-in tariff for PV, 10 kWp roof-top photovoltaics, new installation, average electricity tariff for a typical German household, 3 people, 3,500 kWh/year

** IHS Technology, Press Release: PV Storage Market Set to Explode to $19 Billion in 2017; Germany Leads Again, 2013

Source: IWR, BMU, BNetzA, BDEW
German utilities are in need of new business models

Recent statements of top-managers from German major utilities

“Currently, all traditional utilities have their back to the wall.“

Kurt Mühlhäuser (former CEO of Stadtwerke München)

“The utilities‘ business model is dead.“

Werner Brinker (CEO of EWE)

“We are facing the worst structural crisis in the history of electrical power supply.“

Peter Terium (CEO of RWE AG)

German utility managers expect a decline in electricity sales of EUR 8.3 bn. (11%) by 2020, in some smaller rural utilities even up to 19%, due to “prosumers“.

Model-based estimation of RBS’s expected profitability and degree of self-supply under optimistic assumptions

Methods (1/2): RBS model

**Input parameters**

- **Standard load profile SLP** (15 minutes / 365 days) and total annual demand
- **PV generation profile** (15 minutes / 365 days) and total generation
- **Feed-in tariff** (0.136 €/kWh)
- **Electricity price** (only variable cost for energy: 0.27 €/kWh) and historic growth rate of 4.7% p.a.
- Technical parameters (degradation of PV and RBS, RBS efficiency, etc.)

**Output parameters**

- Degree of self-supply
- Net present value (NPV) of RBS operation

**Optimistic reference scenario**

- PV capacity: 7 kW_p
- RBS capacity: 4 kWh_{eff}
- RBS peak power: 2 kW_p
- RBS lifespan: 20 years
- Cost of capital: 3.1% p.a.

Source: Graebig et al
Customer survey on purchasing criteria and willingness to pay

Methods (2/2): online customer survey

- Partner: “typical” municipal utility in southern Germany
- Small city with 30,000 residents, less than 3% unemployment
- Online survey in June 2013:
  1. Feedback for the utility
  2. Utilities in general
  3. Perception of RBS
- Objective of the RBS survey:
  1. Purchasing criteria and willingness to pay
  2. Structural equation modelling for perceived value proposition

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<tr>
<th>Invitation via e-mail</th>
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<tbody>
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<td>Valid responses</td>
<td>377</td>
</tr>
<tr>
<td>Private customers</td>
<td>360</td>
</tr>
</tbody>
</table>

17.7% Valid responses

Source: Graebig et al
Benefit of RBS below 1,000 €/kWh$_{\text{eff}}$

RBS pay-back (NPV over 20 years) under optimistic assumptions*

* Assumptions: 4 kWh$_{\text{eff}}$ RBS capacity; 2 kW$_{p}$ RBS peak power; 20 years RBS lifespan; 3.1% p.a. cost of capital

Source: Graebig et al
Cost of Li-based RBS around 3,000 €/kWh_{eff}

Market overview of RBS in Germany, 2013*

* “Pb” denotes lead-based batteries, “Li” lithium-ion-based batteries
Source: providers' websites, researched by André Huschke; Focus magazine, 2013
Degree of self-supply is substantially enhanced by RBS

Degree of self-supply, based on PV, with and without RBS*

* Assumptions: 7 kW$_p$ PV capacity; 4 kWh$_{eff}$ RBS capacity; 2 kW$_p$ RBS peak power; 20 years RBS lifespan; 3.1% p.a. cost of capital

Source: Graebig et al
Customers attribute “soft factors” to RBS

Customers’ attitude towards RBS

I like the idea of an RBS.
I can envision using an RBS.
I am planning on purchasing an RBS.

Top-5 reasons for an RBS

Saving money through higher PV self-supply
Avoiding future electricity price rises
Independent electricity supply for my home
Protecting environment, mitigating climate change
Contributing to the “Energiewende”

Source: Graebig et al
Willingness to pay exceeds the expected pay-back

What would be your preferred mode of payment for an RBS?

- Purchasing: 49.7%
- Leasing: 25.6%
- n/a: 24.7%

n = 352

What would you consider a fair price (one-time purchasing price or monthly leasing fee, respectively)?

- [EUR]
  - 10: 10%
  - 30: 15%
  - 50: 25%
  - 70: 10%
  - 90: 5%
  - >100: 15%

- [EUR]
  - 1,000: 30%
  - 3,000: 15%
  - 5,000: 10%
  - 7,000: 5%
  - 9,000: 5%
  - >10,000: 10%

Source: Graebig et al
RBS may trigger some very innovative business models

Conclusion and outlook: 5 hypotheses about RBS

(1) Two-fold value proposition: self-sufficiency vs. cost-efficiency.

(2) Pay-back of RBS is only 20-30% of purchasing price ...
   ... but customers value the “soft factors“, particularly self-sufficiency.

(3) RBS may generate additional value (e.g., micro-CHP, “battery cloud“, etc.).

(4) RBS provide new business opportunities for utilities (leasing, customer retention, cross-selling, etc.).

(5) International markets beyond Germany might be more attractive: security of supply as an additional value proposition.

* Note: RBS is targeted to microeconomic decision-makers – no system perspective.

Source: Graebig et al
Standard load profile (SLP) smoothens demand peaks and leads to an overly optimistic assessment of RBS

Comparison of standard load profile (SLP) with a high-res synthetic load profile*

* One Thursday in February. SLP (15 min) vs. synthetic load profile (1 min), 4,577 kWh total annual electricity demand.
Source: refined PV/RBS model by Graebig, Birkholz, Eicke, Huschke (unpublished paper)
More than 70% self-supply achievable

Self-sufficiency through RBS under optimistic assumptions

Source: Graebig et al
Self-sufficiency is major driver for a positive attitude towards RBS

Preliminary results from the structural equation model

Source: Graebig et al