Trends of Stationary Battery Storage Systems in Germany – A Database Analysis

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Introduction

- Increasing number of large scale stationary battery projects worldwide

Selected projects:

100 MW / 129 MWh, Hornsdale Power Reserve, Australia

16 MW / 6 MWh, Shin-Chungju Substation, South Korea
Source: Kokam, Ike Inkwan Hong, 2015

48 MW / 50 MWh, EnspireME, Jardelund, Germany
Source: EnecoGroup, 2018

Build-up of a battery project database for Germany as a basis for evaluation of market development, technology trends and techno-economic data
The Battery Storage Database

- Contains information about large scale stationary battery storage systems in Germany (without PV home storage systems for private households)
- Continuously updated regarding battery storage systems which are decommissioned, in operation or planned
- Includes more than 140 projects (Status: July 2018) of which 59 projects with a system size of ≥ 1 MW and/or ≥ 1 MWh have been considered in the present analysis
- From the selected 59 projects, 50 projects are classified as commercial projects and 9 as research and development projects
- Sources include scientific as well as non-scientific literature, company information, web-sites and personal communications

Overview of data categories

<table>
<thead>
<tr>
<th>Location</th>
<th>Power</th>
<th>Capacity</th>
<th>Operator</th>
<th>Cell chemistry</th>
<th>System integrator</th>
<th>Cell manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning date</td>
<td>Application field</td>
<td>Classification (Commercial/R&amp;D)</td>
<td>Investment</td>
<td>Lifetime</td>
<td>Notes</td>
<td>Sources</td>
</tr>
</tbody>
</table>

Sources: Scientific as well as non-scientific literature, company information, web-sites and personal communications.
Locations of Stationary Battery Storage Systems in Germany

2012

2018

Battery type
- Redox-Flow
- Lithium-Ion (Second Life)
- Lithium-Ion
- Hybrid
- Sodium-Sulfur
- Lead-Acid

Battery power
- 5 MW
- 50 MW

2018 projects partly under construction
Development of Battery Projects

- Increasing number of battery projects (2012: 6 projects -> 2018: 59 projects)
- Main application field: provision of primary control power
- Most projects are based on Lithium-Ion cell chemistry

Hybrid systems (2018): 2 x Li-ion + Redox-Flow, 2 x Li-Ion + Lead-Acid, 2 x Li-Ion + Sodium-Sulfur
Development of Battery Projects

- Most battery projects are realized in the segment 1-5 MWh (2018: 23 out of 59 projects)
- Trend towards larger projects (> 5 MWh up to > 20 MWh) from 2016 on
- Largest project (single location): 50 MWh (2018)
Development of Cumulated Battery Storage Capacity

- Cumulated battery storage capacity (2018) sums up to approx. 0.5 GWh (Pumped hydro power Germany 2018 approx. 38.5 GWh [1])
- Lithium-Ion is the dominant cell chemistry regarding the installed capacity

[1] Stenzel, P. et al., Energiespeicher, BWK, 5, 2018
Development of Cumulated Battery Power

- Cumulated battery power (2018) sums up to approx. 430 MW (Pumped hydro power Germany 2018 approx. 6,225 MW [1])
- Cumulated battery power for primary control approx. 400 MW (after system commissioning of all 2018 projects; Primary control tender Germany: 620 MW [2])

## Prequalified Power for Ancillary Services in Germany (June 2018)

<table>
<thead>
<tr>
<th>Technologie</th>
<th>PRL</th>
<th>SRL+</th>
<th>SRL-</th>
<th>MRL+</th>
<th>MRL-</th>
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</thead>
<tbody>
<tr>
<td>Kernenergie</td>
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<td>0,42</td>
<td>0,42</td>
<td>2,04</td>
<td>2,04</td>
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<td>5,15</td>
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<td>1,56</td>
<td>5,19</td>
<td>4,98</td>
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<tr>
<td>Gas</td>
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<td>2,99</td>
<td>3,03</td>
<td>8,58</td>
<td>8,27</td>
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<td>Öl</td>
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<td>0,31</td>
<td>0,02</td>
<td>2,03</td>
<td>0,14</td>
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<td>2,27</td>
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<tr>
<td>Wasser</td>
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<td>13,76</td>
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<td>Nachfrage/DSM</td>
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<tr>
<td>Sonstige</td>
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<td>0,08</td>
<td>0,21</td>
<td>0,50</td>
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<tr>
<td><strong>Summe (in GW)</strong></td>
<td><strong>5,44</strong></td>
<td><strong>22,42</strong></td>
<td><strong>22,50</strong></td>
<td><strong>40,56</strong></td>
<td><strong>39,17</strong></td>
</tr>
</tbody>
</table>

Übersicht der Präqualifizierten Leistung (in GW) je Primärenergieträger/Kategorie in Deutschland

Quelle: [www.regelleistung.net](http://www.regelleistung.net), 17.07.2018
Rapidly falling capacity specific investment (-14%/a) with Lithium-Ion batteries setting the benchmark

- No clear correlation of investment with increasing storage capacity
- Large investment bandwidth for comparable system size (storage capacity)
Development of Battery Power Specific Investment

Power specific Investment = Total investment per battery power (nominal power)

- Rapidly falling power specific investment (-12%/a) with Lithium-Ion batteries setting the benchmark
- Power specific investment of Lead-Acid batteries (2018) are in the same order of magnitude compared to Lithium-Ion batteries - *Lifetime*?!
Thank You for Your Attention

Contact

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Process and Systems Analysis

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Related Publications

Jahresübersicht Energiespeicher 2018
https://www.researchgate.net/publication/325226016_Energiespeicher

Pumped Hydro Power Plant Database Germany (Status April 2018):
https://www.researchgate.net/publication/325335787_Kraftwerkdatenbank_PSW_Deutschland_April_2018
Research Topics within the Process and Systems Analysis Group

Sector Coupling Team

RE- Input – Europe
Power Generation
Power flow model, Conventional power plants, Europe

Residential - Prosumption
Residential, Germany

Residential & Storage solutions

Methodical science for energy system models

Overall energy systems model – Germany

CompanyName

Software Engineering

Infrastructure analysis, Germany, Japan

Market introduction, Germany

Transport

Transport Team

Infrastructure analysis, Germany, Japan

Transport

Infrastructure analysis, Germany, Japan

Industry

Carbon Capture and Storage (CCS)

Selected paths: worldwide

Stationary Energy Systems Team

Peter Lopien

Overall energy systems model – Germany