Learnings from experience with 1 MW & 18 MW BESS operation

Michael Koller, 08.10.2019
EKZ’s experience with utility-scale BESS
Dietikon (1 MW) and Volketswil (18 MW)

- March 2012: Commissioning BESS Dietikon (Pilot with ABB)
- June 2014: Prequalification BESS Dietikon
- May 2018: Prequalification BESS Volketswil

- EKZ BESS in Dietikon first non hydro power plant in Switzerland prequalified for primary frequency regulation.
- First standalone battery in Europe to participate in frequency regulation without backup of a conventional power plant.
Storage technology costs are improving fast, and EKZ has already benefited

**Prices for Li-ion battery modules [CHF / kWh]**

- **Battery modules actual values**
- **Forecast**
- **EKZ PRL System**
- **EKZ Self-consumption system**

**Hardware integration, inverter, planning, installation & commissioning**

- **Battery modules (estimate)**

**Forecast**

- **EKZ BESS Dietikon 2011**
  - 1.1 MW – 580kWh
  - 5 years guaranteed lifetime of LG Chem
  - Project costs of about 4’310 CHF/kWh | 2’275 CHF/kW

- **EKZ BESS Volketswil 2017**
  - 18 MW – 7.5 MWh
  - 10 years guaranteed lifetime of LG Chem
  - Project costs of about 800 CHF/kWh | 335 CHF/kW
# Development of BESS technology

## Features Dietikon BESS vs. Volketswil BESS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Dietikon BESS</th>
<th>Volketswil BESS</th>
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<tbody>
<tr>
<td>Comissioning</td>
<td>2012</td>
<td>2018</td>
</tr>
<tr>
<td>Power</td>
<td>1.3 MW $\times 14$ 18 MW</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>580 kWh $\times 13$ 7.5MWh</td>
<td></td>
</tr>
<tr>
<td>System integrator</td>
<td>ABB</td>
<td>NEC</td>
</tr>
<tr>
<td>Battery manufacturer</td>
<td>LG Chem</td>
<td>LG Chem</td>
</tr>
<tr>
<td>Battery Technology</td>
<td>Li-Ion</td>
<td>Li-Ion</td>
</tr>
<tr>
<td>Lifespan</td>
<td>5 years (guaranteed)</td>
<td>$\times 2$ 10 years (guaranteed)</td>
</tr>
<tr>
<td>Project costs</td>
<td>$\approx 2.5$ MCHF (4’000 CHF/kWh) $\times 2.5$ $\approx 6$ MCHF (800 CHF/kWh)</td>
<td></td>
</tr>
<tr>
<td>Applications</td>
<td>Peak shaving</td>
<td>Frequency regulation</td>
</tr>
<tr>
<td></td>
<td>Islanded operation / microgrid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voltage control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency regulation</td>
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</tbody>
</table>
EKZ BESS systems
BESS Dietikon (1MW, 2012)
BESS Volketswil (18 MW, 2018)
System overview

3 x Battery container 7.5 MWh
6 x Step up transformer
6 x Converter 18 MVA
Primary frequency control market & operation
Long term development of the PFC price
Weekly auctions

Remuneration for reserved power (weekly auctions). No remuneration for energy delivered.
Recent PFC price developments
Price differences and daily auctions
SoC statistics for BESS Dietikon in 2015

- State of Charge (SoC) between 40.2% - 75.7% at all times
  (1.3 MW, 580 kWh storage capacity)
Operation statistics BESS Volketswil 2018 – 2019

avg: 51.7 %

avg $|P|$: 629 kW
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Performance and aging
Efficiency values BESS Dietikon

**EKZ/ABB**

<table>
<thead>
<tr>
<th>Efficiency</th>
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<tbody>
<tr>
<td>85%</td>
</tr>
<tr>
<td>85.60%</td>
</tr>
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</table>

**Enel/Siemens**

<table>
<thead>
<tr>
<th>Efficiency</th>
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</thead>
<tbody>
<tr>
<td>85%</td>
</tr>
<tr>
<td>85.37%</td>
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</tbody>
</table>

VS.

**Cycle with 50% of power and capacity incl. all auxiliary power**

## Efficiency values 18 MW BESS Volketswil

<table>
<thead>
<tr>
<th>Operation type</th>
<th>RTE*</th>
</tr>
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<tbody>
<tr>
<td>0.5 MW cycle**</td>
<td>84.56 %</td>
</tr>
<tr>
<td>3 MW cycle**</td>
<td>94.72 %</td>
</tr>
<tr>
<td>10 MW cycle**</td>
<td>91.51 %</td>
</tr>
<tr>
<td>normal PRL operation</td>
<td>~ 83 %</td>
</tr>
</tbody>
</table>

* including transformer, converter and battery losses, excluding consumption of auxiliaries
** between 20 and 100 % SOC
Aging analysis BESS Dietikon
Performed by ABB Corporate Research CH

Estimated remaining lifetime (July 2018):
~ 4 years (70% remaining capacity)
~ 1 years (80% remaining capacity)
Aging analysis BESS Dietikon
Performed by ABB Corporate Research CH
Regulation
ENTSO-E frequency regulation guidelines
Is regulation rewarding the benefits?

- Ongoing cost-benefit analysis to determine activation requirement: from 15 to up to 30 minutes. No emphasis on response times
- Additional properties specified for storage:
  - Power to PFC power ratio: 1.25
  - Energy to PFC power ratio: >30 min to 1 hour
  - Restrictions on recharging strategies

<table>
<thead>
<tr>
<th>PCR usage requirements</th>
<th>Zurich BESS strategy</th>
<th>Intra-day market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal PCR usage</td>
<td>220 kWh</td>
<td>640 kWh</td>
</tr>
<tr>
<td>Normal PCR usage + ±15 minutes full activation requirement</td>
<td>720 kWh</td>
<td>1140 kWh</td>
</tr>
<tr>
<td>Normal PCR + ±30 minutes full activation requirement</td>
<td>1220 kWh</td>
<td>1640 kWh</td>
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Source: Koller et al. in Cigré 2016.

Depending on outcome of cost-benefit analysis and regional TSO’s fine print, batteries 8x the size needed in practice might be required.
Key learnings BESS procurement
Which aspects stand out for utilities?
Learnings from 2x MW-scale BESS procurements

■ **Capacity warranty**
  - Flexible capacity warranty allowing for changes in utilization of deployed BESS, e.g. additional use cases not envisaged initially (usage dependent guaranteed capacity)
  - Temperature-independent capacity warranty (responsibility of system integrator)

■ **Availability warranty**
  - For available **power and capacity**
  - Specify availability warranties as a function of AC-sub-units

■ **Possibility for capacity extensions**

■ **Enforce multi-week trial period**
  - Time to detect and correct some initial issues (e.g. correct settings/parametrization) which are not possible to detect during commissioning tests
Conclusion
Conclusion

- **Significant improvements of BESS in the recent years** (costs, guaranteed lifespan, robustness…)

- **BESS has a proven track record for different applications.**

- **Energy storage is part of EKZ’s strategy for the energy transition**
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Thank you.