Evaluating the Business Case for BESS in the Primary Frequency Control Market

Michael Koller, Energy Storage Specialist
EKZ: Providing safe, reliable electricity

“EKZ delivers cost-effective, reliable and environmentally friendly electricity to around one million people.”

- One of the largest power providers in Switzerland
- Supplies around 10 per cent of the country’s electricity consumption
- Commitment to energy efficiency and renewable energy
- EKZ Smart Grid Lab Initiative
- Smart Grid and Energy Storage consulting services
The Zurich 1 MW BESS

Li-Ion batteries 500 kWh
Transformer
Coupling Transformer
PCS 1 MVA
Frequency reserves with the Zurich 1 MW BESS

Zurich 1 MW BESS fully certified to participate in market for primary reserves since July 2014

Outage of a Swiss nuclear power plant of 1 GW at 04:46 am UCT
Reserve requirements and market structure for primary reserves since April 7th 2015

Total market size: 783 MW
Pay-as-bid and the TSO-TSO model

The Zurich 1 MW BESS / Michael Koller, EKZ / ESWF 2015

Provider CH

Provider AT

Total requirement: 117 MW

Requirement AT: 71 MW

Requirement CH: 46 MW

Source: A. John, swissgrid.
Historical prices for primary reserves

Results from weekly tenders 2011 – 2014
### Profitability of a 5 MW BESS for primary reserves

<table>
<thead>
<tr>
<th>Location</th>
<th>EKZ Substation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BESS</td>
<td>approx. 4 MEUR</td>
</tr>
<tr>
<td>Grid connection</td>
<td>0 oder 0.6 MCHF</td>
</tr>
<tr>
<td>Construction</td>
<td>0.5 MCHF</td>
</tr>
<tr>
<td>Total CAPEX</td>
<td>4.5-5.1 MEUR</td>
</tr>
<tr>
<td>OPEX</td>
<td>0.06 MCHF/a</td>
</tr>
<tr>
<td>Revenues</td>
<td>0.9 MEUR/a, Degression 3% p.a.</td>
</tr>
<tr>
<td>Time Period</td>
<td>20 years (battery replacement after 10 yrs.)</td>
</tr>
<tr>
<td>Power</td>
<td>6 MW (5 MW primary reserves)</td>
</tr>
<tr>
<td>Capacity</td>
<td>3-4 MWh (new LFCR code?)</td>
</tr>
<tr>
<td>Pay-back</td>
<td>7.8 years</td>
</tr>
<tr>
<td>Project - IRR</td>
<td>13.3% p.a. (in EUR)</td>
</tr>
</tbody>
</table>
CAPEX analysis

- Currently unclear if grid connection fee has to be paid
- Division between PCS and batteries only indicative, system costs around 85% of total project costs
OPEX analysis

Total costs of 60 kCHF per annum

- Energy costs storage 35%
- Energy costs auxiliary systems 9%
- Unforeseen expenses 8%
- Weekly tenders 25%
- Preventive Maintenance 7%
- Corrective Maintenance 7%
- Supervision in control center 9%
- Unforeseen expenses 8%
- Total costs of 60 kCHF per annum
Energy costs from storage cycling

- Based on simulations with 1 s grid frequency in ENTSO-E Central Europe and EKZ’s smart SoC-control algorithm.
- No grid utilization fees for storage
  (in Switzerland grid utilization fees have to be paid exclusively by end-consumers of electricity)

<table>
<thead>
<tr>
<th></th>
<th>Energy [MWh p.a.]</th>
<th>Tariff [CHF/MWh]</th>
<th>Costs / Renumeration [kCHF]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy from grid / BESS charging</td>
<td>970</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>Energy to grid / BESS discharging</td>
<td>-860</td>
<td>50</td>
<td>-43</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>-</td>
<td>21</td>
</tr>
</tbody>
</table>
Regulatory developments

- Fast and accurate response of BESS not rewarded, no pay-for-performance regulation within ENTSO-E Central Europe in sight
- New network code on *Load Frequency Control Reserves (LFCR)* increases minimum provision duration capability from 15 to 30 min
- New LFCR to become binding in 2017 within European Union

Consequences

- 2x battery capacity required
- Up to 4x battery capacity required depending on the interpretation of the LFCR and the adaption of TSO’s prequalification rules
- Profitability of BESS in primary reserve market questioned / delayed
Sensitivity analysis of business case

IRR change from a variation of selected input parameters by ±10%

- OPEX
- Revenues
- CAPEX

IRR change from a variation of selected input parameters by ±100%

- OPEX
- Revenue degression p.a.
Conclusion

Business case of BESS in the central-west European market for primary frequency reserves looks promising

Two main uncertainties remain at the moment:
- Price level of primary reserves in newly formed joint market
- Adaptation of new LFCR and consequences on battery sizing
Further reading on the Zurich 1 MW BESS

European Power Systems Research – special issue on Smart Grid implementation

CIRED Workshop 2014

IEEE Power & Energy Society General Meeting 2013

IEEE PowerTech 2013, Grenoble

CIRED 2013
Thank you

Michael Koller
Energy Storage Specialist
michael.koller@ekz.ch