HOW CAN STATKRAFT BECOME "THE GREEN BATTERY" OF EUROPE?

- or contribute to ......?

Arne Sandvold
Statkraft Energi as
Power Generation Development
Environment-friendly power generation: 52.5 TWh*
- 33% of power generation in Norway
- 12% of power generation Nordic region
- 1% of power generation in Europe

Gross operating revenues 2011: NOK 22.4 billion

Total assets 2011: NOK 144 billion

3,400 employees in more than 20 countries
Supporting the power system in Europe

Due to the energy regulating capacity, Norway may support other power systems that require backup solutions and storage.

- Nordic hydro reservoirs content 121 TWh
- Norway 85 TWh (Statkraft 35 TWh)
NORWEGIAN POSSIBILITIES

Appr. 50% of total hydro reservoirs in Europe – 85 TWh

- Three alternative options:
  1. Change the operation pattern in existing plants
  2. Increase installed capacity
  3. Build pumped hydro storage in connection with existing reservoirs

Both increased capacity and pumped storage is possible where the distance to the Continent is the shortest

- Without new greenfield assets or reservoirs, but by extended use of existing
The hydrology vs energy consumption

Data for Norway

Excisting PSH in Norway developed for seasonal pumping
Scandinavian reservoirs – typical seasonal variation
Future PSH possibilities in Norway depends on:
- limitations in the change of water level in upper and lower reservoirs
- and duration for pumping / generation

The technical potential is not the main challenge!

<table>
<thead>
<tr>
<th>Change in waterlevel</th>
<th>PSP Capacity (MW)</th>
<th>Increased capacity existing plants (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>duration pumping mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td>7 days</td>
</tr>
<tr>
<td>0,5 m/hour</td>
<td>85000</td>
<td>30000</td>
</tr>
<tr>
<td>0,1 m/hour</td>
<td>30000</td>
<td>16000</td>
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<tr>
<td>0,01 m/hour</td>
<td>3200</td>
<td>3200</td>
</tr>
</tbody>
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LAKE BLÅSJØ
7.8TWH RESERVOIR

Potential upper reservoir, several possibilities
Typical lower reservoir
PSP - Environmental possibilities / challenges

- No new "greenfield assets" is needed
  - only extending existing plants / reservoirs
  - no new big releases of water into running rivers
- Statkraft R&D-projects ongoing in existing reservoirs:
  - More often limitations, but not outside existing water levels
  - More often lower levels, not only late winter / spring
  - Erosion and instability
  - Biodiversity, Local climate, Temperatures, Broken Ice etc.
- Larger release of fresh water into the fjords
- New rock caverns & tunnels – need of larger spill areas "outdoors"
- Area usage due to new interconnectors & domestic infrastructure
Interconnectors driven by price differences

Average week profile 2009 - 2011

Euro
Summary

- Large possibilities for utilizing Norwegian reservoirs and new PSH as a "European Battery"
- Existing flexibility will be utilized first
  - Requires large investments in infrastructure
- Political will for PSP, both crossborder + local?
  - Public acceptance - governing of expectations
  - Environmental solutions, taxes
- Plans for new interconnectors are modest
  - We support Statnetts plans for GER (2018) UK (2020)
  - But more is needed
- Business Case Development?
  - Future Market Design?
  - Who is the Customer / Market Place
  - Business Model (incl. interconnectors)
  - Real Case simulations and profitability evaluations
- The need for flexibility and storage will be covered by a range of technologies
  - and we can contribute
THANK YOU