Swedish nuclear power

Present status and outlook

2016-03-03
Confidentiality - None (C1)
Closure of four Swedish reactors

- Announcement April 2015 to close R1 and R2 earlier than planned
- The reason is the poor profitability
- Followed by announcement to close Oskarshamn 1 in 2017 and that Oskarshamn 2 will not start (off-line for modernisations since 2013)
- 2800 MWe nuclear will be closed
- As comparison, current Finnish nuclear capacity is 2750 MWe, Swedish is 9650 MWe (including O2)

<table>
<thead>
<tr>
<th></th>
<th>Net power</th>
<th>Commercial operation</th>
<th>Year of closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>881 MWe</td>
<td>1976-01-01</td>
<td>2020</td>
</tr>
<tr>
<td>R2</td>
<td>807 MWe</td>
<td>1975-05-01</td>
<td>2019</td>
</tr>
<tr>
<td>O1</td>
<td>473 MWe</td>
<td>1972-02-06</td>
<td>2017</td>
</tr>
<tr>
<td>O2</td>
<td>638 MWe</td>
<td>1975-01-01</td>
<td>2013</td>
</tr>
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Ringhals units 1 (left) and 2 (right)
Remaining reactors in good shape

- Reactors have been modernised over the past ten years
  - Extensive investments have been made in all units – mid-life uprates
  - To some part, investments remain, dominated by “independent core cooling” protecting against events affecting all four trains of today’s safety systems
  - Maintenance without major investments is expected for the coming 25-30 years
- Operation of F123 and R34 (and O3) until the early 2040s is – technically – fully feasible
Difficult times for electricity producers

Electricity spot prices in the Nordic countries, Germany and the Netherlands, monthly averages

- Nordic spot prices dropped 29% in 2015
  - Ongoing downward trend continued
- Electricity prices falling in all of Vattenfall's markets
- **Future prices are at a level below the production costs for major production facilities**
  - Nuclear is in trouble. Swedish hydro also affected
    - Profitability needs to improve

<table>
<thead>
<tr>
<th>Year</th>
<th>Market price €/MWh (24 February)</th>
</tr>
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<tbody>
<tr>
<td>2017</td>
<td>17,65</td>
</tr>
<tr>
<td>2018</td>
<td>17,45</td>
</tr>
<tr>
<td>2019</td>
<td>17,50</td>
</tr>
<tr>
<td>2020</td>
<td>19,02</td>
</tr>
<tr>
<td>2021</td>
<td>20,15</td>
</tr>
</tbody>
</table>
Reactors are not profitable

Swedish nuclear reactors

- **Will be closed by 2020**
- **Needs investment**
- **Closed**

**Ringhals**
- 70% Vattenfall
- 30% Uniper

**Oskarshamn**
- 54.5% Uniper
- 45.5% Fortum

**Barsebäck**
- Closed in 1999 and 2005

**Forsmark**
- 66% Vattenfall
- 22% Fortum
- 10% Uniper
- 2% Skellefteå Kraft

Costs and revenues

- **Cost**
  - 32 öre/kWh
  - 7 öre/kWh
  - 25 öre/kWh

- **Revenue**
  - 22 öre/kWh

- **Average spot price in SE3 last 12 months**
  - -31%

* Swedish nuclear capacity tax is based on installed capacity (not production volume)
Unsustainable situation

- Difficult to motivate necessary investments unless the profitability of operation is sound
  - Independent core cooling a requirement by 2020
- Major efforts to reduce production costs are under way
  - Not sufficient
- The six remaining reactors will have to close – soon
- Two potential game changers
  - Higher prices – which we don’t see in the coming years
  - Removal of the tax on installed capacity
Vattenfall’s strategic targets valid as of 2016

- Six strategic targets to year 2020 reflect Vattenfall’s strategic objectives
- The owner – the Swedish government – sets financial targets
- Security of supply is not a parameter in the steering of Vattenfall

<table>
<thead>
<tr>
<th>Strategic objectives</th>
<th>Strategic targets to 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading towards Sustainable consumption</td>
<td>1. Customer engagement, NPS (Net Promoter Score): +2 NPS relative</td>
</tr>
<tr>
<td>Leading towards Sustainable production</td>
<td>2. Commissioned renewables capacity: ≥2,300 MW</td>
</tr>
<tr>
<td></td>
<td>3. Absolute CO₂ emissions: ≤ 21 Mtonnes*</td>
</tr>
<tr>
<td>High performing operations</td>
<td>4. Return on Capital Employed: ≥ 9%</td>
</tr>
<tr>
<td>Empowered and engaged organisation</td>
<td>5. Safety as LTIF (Lost Time Injury Frequency): ≤1,25</td>
</tr>
<tr>
<td></td>
<td>6. Employee Engagement Index: ≥70%</td>
</tr>
</tbody>
</table>

*Assumes significant structural changes
Parliamentary energy commission

Upper row from the left: Mikael Odenberg (GD Svenska Kraftnät), Cecilie Tenfjord-Toftby (M), Birger Lahti (V), Lise Nordin (MP), Maria Weimer (L), Ingemar Nilsson (S), Maria Strömkvist (S), Mattias Bäckström-Johansson (SD), Bo Diczfalusy (Head of secretariat), Anton Steen (Secretary), Gunilla Andréé (Secretary) Bottom row from the left: Anne Vadasz-Nilsson (GD Energimarknadsinspektionen), Penilla Gunther (KD), Rickard Nordin (C), Ibrahim Baylan (S), Åsa Westlund (S), Erik Brandsma (GD Energimyndigheten), Lars Hjälmered (M)

- All parties in parliament are represented
- Three heads of authorities
- Headed by the minister of energy
- Aims at broad agreement on the energy policy 2025-2050 (focus on electricity)
- Strong focus on Sweden, limited discussions on consequences in other countries
- Report due 2017-01-01
Vattenfall’s vision is to be a dedicated partner to its customers and society at large, providing convenient and innovative energy solutions. Vattenfall aims to be a leader in sustainable production, ensuring reliable and cost-efficient energy supply. Vattenfall is committed to be climate neutral by 2050.

We call this *Energy You Want*
### Selected key actions

<table>
<thead>
<tr>
<th>Group-wide</th>
<th>BA specific</th>
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<tbody>
<tr>
<td>Increase customer centricity</td>
<td>Grow in digitalized customer businesses</td>
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<tr>
<td>Actively pursue partnering</td>
<td>Capture value in new energy markets</td>
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<tr>
<td>Promote a sustainable energy market design</td>
<td>Develop community partnerships</td>
</tr>
<tr>
<td>Divest lignite</td>
<td>Secure nuclear and invest in hydro flexibility</td>
</tr>
</tbody>
</table>
Friday night in the Nordic

Friday 26/2 20.00
Helsinki -2°C
Stockholm -1°C
Oslo -1°C
Copenhagen +3°C
Swedish production Friday night 2016-02-26

- **Sverige**: 7633 MW
- **Danmark**: 1635 MW
- **Norge**: 634 MW
- **Finland**: 1280 MW
- **Estland**: 11996 MW

**Total production**: 23178 MW
**Total consumption**: 20534 MW
**Exporters**: 2644 MW

**Kärnkraft**: 32.9%
**Värmekraft**: 7.1%
**Ospecificerat**: 2.7%
**Vindkraft**: 5.5%
**Vattenkraft**: 51.8%
Finnish production Friday night 2016-02-26

<table>
<thead>
<tr>
<th>Sverige</th>
<th>Danmark</th>
<th>Norge</th>
<th>Finland</th>
<th>Estland</th>
<th>Lettland</th>
<th>Litauen</th>
<th>Totalt</th>
</tr>
</thead>
</table>

**Diagram:**

- **Kärnkraft:** 2776 MW
- **Värmekraft:** 3860 MW
- **Ospecificerat:** 136 MW
- **Vindkraft:** 342 MW
- **Vattenkraft:** 2310 MW

**Data for:** 2016-02-26

**Total production:** 9424 MW

**Total consumption:** 11634 MW

**Importers:** 2211 MW

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Swedish nuclear power | Torbjörn Wahlborg | 2016-03-03