IV GENERATION NUCLEAR POWER PLANT IN THE INTEGRATED NORDIC POWER MARKET

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28.01.2020
BACKGROUND

- Electricity produced in Europe is mainly affected by the climate commitments

- Several trends in the Estonian power system motivate the need for new investments in zero or low-carbon generation capacity
  - Gradual market-based phase-out of oil shale
  - Greatly increased carbon price

- IV generation nuclear power plant opens a new opportunity for Estonia, due to their much smaller size and overnight investment cost compared to the existing ones
PURPOSE OF THE STUDY

- Investigate the competitiveness of an NPP in the regional electricity market in 2030-2040, taking into account regional security of supply and climate policy objectives.

- The functioning of the electricity market and the behavior of the NPP in the market was analyzed with different future scenarios focusing on the following market outputs:
  - the impact of the NPP on the regional electricity market
  - revenue from electricity production
  - operational costs
METHODOLOGY

- IRR and NPV for financial feasibility assessment
- Balmorel market model
  - Power system analysis and NPP revenue assessment
  - Balmorel is a partial equilibrium model for analysing the electricity and combined heat and power sectors in an international perspective
- Balmorel advantages:
  - Large user base
  - Open source (the code can be verified and updated);
  - Several international and local studies: BENTE, Flex4RES, ENMAK etc.
STUDIED SCENARIOS

Base scenarios
- Sustainable Development (SD)
  - high carbon prices
  - lower fossil fuel prices
- Current Policies (CP)
  - low carbon prices
  - higher fossil fuel prices

NPP scenarios
- 300 MW NPP
- 300 MW NPP with 300 MW storage
**MAIN ASSUMPTIONS**

- Generation portfolio data from the Flex4RES Project
- Technology data and prices from the Danish Energy Agency, “Technology data for generation of Electricity and District Heating”
- Commodity and carbon prices from IEA’s World WEO2018 (Current policies and Sustainable development)
- Transmission capacities from ENTSO-E TYNDP 2018
- NPP investment and operational costs from Fermi Energia OÜ

**Forecast of carbon and fuel prices in the baseline scenarios**
MODELLING RESULTS – SYSTEM DEVELOPMENT

- Fossil vs wind
RESULTS - ESTONIAN POWER BALANCE

![Diagram showing the electricity balance from 2030 to 2040 for Current Policies and Sustainable Development. The green bars represent sustainable development, while the blue bars represent current policies. The years 2030, 2032, 2034, 2036, 2038, and 2040 are shown along the x-axis, with the electricity balance in GWh on the y-axis.]
RESULTS – SPOT PRICES IN ESTONIA

- Annual average prices:
  - 43-56 €/MWh (CP)
  - 48-60 €/MWh (SD)
RESULTS - ANNUAL POWER GENERATION IN ESTONIA

- Wind vs NPP
- Storage allows more wind
RESULTS - ESTONIAN POWER BALANCE WITH NPP

![Chart showing electricity balance from 2030 to 2040 with different scenarios: CP+NPP, CP+NPP+STO, SD+NPP, SD+NPP+STO.](chart.png)
RESULTS - NPP REVENUES FROM THE DAY-AHEAD POWER MARKET

[Graph showing earnings for different scenarios and years]
**CONCLUSION OF THE FINANCIAL ANALYSIS**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>IRR (%)</th>
<th>NPV (M€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>12,0%</td>
<td>124</td>
</tr>
<tr>
<td>CP with storage</td>
<td>10,2%</td>
<td>13</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td><strong>14,7%</strong></td>
<td><strong>250</strong></td>
</tr>
<tr>
<td>SD with storage</td>
<td>13,5%</td>
<td>236</td>
</tr>
</tbody>
</table>
SENSITIVITY OF NPP NPV
CONCLUSION

- NPP ensures Estonia’s position as a net exporter
- NPP has an impact on local security of supply and available capacities
- A more renewable future allows more opportunities for storage and storage enables more renewable energy
- The IRR and NPV show feasible financial result for NPP project
- Storage generates more revenues but does not pay in day-ahead market
- Further revenues could be generated through system services
THANK YOU FOR YOUR ATTENTION!

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