Energy systems
Quantitative analysis of the NordPool electricity system

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Sintef Energy Research

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   - Outline
   - Methodology

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   - Area model
   - Production capacities, 2020

3. Simulation results
   - Hydropower
   - Thermal production
   - Energy balance
   - CO$_2$-emissions

4. Summary and concluding remarks
Outline

- Methodology
- Electricity system model in 2020
- Results
  - Hydropower, inflow, production and reservoir handling
  - Thermal power, production
  - Energy balance
  - $CO_2$ emissions
Analysis methodology

- Simulate operation of the NordPool electricity system with three climatic scenarios
- EMPS-model
  - Water-values and simulation
- Climatic scenarios
  - Reference, Echam, Hadam
  - Data provided by NVE, SMHI and SYKE
- Electricity system model in 2020
  - Predictions made by Eurelectric and Statnett
- Fuel costs in 2020
  - Data provided by EA energy analyses
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4. Summary and concluding remarks
Area model, 2020
Production capacities in 2020

<table>
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<th>Country</th>
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<th>Thermal</th>
<th>Hydro</th>
<th>Wind</th>
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</table>
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4 Summary and concluding remarks
Annual average inflow over the year, GWh

**Norway**

**Sweden**

**Finland**

- **Inflow, GWh**

- **Week**

- **Reference**
- **Echam**
- **Hadam**
Average annual inflow, TWh/year

![Bar chart showing average annual inflow for different regions with winter and summer inflow categorized.](chart.png)
Annual average reservoir level over the year, GWh

Norway

Sweden

Finland

Reservoir level, GWh

Week

Reference

Echam

Hadam
Annual average hydropower production over the year, GWh

Norway

Sweden

Finland

Hydropower production, GWh

Week

Reference — Echam — Hadam
Annual average hydropower production, GWh

- Norway
- Sweden
- Finland

- Winter
- Summer
Average annual thermal production, TWh/year

![Bar chart showing thermal production for different regions and seasons](chart.png)
Average annual energy balance

![Average annual energy balance chart](chart.png)

- **Hydropower**
- **Thermal production**
- **Energy balance**
- **CO\(_2\)-emissions**
CO$_2$-emissions in the NordPool region

![CO$_2$-emissions graph]

- **Norway**
  - Reference: 1 million CO$_2$-equivalents
  - Echam: 2 million CO$_2$-equivalents
  - Hadam: 3 million CO$_2$-equivalents

- **Sweden**
  - Reference: 4 million CO$_2$-equivalents
  - Echam: 5 million CO$_2$-equivalents
  - Hadam: 6 million CO$_2$-equivalents

- **Finland**
  - Reference: 10 million CO$_2$-equivalents
  - Echam: 11 million CO$_2$-equivalents
  - Hadam: 12 million CO$_2$-equivalents

- **Denmark**
  - Reference: 25 million CO$_2$-equivalents
  - Echam: 27 million CO$_2$-equivalents
  - Hadam: 29 million CO$_2$-equivalents
$CO_2$-emissions adjusted for import and export

![Graph showing $CO_2$-emissions adjusted for import and export]
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   • \( CO_2 \)-emissions

4 Summary and concluding remarks
Average annual characteristics for the NordPool area

- Inflow
- Reservoir level
- Hydro production

Legend:
- Reference
- Echam
- Hadam
Average annual energy balance, NordPool

![Chart showing average annual energy balance for NordPool, comparing Reference, Echam, and Hadam models. The chart indicates contributions from Wind, Thermal, Hydro, and Demand categories.]
• Average annual inflow increase with 12-13 %
• More inflow during winter, less or unchanged during summer
• Higher temperatures causes demand to decrease with 2-3 %
• Thermal production is substituted by hydro production
• Less imports from and more export to continental Europe
• $CO_2$ emissions decrease with 25 (57) %