Economic and Climate Effects of Increased Integration of the Nordic and German Electricity Systems

Distributional Effects of System Integration and Qualitative Discussion of Implications for Stakeholders

Jonas Egerer, Alexander Zerrahn, and Prof. Christian von Hirschhausen
Berlin, 11.06.2015
Introduction: Main findings of qualitative part

Distributional Effects of System Integration and Qualitative Discussion of Implications for Stakeholders

Main finding #1

- System integration yields positive total benefits in the energy-only market
- System integration results in an uneven distribution of benefits
- Distributional effects can be several times higher for consumers & producers
- Development of additional wind and hydro power in Norway and Sweden:
  - Strong depression of prices (merit order effect)
  - Interconnectors are mainly used for increased export from the Nordics to Germany
Distributional Effects of System Integration and Qualitative Discussion of Implications for Stakeholders

Main finding #2

- Cross-border allocation of network investment costs could provide incentives for countries without direct benefits

- Challenge to decide on
  - Mechanism for cost allocation (ex-ante negotiations / ex-post allocation)
  - Projects of cross-border significance or national network enforcement

- National electricity prices and tariffs vary by industry versus small consumer
  - Energy-intensive industry benefits from renewables and weak interconnection
  - Current price composition benefits energy-intensive industry
Distributional effects with additional system integration

1. Additional interconnection results in benefits on national level
   • Welfare effects (consumer, producer and network rents)
   • Reduction in national power plant capacity

2. Convergence in market prices causes distributional effects
   • Distributional effects are substantially higher than national benefits
   • In the Nordics producers gain and consumers lose and vice versa in Germany
Qualitative Part: Distributional effects and national benefits

- National benefits of integration increase from 70 to 238 mn EUR/year

**Moderate RES scenario**
- Norway, Sweden and Germany benefit from trade gains in the energy-only market

**High RES scenario**
- Norway and Sweden benefit from trade gains in the energy-only market
- Finland and Germany mainly by lower conventional capacity (capital and fixed costs)

- Denmark as transit country does not benefit

<table>
<thead>
<tr>
<th></th>
<th>Norway</th>
<th>Sweden</th>
<th>Finland</th>
<th>Denmark</th>
<th>Germany</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate RES</strong></td>
<td>[mn EUR]</td>
<td>+35</td>
<td>+14</td>
<td>+12</td>
<td>-7</td>
<td>+18</td>
</tr>
<tr>
<td><strong>High RES</strong></td>
<td>[mn EUR]</td>
<td>+53</td>
<td>+56</td>
<td>+69</td>
<td>0</td>
<td>+59</td>
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</tbody>
</table>
Qualitative Part: Distributional effects and price effects across countries

- Price effect of integration higher for Norway and Denmark in high RES
- Finland sees reverse effect (lower prices of integration) for high RES
- Wind power profits more than average

![Bar charts showing price effects across countries for moderate and high renewable scenarios.](chart.png)
• **Strongest effect in the Nordic countries (200-350 mn EUR)**
• **Wind power producers gain in all countries**
• **Effects in Germany are somewhat limited**

<table>
<thead>
<tr>
<th>Change in stakeholder rent [mn EUR/year]</th>
<th>Norway</th>
<th>Sweden</th>
<th>Finland</th>
<th>Denmark</th>
<th>Germany</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion rent</td>
<td>-128</td>
<td>-9</td>
<td>-1</td>
<td>-17</td>
<td>-10</td>
<td>-165</td>
</tr>
<tr>
<td>Consumers</td>
<td>-233</td>
<td>-250</td>
<td>-219</td>
<td>-63</td>
<td>91</td>
<td>-673</td>
</tr>
<tr>
<td>Hydro power</td>
<td>336</td>
<td>92</td>
<td>28</td>
<td>0</td>
<td>-4</td>
<td>452</td>
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<tr>
<td>Photovoltaic</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>-5</td>
<td>-4</td>
</tr>
<tr>
<td>Wind power</td>
<td>59</td>
<td>49</td>
<td>29</td>
<td>55</td>
<td>13</td>
<td>204</td>
</tr>
<tr>
<td>Biomass</td>
<td>0</td>
<td>27</td>
<td>34</td>
<td>15</td>
<td>-12</td>
<td>64</td>
</tr>
<tr>
<td>Conventional</td>
<td>1</td>
<td>103</td>
<td>128</td>
<td>5</td>
<td>-50</td>
<td>188</td>
</tr>
<tr>
<td>Total country</td>
<td>35</td>
<td>12</td>
<td>-1</td>
<td>-5</td>
<td>34</td>
<td>75</td>
</tr>
</tbody>
</table>

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Qualitative Part: Distributional effects across stakeholders – high RES scenario

- Same effects in high RES scenario, except for Finland
- Redistribution increases primarily in Norway, Sweden and Denmark
- Additional exports from the Nordics mitigates merit order effect
Exposure of residential consumers to price changes

- Electricity demand of small consumers varies between countries
- Correlation of demand and electricity prices
- Main difference in price composition: taxes and levies

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<tbody>
<tr>
<td>Year</td>
<td>2012</td>
<td>2012</td>
<td>2013</td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>Residential demand [GWh]</td>
<td>38,573</td>
<td>35,086</td>
<td>21,510</td>
<td>14,285</td>
<td>138,400</td>
</tr>
<tr>
<td>Average consumption [kWh/capita]</td>
<td>7,736</td>
<td>3,672</td>
<td>3,946</td>
<td>2,560</td>
<td>1,719</td>
</tr>
</tbody>
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<tr>
<td>Energy and supply [cent/kWh]</td>
<td>5.22</td>
<td>5.65</td>
<td>6.03</td>
<td>4.83</td>
<td>8.66</td>
</tr>
<tr>
<td>Network tariff [cent/kWh]</td>
<td>7.57</td>
<td>7.56</td>
<td>4.84</td>
<td>7.66</td>
<td>6.23</td>
</tr>
<tr>
<td>Total [cent/kWh]</td>
<td>17.78</td>
<td>20.46</td>
<td>15.59</td>
<td>29.35</td>
<td>29.21</td>
</tr>
</tbody>
</table>
Exposure of large industrial consumers to price changes

- Energy price is significant component
- Recent price development: Lower electricity prices in energy-only market in Germany due to renewables and merit order effect
- Network costs and taxes very modest compared to small industrial, services or residential

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<td>3.57</td>
<td>4.49</td>
<td>4.71</td>
<td>3.93</td>
<td>4.91</td>
</tr>
<tr>
<td>Network costs</td>
<td>0.60</td>
<td>0.74</td>
<td>0.57</td>
<td>3.83</td>
<td>1.30</td>
</tr>
<tr>
<td>Taxes and levies</td>
<td>0.14</td>
<td>0.01</td>
<td>0.70</td>
<td>0.90</td>
<td>3.50</td>
</tr>
<tr>
<td>Total</td>
<td>5.61</td>
<td>5.29</td>
<td>5.98</td>
<td>8.66</td>
<td>9.71</td>
</tr>
</tbody>
</table>

- Some sectors in the Nordic countries especially electricity-intensive
  - Pulp and paper (Sweden, Finland), basic metals (Norway, Sweden, Finland)
  - Sectors do not stick out in terms of employment and turnover
  - Mitigation options, although somewhat limited

[1] Additional exemptions exist for companies exposed to international competition. For individual firms, taxes and levies can be significantly lower.
Qualitative Part: Cross-border network development

Challenge: Uneven allocation of benefits from system integration

National-strategic incentives for integration

- Network costs are primarily recovered by national tariffs
- Congestion rents on interconnectors can recover some costs
- Additional congestion rents do not pay for interconnectors

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<th>Moderate Renewable scenario</th>
<th>High Renewable scenario</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Graph of internal rents and cross-border rents" /></td>
<td><img src="image2.png" alt="Graph of internal rents and cross-border rents" /></td>
</tr>
</tbody>
</table>
Qualitative Part: Cross-border network development

National and regional perspectives on network development

Cost-benefit allocation of network investment

• Inter-TSO compensation mechanism does not address long run marginal costs (ex-post calculation from market results)

Current investments

• Bilateral projects between TSOs (Nord.Link, NSN)
• Projects of Common Interest for trans-European energy infrastructure
  • Identified by contribution to the integration of national electricity system and system benefits (security of supply, competition and RES integration)
  • Benefit from accelerated planning, increased visibility, financial support from Connecting Europe Facility
  • Currently four PCI projects in Nordic-German region (DE - DK, DE - NO)
Summary

• System integration yields positive total benefits in the energy-only market

• System integration results in an uneven distribution of benefits

• Distributional effects can be several times higher for consumers & producers

• Cross-border allocation of network investment costs could provide incentives for countries without direct benefits

• National electricity prices and tariffs vary by consumer groups, i.e. large and small industries and residential
Vielen Dank für Ihre Aufmerksamkeit.
Backup: Congestion management and price zones

Different scenarios for splitting the German-Austrian bidding zone
Backup: Congestion management and price zones

- Many uncertain parameters
  - Number and size of bidding zones
  - Progress in internal (north-south) line enforcement in Germany
  - Inter-zonal NTCs vary on hourly basis
- Zonal electricity prices deviate in hours of binding trade constraints
- Effect on price/scarcity signals at borders and change in trade flow between German and the Nordic bidding zones

- Implications on benefits and distributional results
- Price zones alter the incentive for additional cross-border lines