100% renewable energy systems
Wind Power and Current Market Structures: Theoretically

Figure 4. Principle chart: The possible economic suicide of wind power, or the merit order effect (Hvelplund et al., 2013).
Wind Power and Current Market Structures: Empirically

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Wind Power and Current Market Structures

To what extent can wind power be sustained through demand side initiatives, given the current market structures?

Our expectation: It is not enough to sustain current market structures in a 100% renewable energy system.
Research question?

"Is the current market structure able to sustain the private economy of wind power in a 100% renewable energy system?"
Methods

1) Analysing a 100% renewable smart energy system
2) Identify the marginal producing unit in each hour
3) Identify the marginal cost in each hour
4) Summarize cost and earning
5) Calculate private return to capital for wind power investors
Using IDA Smart Energy Vision to represent the energy system

Assumption is a fully connected energy system

Uses technical simulation to create a balanced system
Scenarios

The marginal price is based on fuel costs:
1) Low fuel costs
2) Medium fuel costs
3) High fuel costs

Two technology cost scenarios:
1) 2015 prices
2) 2050 prices
Key figures

Renewable Capacity

• 5000 MW onshore Wind
  – 16.2 TWh annual production
  – Payment in 55% of the hours

• 14000 MW offshore wind
  – 63.76 TWh annual production
  – Payment in 55% of the hours
### Key figures

#### Marginal production prices (EUR/MWh)

<table>
<thead>
<tr>
<th></th>
<th>Low fuel costs</th>
<th>Medium fuel costs</th>
<th>High fuel costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running power plant</td>
<td>52</td>
<td>66</td>
<td>79</td>
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<tr>
<td>Running central CHP</td>
<td>44</td>
<td>59</td>
<td>68</td>
</tr>
<tr>
<td>Running decentral CHP</td>
<td>49</td>
<td>64</td>
<td>73</td>
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</table>

#### Investment and O&M costs

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<tbody>
<tr>
<td>2015 prices</td>
<td>1.07</td>
<td>173</td>
<td>2.46</td>
<td>1 076</td>
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<tr>
<td>2050 prices</td>
<td>0.83</td>
<td>140</td>
<td>1.39</td>
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## Results

### Offshore Wind

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<tr>
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<th>Low fuel costs</th>
<th>Medium fuel costs</th>
<th>High fuel costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 prices</td>
<td>N/A</td>
<td>N/A</td>
<td>-11%</td>
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<tr>
<td>2050 prices</td>
<td>-5%</td>
<td>-2%</td>
<td>0%</td>
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### Onshore Wind

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<th>High fuel costs</th>
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</thead>
<tbody>
<tr>
<td>2015 prices</td>
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<td>-12%</td>
<td>-7%</td>
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<tr>
<td>2050 prices</td>
<td>-10%</td>
<td>-4%</td>
<td>-2%</td>
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</table>
Conclusions

• The internal rate of return does not suggest any feasible private investments

• This is in a system with large amount of system integration

• We need to consider how to make private investments feasible