Support schemes and risk premiums for renewable energy technologies

Morthorst, Poul Erik; Grenaa Jensen, Stine

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Support Schemes and Risk Premiums for Renewable Energy Technologies

Poul Erik Morthorst, Risø DTU
Stine Grenaa Jensen, Danish Energy Association

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Offshore Wind Power Development

2008

- Denmark: 409 MW (28%)
- UK: 591 MW (40%)
- Netherlands: 247 MW (17%)
- Sweden: 133 MW (9%)
- Rest: 91 MW (6%)

1500 MW
Offshore Wind Power Development

2008

- UK: 591 MW (40%)
- Sweden: 3312 MW (23%)
- Germany: 10927 MW (29%)
- Denmark: 1276 MW (10%)
- Rest: 91 MW (6%)
- Other: 3877 MW (10%)
- Total: 1500 MW

Planned 2015

- UK: 8755 MW (23%)
- Germany: 10927 MW (29%)
- Sweden: 3312 MW (9%)
- Denmark: 3312 MW (9%)
- Norway: 1553 MW (4%)
- Ireland: 1603 MW (4%)
- Finland: 1330 MW (4%)
- Spain: 1976 MW (5%)
- Netherlands: 2833 MW (8%)
- Rest: 37440 MW (10%)
- Total: 37440 MW
Offshore Wind Farms – Built and Planned

Offshore Wind Farms – Built and Planned

purple = (built small wind turbines), blue = (under construction), grey = (planned)
Offshore Wind Power Development

2008

1500 MW

Planned 2015

37440 MW

Germany
10927 MW
29%

UK
8755 MW
23%

Netherlands
2833 MW
8%

Sweden
3312 MW
9%

Norway
1553 MW
4%

Ireland
1603 MW
4%

Finland
1330 MW
4%

Denmark
1276 MW
4%

Rest
3877 MW
10%

Rest
91 MW
6%

Rest
591 MW
40%

UK
591 MW
40%

Spain
1976 MW
5%

1976 MW
5%

1500 MW

1500 MW

1500 MW
Offshore Wind Power Development

2008

- UK 591 MW (40%)
- Rest 151 MW (6%)

Planned 2015

- Germany 10927 MW (29%)
- UK 8755 MW (23%)
- Netherlands 2833 MW (8%)
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- Spain 1976 MW (5%)
- Denmark 1276 MW (4%)
- Ireland 1603 MW (4%)
- Finland 1330 MW (4%)
- Rest 3877 MW (10%)

Technological Risk has shown to be much higher than expected

- Problems with gearboxes, transformers...
- Operation and maintenance more costly
- Availability
Risk and Uncertainty

- **Technological Risk**
  - Investment Costs
  - Maintenance Costs
  - Production
  - Availability
  - Lifetime

- **Regulatory Risk**
  - Support Levels
  - Market design

- **Market Risk**
  - Power price
  - Competition
  - Fuel prices
  - ....
Experiences until now with Offshore wind power production

Corrected for energy content in wind on land
Risk and Uncertainty

• **Technological Risk**
  - Investment Costs
  - Maintenance Costs
  - Production
  - Availability
  - Lifetime

• **Regulatory Risk**
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• **Market Risk**
  - Power price
  - Competition
  - Fuel prices
  - ....
Risk and Uncertainty

NPV

- Market design
- Performance
- Support mechanisms
- Environmental regulation

- Fuel price risk
- Competition
- Power prices
- Demand
- Fuel supply

Uncertainty in Return of Investment
Risk and Uncertainty

Ex ante optimisation

- Market design
- Performance
- Support mechanisms
- Environmental regulation

Regulatory

RISK

Technological

- Investment costs
- Availability
- Lifetime
- Performance
- Maintenance costs
- ...

Market

- Fuel price risk
- Competition
- Power prices
- Demand
- Fuel supply
- ...

Uncertainty in Return of Investment

NPV

10% - 8% - 6% - 4% - 2% - 0%
Ex ante optimisation

- **Technological Risk**
  - Investment Costs
  - Maintenance Costs
  - Production
  - Availability
  - Lifetime

- **Regulatory Risk**
  - Support Levels
  - Market design

- **Market Risk**
  - Power price
  - Competition
  - Fuel prices
  - ....
- Market design
- **Market Risk**
  - Power price
  - Competition
  - Fuel prices
  - .....

Oilprice

- Technological Risk – Investment Costs
- Maintenance Costs
- Production - Availability
- Regulatory Risk – Support Levels
- Market design
- Market Risk
  - Power price
  - Competition
  - Fuel prices
  - .....

$/bbl

Market Risk

• Power price
• Competition
• Fuel price
• ....

- Market Risk

- Regulatory Risk

- Technological Risk

- Investment Costs
- Maintenance Costs
- Production - Availability
- Lifetime

Oil price

$/bbl


- Power price
- CO2 - 25€/t
- Basic

Natural gas
(40$/bbl)
Natural gas
(60$/bbl)
Natural gas
(120$/bbl)
Wind
Power - coastal site
Wind
Power - inland site

€/MWh

0 10 20 30 40 50 60 70 80 90 100

Regulation costs
CO2 - 25€/t
Basic
Ex ante optimisation

- Technological Risk
  - Investment Costs
  - Maintenance Costs
  - Production
  - Availability
  - Lifetime

- Regulatory Risk
  - Support Levels
  - Market design

- Market Risk
  - Power price
  - Competition
  - Fuel prices
  - ....
Ex-post optimisation

- **Technological Risk**
  - Investment Costs
  - Maintenance Costs
  - Production
  - Availability
  - Lifetime

- **Regulatory Risk**
  - Support Levels
  - Market design

- **Market Risk**
  - Power price
  - Competition
  - Fuel prices
  - ....
Ex post

When the turbine is established the sum of Risks is (almost) constant

- But we can pay somebody else to bear the risk for us
  - We can hedge the power price
  - We can agree on a prepaid service contract
  - We can buy a production warranty

- ... and, of course, some companies are more suited than others for taking risks
Comparison of two support systems:
- A premium system and a fixed feed-in system
- Two actors: The private investor and the state

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Power price (average)</td>
<td>50 €/MWh</td>
</tr>
<tr>
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<td>5 €/MWh (10 %)</td>
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<tr>
<td>Fixed feed-in</td>
<td>84 €/MWh</td>
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<tr>
<td>Duration</td>
<td>44,000 Full Load Hours</td>
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<tr>
<td>Discount rate</td>
<td>6 %</td>
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<td>Production</td>
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Development of Power Price
Development of Power Price
Comparison of two support systems:
- A premium system
- A fixed feed-in system

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<th>Feature</th>
<th>Premium System</th>
<th>Fixed Feed-in</th>
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Premium Feed-in

Support financed by the State - Premium

10,000 Trials
Frequency View
10,000 Displayed

Probability

Euro/MWh

Certainty: 100.00 %
Premium Feed-in

Support financed by the State - Premium

Income pr MWh - Premium
Fixed Feed-in
Fixed Feed-in

![Histogram of Support financed by the State - fixed](image1)

![Histogram of Income per MWh - Fixed](image2)
Risk for the State and the turbine owner

<table>
<thead>
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<th>Support</th>
<th>State</th>
<th>Turbine</th>
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<tbody>
<tr>
<td>Premium</td>
<td>0</td>
<td>3.42</td>
</tr>
<tr>
<td>Fixed</td>
<td>2.78</td>
<td>0.64</td>
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</tbody>
</table>
Correlation between Price and Support

Power Price (€/MWh)

- Investor
- State
- Feed-in
- Premium

- Turbine income-Fixed
- State expenditure-Fixed
- Turbine income-Premium
- State expenditure-Premium

Incorporating feed-in premiums, the correlation between price and support is depicted, illustrating how investor and state expenditure converge as price increases.

Risø DTU, Technical University of Denmark

Poul Erik Morthorst
Conclusions

• After the turbine is established the sum of risks is constant
  – But some companies/organisations might be better suited to bear the risk

• A premium system might for the private investor have a five-fold higher risk than a feed-in system
  – The state bears a high risk in the feed-in scheme

• If the state bears part of the risk this might imply a lower risk premium for society at large