COMMERCIAL COST-BENEFIT ANALYSIS OF DOGGER BANK WINDFARM

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• All analysis and conclusions are solely the responsibility of the authors.
Case analysis Dogger Bank

- The largest offshore windfarm project in the world
- Plans to generate 5% of UK electricity production
- An average strike price of GBP 40.96/MWh (in 2012 terms)
  - CfD, Contracts for Difference, UK government guarantees a fixed electricity price for the first 15 years
- Owned by Equinor (40%), SSE Renewables (40%) and ENI (20%)
- SSE is development operator and Equinor is operations operator
- Estimated Capex of 9 billion GBP
  - Investment started in 2020
- Planned capacity of 3.6 GW
- Depth 20-35 m, 130-190 km from shore
- 13 and possibly 14 MW GE wind turbine generators
  - Several hundreds
Project reference group

• Wind turbine industry researchers at the University of Århus
• Equinor
• Researchers at NHH, NMBU, NTNU and Norce
• Industry specialists
  • Supplier industry, utilities and oil industry
Project assumptions

• Discount rates
  • Fixed price period
    • 5.9% nominal
  • Uncertain price period
    • 8.5% nominal

• Project duration
  • 25 years

• Electricity price
  • The fixed CfD-price is GBP 45.83 for DBA and GBP 48.09, in 2020-terms
  • For 2038-2050 we use the average of the last three years in Denmark (38.96 GBP/MWh) and similar for the UK (71.86 GBP/MWh); and multiply by 0.9, an intermittency wind power discount
    • Denmark has a higher share of offshore wind, and UK is moving in this direction
    • Intermittent wind production over-weighted in periods of low electricity price (cannibalisation)

• Opex
  • 25% of capex, in NPV terms

• Decommissioning cost
  • 25% of Capex, nominal

• Capacity factor
  • 55%
Project economics calculation

- IRR total capital 5.6% nominal
  - 6% nominal before tax
- NPV -970
- Payback time 17 years
### IRR sensitivity

<table>
<thead>
<tr>
<th>Factor</th>
<th>Negative scenario</th>
<th>Positive scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capex +- 15%</td>
<td>4.2%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Capacity factor +- 5</td>
<td>4.4%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Project duration +- 5</td>
<td>4.1%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Price after 2037 +- 20%</td>
<td>4.6%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Opex +- 20%</td>
<td>5.1%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

**IRR sensitivity (baseline 5.6%)**
Sensitivities, IRR change

IRR sensitivity

- Shorter/longer life scenario
- Capex + 15%
- Opex + 20%
- Price after 2037 + 20%
- Capacity factor + 5%
Sensitivities are not symmetric

• Cost overruns more likely than cost cuts
  • Average cost overrun 9.6 % for offshore wind
  • Benefits from going from 12MW to 13/14 MW turbine?

• Reduction in electricity price more likely than an increase?
  • UK has plans for 300% increase in offshore wind capacity by 2030 and an 1000% increase by 2050
  • Neighbouring countries increases capacity
    • Capacity increases faster than increased demand and enhanced system flexibility?
    • Higher demand contingent on lower electricity price?

• The everything-else-equal assumption not likely for increased project duration?
  • Contingent on increased investment and operating cost?