Investment risks in a decarbonising electricity market

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Investment challenges

• Uncertain carbon prices lead to investment risk
  – Demand, fuel prices, policy, technology cost & performance

• During decarbonisation, electricity price may drop
  – Increasing penetration of low marginal cost generation plant creates downward pressure on electricity prices

• Unpromising investment conditions
  – Drop in electricity demand – overcapacity in UK, EU
  – Financial markets under pressure, banks & utilities attempting to de-leverage
  – Political focus on high energy costs for consumers
UK policy response: Electricity market reform

- Carbon price floor

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<th>Confirmed</th>
<th>Indicative</th>
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<td>2017-18</td>
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- Feed-in tariffs for nuclear & renewables
  - Contracts to pay the difference between an agreed strike price and the market price of electricity

- Capacity mechanism
  - Payment to plant (& flexible demand) for being available
  - Move away from energy-only markets, government decides how much capacity on system

- Emissions performance standard
  - 450g/kWh, regulatory back-stop to prevent new unabated coal
Low-C generation support levels in UK

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<td>Anaerobic Digestion (with or without CHP)</td>
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<td>Biomass Conversion</td>
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Modelling Exercise

• Model development undertaken for EPRI
• Project aims:
  – Quantify investment risks through stochastic modelling, including impact of structural changes during decarbonisation
  – Look at system-wide impacts of investment risk
  – Take account for imperfect market pricing (ability of companies to raise prices above SRMC)
  – Identify likely trajectories for policy support
Model Structure

EU long-term expansion planning model (stochastic)

UK long-term expansion planning model (stochastic)

Market structure + real options analysis – long-run price risk

UK agent-based model of price formation

Price mark-up in imperfect markets

Stochastic Inputs:
• Carbon constraints
• Fuel prices
• Technology costs & performance
• Demand profiles
• Etc.

UK short-run electricity market price model (stochastic)

Long-run + short-run risk

Short-run electricity price risk

C-price

C-price

C-price
1. LONG-RUN OPTIMISATION MODEL
Structure of electricity system is stochastic

EU mix under ‘central’ carbon cap

Projection year

Gas price: annual escalator
Testing climate policy approaches
“A rising tide lifts all boats”

- Low-carbon tech A
- Low-carbon tech B

Generation costs reduce over time due to learning and economies of scale

‘cost gap’ shrinks over time, implying reducing need for policy support

Market price for electricity + carbon rises over time

€/MWh

Time
Gap between cost of generation and system short-run marginal cost

Weak Cap (1.74% pa)  Strong Cap (3.5% pa)  Full Decarbonisation

Gas

Nuclear

Offshore Wind
2. SHORT-RUN PRICE RISK MODEL
Impact of low-carbon generation on prices & investment returns

Coverage ratio = net operational earnings / financing costs

Replacing coal with wind

Replacing coal with nuclear

Successive GW of coal replaced with low-carbon sources on an energy like-for-like basis

Investment criterion used in model: 95% chance that coverage ratio is above 1.2
COMBINING SHORT-RUN AND LONG-RUN RISK
## Estimating total investment risk

<table>
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<tr>
<th>Long-run risk premium</th>
<th>+</th>
<th>Short-run risk premium</th>
<th>=</th>
<th>Total risk premium</th>
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<td>(price mark-up required to overcome real option value)</td>
<td></td>
<td>(price mark-up required to overcome capital coverage investment hurdle)</td>
<td></td>
<td>(price mark-up required to overcome risk premia and incentivise immediate investment)</td>
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- Evolution of risk premia over time
- Impact on risk premia of a 5-year or 10-year investment hiatus
Price mark-ups required to overcome risk premia

CCGT
- LR+SR premium CCR>1.2
- LR+SR premium CCR>1
- LR risk premium
- Breakeven NPV=0

Nuclear
- LR+SR premium CCR>1.2
- LR+SR premium CCR>1
- LR risk premium
- Breakeven NPV=0

Offshore Wind
- LR+SR premium CCR>1.2
- LR+SR premium CCR>1
- LR risk premium
- Breakeven NPV=0
3. STRATEGIC PRICING MODEL
Companies may be able to recover risk premiums even in an over-supplied market.
Conclusions

- **Long-run risks are significant**
  - Fuel prices, policy risks, tech costs etc.
  - System structure uncertainty
  - Tight caps do not necessarily mean high returns for low-C plant

- **Short-run risks are significant**
  - System SRMC tends to fall in a decarbonising electricity market

- **Markets would probably adjust in short- to medium-term**
  - Investment hiatus increases incentive to invest due to increased carbon price and reduced reserve capacity
  - Market power could also result in sufficient profit margins

- **BUT, in the long run, market design needs to take account of deep structural changes from decarbonisation**
  - Capacity markets?
  - Other regulatory intervention?
Outstanding Policy Questions

• How will capacity markets and energy markets interact?
• How do well do market reference prices for CfDs work in a shrinking market?
• Are these markets more or less subject to market power?
• Who can finance these transitions?
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