Do liberalized electricity markets discourage investment in renewable technologies?

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Electricity

Electricity is a unique commodity

- Invisible and dangerous
- Demand equals supply instantaneously
- Expensive to store
- Limited control over transport
- Cascading failure a possibility
- Virtually a necessity
- Supply and consumption arrangements are distant (no such thing as a green or black electron)
Power system basics
The issue

Previous model:
Vertically-integrated state monopoly of generation, transmission, distribution & retail.

“Liberalized market” model:
Privately-owned, unbundled, marketplace operating in a carbon-constrained environment.
Energy-only and capacity markets

- Energy-only markets rely solely on wholesale market prices to stimulate investment in generation capacity, although subsidies may also exist to support renewable technologies and carbon prices to discourage investment in carbon-intensive technologies.
- Capacity markets augment energy-only market by providing guaranteed payments for providing additional capacity at short notice.
How a liberalized market operates
(e.g. Australia)

Generators
- Offer their capacity into the pool
- Get paid for what they generate by the pool

Retailers
- Take MW from the pool
- Pay the pool for the MW

Customers
- most buy from retailers
- very few buy direct from a generator
Hedging

Hedges manage Revenue / Cost and Risks

Generators
- gain revenue certainty
- manage low price risks

Retailers
- gain cost certainty
- manage high price exposure
Wholesale market prices

- Market dispatch process determines the regional wholesale market price
- Retail prices are not the same as the Wholesale market price
  - Retail prices include:
    - Wholesale price
    - Transmission use of service charges
    - Distribution use of service charges
    - Retailer costs and margins
Planning and dispatch time frames

Hedge Contracts (risk instruments)

Generators $ MW $

Electricity Wholesale Market “The Pool”

Retailers $ MW $

4 second SCADA monitoring security
5 minute dispatch
30 minute settlement
4 hourly pre-dispatch
7 day ahead STPASA
18 months ahead MTPASA
Settlement time frames

Market operation is continuous
5 Minute Dispatch
  Demand forecast
  Instructions to generators
  prices
Settlement ½ hourly
  average of 5 minute prices
More than one market

- While this is an energy only market there are markets within the market
  - Energy
  - Ancillary services
    - Contingency
    - Frequency control
  - NSCAS (Network Support and Control Ancillary Services)

- These are co-optimised
  - Participants cant offer mutually exclusive services into the market
Generator offer structure

- Offers can be a simple or complex as needed and they are all published at the end of trading day BUT

- Understanding another generators offer is not simple!
  - Daily, hourly and instantaneous hedge and risk positions will affect offers
  - Typical structure
    - Some MW @ very low or –ve $/MWh – up to min load
    - Some MW at SRMC values – up to contracted position
    - Rest at blue sky values
Market dispatch

Highest offer dispatched to satisfy demand in any trading period determines market price
Example of wholesale electricity market: Australia

Wholesale Electricity Market Structure
### Overnight capital costs (2012 $US)

<table>
<thead>
<tr>
<th>Technology</th>
<th>$/kW</th>
<th>$/kW (with CCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced PC</td>
<td>3,246</td>
<td>5,227</td>
</tr>
<tr>
<td>Coal IGCC</td>
<td>4,400</td>
<td>6,599</td>
</tr>
<tr>
<td>CCGT</td>
<td>917</td>
<td>2,095</td>
</tr>
<tr>
<td>OCGT</td>
<td>973</td>
<td></td>
</tr>
<tr>
<td>Wind (on-shore)</td>
<td>2,213</td>
<td></td>
</tr>
<tr>
<td>Wind (off-shore)</td>
<td>6,230</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>5,530</td>
<td></td>
</tr>
<tr>
<td>Solar thermal</td>
<td>5,067</td>
<td></td>
</tr>
</tbody>
</table>

Source: US EIA (2013)
### Levelized cost (2012 US$) of electricity technologies (US plants entering service in 2019)

<table>
<thead>
<tr>
<th>Technology</th>
<th>$/MWh</th>
<th>$/MWh (with CCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced PC</td>
<td>95.6</td>
<td></td>
</tr>
<tr>
<td>Coal IGCC</td>
<td>115.9</td>
<td>147.4</td>
</tr>
<tr>
<td>CCGT</td>
<td>64.4</td>
<td>91.3</td>
</tr>
<tr>
<td>OCGT</td>
<td>128.4</td>
<td></td>
</tr>
<tr>
<td>Wind (on-shore)</td>
<td>80.3</td>
<td></td>
</tr>
<tr>
<td>Wind (off-shore)</td>
<td>204.1</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>96.1</td>
<td></td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>243.1</td>
<td></td>
</tr>
</tbody>
</table>

Source: US EIA (2014)
The tyranny of discounting

As discount rates (i.e. the opportunity cost of capital) increase, the high initial capital cost technologies (e.g. wind, solar, nuclear) become commercially less attractive, particularly if they have long construction time frames (nuclear)

Social discount rates generally considerably below commercial discount rates
Figure 1
Infra-marginal rent in the absence of wind

Price ($/MWh)

Demand

Capacity (MW)

Infra-marginal rents

WP

Baseload technology: nuclear

Baseload technology: coal

Intermediate technology: CCGT

Peaking technology: OCGT
Figure 2

*Infra-marginal rent with wind*

<table>
<thead>
<tr>
<th>Price ($/MWh)</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (MW)</td>
<td></td>
</tr>
</tbody>
</table>

** WP

** Infra-marginal rents

** Baseload technology: nuclear**

** Baseload technology: coal**

** Intermediate technology: CCGT**

** Peaking technology: OCGT**

** Wind**
Figure 3

Scarcity rent

Price ($/MWh)

Demand

Capacity (MW)

WP

Baseload technologies

Intermediate technologies

Peaking technologies

Infra-marginal rents

Scarcity rent
The Value of Loss Load (VOLL)

The VOLL represents the price at which consumers should, on average, be indifferent as to whether or not they receive their marginal unit of supply of electricity. The VOLL should incentivise investment in peaking plants, but in practice the market regulator generally puts a “cap” on the market price, thus diluting the incentive. The cap, however, is generally in place to combat potential abuse of market power rather than investment incentives.
# Overview of investment issues

## General Context

<table>
<thead>
<tr>
<th></th>
<th>Financial crisis</th>
<th>Utilities’ capacity to invest and credit rationing due to regulatory changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Local acceptability issues</td>
<td>“Banana” syndrome (build absolutely nothing anywhere near anyone)</td>
</tr>
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</table>

## Issues pertaining to energy

<table>
<thead>
<tr>
<th></th>
<th>Cash flows volatility and variability</th>
<th>Peak prices depend on weather conditions. Fossil and carbon price risks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Load factor risk</td>
<td>Deploying renewables reduces load factors</td>
</tr>
<tr>
<td></td>
<td>Price restrictions</td>
<td>Price caps reduce prices during peak periods, leading to underinvestment</td>
</tr>
<tr>
<td></td>
<td>Incomplete markets</td>
<td>Flexibility not (or poorly) remunerated</td>
</tr>
<tr>
<td></td>
<td>Energy policy risk</td>
<td>Stop and go of renewables policies and uncertain environmental regulations</td>
</tr>
</tbody>
</table>
Addressing the problem with policy intervention
Financial measures that operate within the energy-only market structure

Contracts for difference (CfDs) involve a regulator (or government) determined “strike” price that generators would receive for their output. If the market price exceeds the strike price, then generators must surrender the difference. If the market price is less than the strike price, then generators are paid the difference. The intention is to guarantee long-term prices, thus encouraging investment free of carbon pricing and changeable renewables policy.
## UK Contract for Difference “strike” prices (2012 prices)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Draft strike price and period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass conversion</td>
<td>£105/MWh: 2014/15 onwards</td>
</tr>
<tr>
<td>On-shore wind</td>
<td>£95/MWh: 2014/15 dropping to £90/MWh by 2018/19</td>
</tr>
<tr>
<td>Off-shore wind</td>
<td>£155/MWh: 2014/15 dropping to £140/MWh by 2018/19</td>
</tr>
<tr>
<td>Landfill gas</td>
<td>£55/MWh: 2014/15 onwards</td>
</tr>
<tr>
<td>Large solar photovoltaics</td>
<td>£120/MWh: 2014/15 dropping to £100/MWh by 2018/19</td>
</tr>
<tr>
<td>Tidal/wave</td>
<td>£305/MWh: 2014/15 onwards</td>
</tr>
<tr>
<td>Nuclear (Hinkley Point C)</td>
<td>£92.50/MWh: from 2023 for 35 years</td>
</tr>
</tbody>
</table>
Policy interventions that modify the energy-only market structure

- Impose quantity obligations on suppliers (such as renewables obligations) that forces the market to adopt technologies that would otherwise not be adopted
- Carbon price guarantees
- Targeted capacity payments for peaking plants
- Emission performance standards
Conclusions

- Liberalized electricity markets have raised the risks faced by investors in high-capital-cost, low-operating-cost, generation technologies.
- Uncertain/variable environmental policies discourage investment in low-carbon technologies.
- The current structure of energy-only markets is likely to lead to investment shortfalls.
- Market price guarantees: the answer or simply subsidies by stealth?
Thank you!

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