What future(s) for liberalized electricity markets?

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Cambridge Spring Research Seminar

5th June 2015
Outline

• Future utility challenges
  – Supporting non-commercial *renewables*
  – *Pricing* problematic with low variable cost plant

• Challenges in liberalized markets
  – *Investment* often problematic without contracts
  – Tension between capacity adequacy and efficient pricing

• Future challenges
  – *Decentralised generation*, new loads – EVs, heat pumps, …

*What models are on offer?*
Future utility challenges

• Targets require massive growth of non-fossil plant
  – Low variable cost, high capital cost
  – Currently not commercial, needs subsidy
  =&gt; Requires political support

• Growth of decentralised generation and peaky load:
  – PV, micro-CHP, EVs, heat pumps =&gt; peakier net demand

• Infrastructure & energy: capital cost dominates
  – network designed for peak not average flows

• Falling capacity margins =&gt; higher fixed costs
  – How can generators recover fixed costs?
UK target for renewables: 
**Future Energy Scenarios**

Future energy scenarios 2015
Low peak, huge capacity growth

UK Generation capacity under Gone Green

Switch from coal to gas
Low capacity factors for plant with high MC

UK Capacity factor for various fuels under Gone Green

- Nuclear
- Total
- Coal
- Gas
- Imports
- Wind
- Solar PV

Capacity factor

2015/16 2020/21 2025/26 2030/31

www.eprg.group.cam.ac.uk
Pricing and investment

• SMC: system marginal cost, highest MC generating
• Efficient price = SMC + CP
  \[ CP = \text{LoLP} \times (\text{VoLL} - \text{SMC}) \]
  \( \text{VoLL} = \text{Value of Lost Load} \)
• How confident are gencos that the price will cover their average total cost (AC) and justify investment?
  – High cost fossil mostly at margin => SMC/AC high
  – Or price set abroad over interconnectors
    => plant expected to cover cost, private investment OK
  – Low cost low-C often at margin => SMC/AC low
    => Requires scarcity/capacity price and longer-term contracts
Wholeale prices driven by fuel costs and market power

Real GB electricity and fuel costs 1990-2014
centred annual moving averages
Can biomass set the price?

UK Capacity factor for various fuels under *Gone Green*
Similar with Slow Progression

Capacity factors for various fuels under Slow Progression

- Nuclear
- Biomass
- Imports
- Total
- Gas
- Coal
Electricity Market Reform: does it solve the problems?

• **Energy Act** 18 December 2013 to address:
  – Security of supply and carbon/RES targets
  – problems with EU ETS
  – Market/policy failures

• To deliver **secure low-C in UK affordably**
  => capacity payments auctioned
  – HMT sets Carbon Price Floor in 2011 for 2014
    • but reneged on it in 2014
  – de-risk investment => Contracts to lower WACC
    • Originally bureaucratically set, now auctioned
UK’s Carbon Price Floor - in Budget of 3/11

EUA price second period and CPF £(2012)/tonne

Source: EEX and DECC Consultation
EMR – results so far

• Capacity auction December 2014:
  – PTE criticized over-cautious excessive procurement
    • ignoring interconnector contribution
  – New entry price predicted at £49/kWyr for CCGT
    • Could have cost £2.5 billion
• Market clearing price £19.40/kWyr, CCGT entered
  => auctions much better than bureaucrats
    – PTE + DG COMP forces interconnectors to be included
• CfDs – those with fixed prices did well
  – DG COMP requires market testing
  => Auction run, set lower prices
GB Dec 2014 Capacity auction result

Net CONE – predicted entry price

Source: National Grid (2014b)
## CfD 2015 auction results

<table>
<thead>
<tr>
<th>Technology</th>
<th>admin price</th>
<th>lowest clearing price</th>
<th>2015/16</th>
<th>2016/17</th>
<th>2017/18</th>
<th>2018/19</th>
<th>Total Capacity (MW)</th>
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<tbody>
<tr>
<td>Advanced Conversion Technologies</td>
<td>£140</td>
<td>£114.39</td>
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<td>Energy from Waste with</td>
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<td>Combined Heat and Power</td>
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<td>£114.39</td>
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<tr>
<td>Offshore wind</td>
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<td>£114.39</td>
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<tr>
<td>Onshore wind</td>
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<td>£79.23</td>
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<td></td>
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<tr>
<td>Solar PV</td>
<td>£120</td>
<td>£50.00</td>
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<td>£79.23</td>
<td>£79.99</td>
<td>£82.50</td>
<td>748.55</td>
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</table>

Source: DECC (2015)

**Foolish bid - withdrew**
Creating a seamless internal energy market that benefits citizens, ensuring security of supply, integrating renewables in the market and remedying the currently uncoordinated development of capacity mechanisms in Member States call for a review of the current market design.

– The Commission will propose a new European electricity market design in 2015, which will be followed by legislative proposals in 2016.
Several possible investment solutions

• Real public sector interest rates now near zero
  – Govt finance attractive when backed by productive assets
  – Aggregate risks low, markets amplify company risks
  => finance low-C generation from state development banks

• But need contestability to deliver efficiency
  => auctions for PPA contracts
    • Or regulated revenues if flexibility needed? (but generating is simple!)
  => single buyer (ISO) for efficient dispatch? Or Pool?

*Design market to fit technology*
A new European market design

- Present Target Electricity Model is energy-only market
  - *Successfully coupled interconnectors day-ahead*
- But has not addressed reliability and balancing
  => Patchwork of capacity remuneration mechanisms (CRMs)
- US FERC – suggest Standard Market Design
  - Based on best pricing principles and hedges
  - *Voluntary*, but nodal pricing seems to be winning

*What guiding principles?*

*Is there an EU SMD that should be an option?*
Guiding principles

- **Efficient pricing** solves many problems
  - Trade benefits country with efficient pricing
  - Pricing all **flexibility** reduces need for CRM
  - Each MS chooses its own market design subject to no distorted prices in coupled markets
  => Need to rethink renewables support schemes

- One market design unlikely to fit all Member States
  - Contrast isolated centrally dispatched SEM with Nord Pool
- Capacity and energy are two different products
  => pay for peak capacity used
  - For wires for peak demand (no net metering for DG)

*Reduce risk by contracts, not price distortions*
Premium FiT risky

Support to Wind under the ROC Scheme (real prices)
Renewable support models

• DG Comp wants **renewables integrated in the market**
  – Wind & PV depress prices in some hours
  => **Premium FiT discourages excess supply automatically**
  – But raises **market and balancing risk**

• **Hedge with CfD on predicted output/revenue**
  – Ideally offered by traders, perhaps with trader of last resort
  – ISO could offer insurance against balancing risk

• **Any subsidies needed via capacity payment**
  – Based on de-rated capacity, paid on availability
  – CP set through periodic **auctions in nominal terms for n yrs**
**Optional EU Standard Market Design?**

- **Central dispatch in voluntary pool**
  - ISO manages balancing, dispatch, wind forecasting
  - \( \text{LMP} + \text{capacity payment} = \text{LoLP} \cdot (\text{VoLL} - \text{LMP}) \)
  - Hedged with reliability option (RO)

- \( \Rightarrow \) reference prices for CfDs, FTRs, balancing, trading

- **Auction/tender LT contracts for low-C generation**
  - Financed from state investment bank
    - Credible counterparty to LT contract, low interest rate
    - CfDs when controllable, Premium FiTs when not, or
    - Capacity availability payment plus energy payment
      - Counterparty receives LMP, pays contract

- **Free entry of fossil generation, can bid for LT RO**
  - To address policy/market failures
Future utility solutions

• PV, CHP, EVs, heat pumps => peakier net demand
• Smart solutions => manage distribution networks
  – to handle constraints without excess underutilised investment
  => time-of-use pricing or automatic appliance control
⇒ demand side services needed to handle intermittency
⇒ needs efficient aggregators for small DSR and DG
  ⇒ Virtual Power Plant concept offers DSR to grid and networks

• network designed for peak not average flows
  ⇒ pay for T&D capacity = insurance, including energy
  ⇒ Two-part tariff feasible with smartish meters
Assessment

• Low-C investment is durable and capital intensive
  – needs *stable credible future prices* to invest
    • and guaranteed contracts for cheap finance
    • Two-part tariffs for energy and access?
• EU policy is a messy 28-state compromise
  – neither stable nor credible: => subsidiarity!
• Each country searches for best solution
  => some mix of contracts and capacity markets
• Gains from cross-border trading higher with RES
  – share reserves & renewables to reduce investment
  – Enable efficient solutions to drive out bad

  *rapidly evolving environment for utilities*
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Acronyms

AC  Average cost
CCGT  Combined cycle gas turbine
CfD  Contract for difference
DG, DSR  Distributed Generation, Demand Side Response
EMR  (UK) Electricity Market Reform
EV  Electric vehicle
FiT  Feed-in tariff
HMT  HM Treasury (Min of Finance)
ISO  Independent System Operator
LMP  Locational marginal price or nodal price
LoLE  Loss of Load Expectation = sum of LoLP = Loss of Load probability
LT  Long-term
PPA  Power purchase agreement
PV  Photo voltaic
RES  Renewable energy supply
RO  Reliability Option
SEM  Single Electricity Market of island of Ireland
SMC  System marginal cost
SMD  Standard Market Design (the US model)
T&D  Transmission and distribution
VOLL  Value of Lost Load
WACC  Weighted average cost of capital
Spare Slides

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Energy Union Feb 2015

• In line with the Environmental and Energy Aid Guidelines, renewable production needs to be supported through market-based schemes that address market failures, ensure cost effectiveness and avoid overcompensation or distortion.


• …the new European energy Research & Innovation approach should comprise an updated Strategic Energy Technology Plan
Local conditions influence price setting

• Nordic model – huge low-MC storage hydro
  – Well interconnected to markets with different fuel mix
• French model: 88% zero-carbon zero MC
  – But well interconnected, high exports/imports, EdF dominant
• GB model: coal, gas, nuclear almost equal
  – Competitive market, interconnection 5% but rising
• DK: wind 80% of peak demand, coal 45%
  – Very strong interconnection
• DE: high wind + PV erodes peak prices
  – reasonable interconnection, weak N-S grid
• SEM (NI+IE) small, 15% interconnected, diversified
  – Wind growing to 75% non-synchronous penetration
Does gas usually set price?
Criticisms of EMR

• “Contracts mark return to Single Buyer Model”
  – but all IPPs in 1990s were long-term PPAs

• “Bureaucrats, not markets choose investment”
  – but current RES support designed after intense lobbying by incumbents
  => auctions to create competition
  => contracts should incentivise efficient operation

• “Wholesale price will be distorted by contracts”
  – CfDs are financial, problem is low variable cost plant => consumer capacity payments / reliability options?

• Without govt. underwriting contracts no cheaper
  – need guarantees that are defensible under State Aid rules