UK Electricity Market Reform and the Energy Transition: Emerging Lessons

Michael Grubb, University College London
David Newbery, EPRG, University of Cambridge

41st International IAEE Conference
Groningen, The Netherlands
12th June 2018

Outline

• Evolution of UK policy & regulation
  • EMR reforms: aims and instruments
    – Need better support for RES
    – Need better signals than ETS for decarbonization
    – Need timely flexible capacity
  • EMR results
    – carbon price support, Emissions performance standard
    – CfDs for zero-carbon generation and auctions
    – capacity auctions
  • Lessons for market design and regulation
    – Capacity needs reward
    – auctions better than bureaucrats
    – RES support needs improving
    – network tariffs need major rethink

Evolution of electricity market and policy

UK electricity journey – overview

<table>
<thead>
<tr>
<th>Policy environment</th>
<th>Regulatory remit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First liberalisation</strong></td>
<td>&quot;Promote competition&quot;</td>
</tr>
<tr>
<td>- Competition through electricity pool</td>
<td></td>
</tr>
<tr>
<td>- System marginal price + cap/l payment</td>
<td></td>
</tr>
<tr>
<td>=&gt; &quot;Dash for gas&quot;, based on Long term contracts (PPAs) with distrib' companies</td>
<td></td>
</tr>
<tr>
<td>=&gt; Some contract support for renewables</td>
<td></td>
</tr>
<tr>
<td>=&gt; Collapse of R&amp;D</td>
<td></td>
</tr>
<tr>
<td><strong>1990s</strong></td>
<td>Concerns about oligopolistic power</td>
</tr>
<tr>
<td><strong>Bilateral trading</strong></td>
<td>&quot;Protect interests of consumers&quot;</td>
</tr>
<tr>
<td>market (NETA/BETTA)</td>
<td></td>
</tr>
<tr>
<td>- replace pool, energy-only market</td>
<td></td>
</tr>
<tr>
<td>- Vertical integration of generators with supply companies;</td>
<td></td>
</tr>
<tr>
<td>=&gt; Limited investment</td>
<td></td>
</tr>
<tr>
<td>=&gt; Market certificate trading (ROCs) support for renewables</td>
<td></td>
</tr>
<tr>
<td><strong>2000s</strong></td>
<td>Growing concerns about lack of investment or new entry, transmission connection &amp; bottlenecks, and short-termism</td>
</tr>
<tr>
<td><strong>Electricity Market Reform (EMR)</strong></td>
<td>&quot;Protect interests of present and future consumers&quot;</td>
</tr>
<tr>
<td>+ Climate Change Act</td>
<td></td>
</tr>
</tbody>
</table>
Why Electricity Market Reform?

• ETS offers inadequate low-C investment signal
• RES lagging countries with feed-in tariffs
• Ambitious RES targets increase intermittency
  – Need flexible peaking reserves
  – Normally comes from old high cost plant = coal
  • Large Combustion Plant Directive 2016 limits coal
  • Integrated Emissions Directive further threat to coal
  • Carbon price floor => close old coal
  – high EU gas prices and low load factors
  • gas unprofitable, new coal threatened by future C price
• Future prices now depend on uncertain policies
  – on carbon price, renewables volumes, other supports
  – on policy choices in UK and EU

Hard to justify investing in reliable power
Consensus that market not delivering objectives

Electricity Market Reform (EMR)

• Controversial step for a pioneer of electricity liberalisation
• Ofgem’s Project Discovery (2009) – Regulator’s detailed study of the future challenges of the electricity market
• Addressing key risks identified became the three aims of EMR:

1. Reduce the risks to security of supply
2. Reduce costs to consumers
3. Support progress towards climate change targets

What is EMR?

Contracts for Difference (fixed-price 15-yr contracts)
Capacity Mechanism (capacity payments on availability)
Carbon floor price
Emissions Performance Standard

EMR brought major changes to the market.
Main regulatory input on design of Capacity Mechanism and overall institutional

UK’s Carbon Price Floor - Budget March 2011
EUA price second period and CPF £(2012)/tonne

To £70/t by 2030
Budget 2014
Carbon Price Support - Corrective tax

Source: EEX and DECC Consultation
Coal displaced by RES & gas: carbon price floor working

Contracts for Difference (CfDs) (structure for renewable energy & nuclear)

Auctions better than bureaucrats!

RES CfD 2015 auction results

UK RES catching up

Cumulative increment in share of RES in generation from 2004
Countries exceeding EU-28 increment

Source: DECC (2015)

www.eprg.group.cam.ac.uk
UK Off-shore wind auction prices

- Bureaucrats set First auction
- Strike price for five offshore wind farms depending on completion date
- £155 (£119.89 inc. East Anglia 1)
- £140 (£114.39 inc. North Sea Gaidh), prices halve
- Allocation / auction rounds
- Delivery years (no. first generation)
- 4 years difference in delivery years

Reforming RES-E support

- Learning spill-overs need remuneration
  - Almost entirely from making and installing equipment
  ⇒ Contract €X/MWh for (e.g.) 30,000 MWh/MW, auction determines premium €X

Reasons:
- Subsidy targeted on source of learning = investment aid
  - Reduces cost of capital and risk via debt finance
  - Ideally associated with CO₂ credit per MWh
- Could expose RES to current locational spot price
  ⇒ incentivizes efficient location, connection
- Does not amplify benefits of high wind/sun
  - Not over-reward favoured locations with same learning
- Auction better than bureaucrats at minimizing cost

Capacity Mechanism / Market
(to reward ‘firm’ generating capacity)

- Ensure market can deliver security of supply
- Payment for availability to encourage investment

Why

- Market wide auction of capacity obligations, run by National Grid
- Successful bidders get fixed revenue additional to wholesale market
- Obligated to deliver capacity when needed or face penalties
- Technology neutral – but those receiving CfDs are not eligible
- Pilot scheme to help Demand Side Response (DSR)

How

- Reduces price volatility
- Insurance against blackouts
- Encourages demand side - somewhat
- ? Expected cost – estimate required for new CCGTs, around £50/kW/yr
  ⇒ Would appear to cost consumers £2.5bn/yr for 50 GW capacity
  ⇒ Lower prices – impact on interconnector / other investment
- Design makes it very difficult for DSR to participate equally

New build 2014 T-4 auction

- Cleared at £19.40/kWyr
- Average Size 11 MW
- 786.9
- 1656.2
- 165.9
- 108.4
- 8.2
- 2.7
- 67.1
- OCGT/ recip
T-4 for 2021/22 cleared at £8.40/kWyr

Flaws in GB Capacity Procurement

- Transmission-connected generation TG pays full G TNUoS
- Distribution-connected generation DG receives L TNUoS
  - But avoided cost at most the transmission demand residual
    = extra money to pay full cost less efficient charge of transmission
  ⇒ represents extra £50/kWyr embedded benefit in 2018/19
  ⇒ Auction cleared at £20/kWyr
  ⇒ DG gets £70/kWyr and TG gets £20/kWyr
  ⇒ Large number of small (10 MW) diesel and reciprocating engines win capacity contracts on distribution network

Over-encourages entry of costly subscale plant

GB Transmission demand residual – extra to DN connex

Source: Ofgem (2017)

Reduce TDR to £0

Embedded benefit not material

Reliability Options (RO) preferable to Capacity agreements

- RO sets strike price, s (e.g. at €500/MWh)
- Market price p reflects scarcity (Voll x LoLP)
  - SO sets floor price to reflect spot conditions
  - Wholesale price signals efficient international trade
- RO auctioned for annual payment P
  - 7-10 yrs for new, 1 yr for existing capacity
- Gen pays back wholesale price p
  - less strike price if available (p – s)
  - G chooses whether to be paid p or s + P
- Suppliers hedged at strike price s for premium P
  Trade over interconnectors efficient
  No need to pay foreign generators
Criticisms of EMR

• “Contracts mark return to Single Buyer Model”
  – but all IPPs in 1990s had long-term PPAs
• “Bureaucrats, not markets choose investment”
  – but current RES support Govt designed after intense lobbying by incumbents
  => tenders, auctions to create competition
=> contracts should incentivise efficient operation
• “Wholesale price will be distorted by contracts”
  – fossil mostly at margin until 2020+, problem is excess PV on sunny summer weekends
  – Problem from RES, not contracts

D Newbery
www.eprg.group.cam.ac.uk

UK Electricity Market Reform - Key lessons

• For Strategic investments – e.g. security and sustainability, especially emerging renewables - a role for government is inescapable
• Can shifting some risk to government (e.g. long term contract) be good?
  Yes if
  – the risks arise from private perception of policy risk;
  – markets (particularly capital markets) are myopic; or
  – the benefits are partly public (e.g. due to inadequate environmental pricing, or innovation / learning, etc.)
• Do we need a Capacity Mechanism in addition to low carbon supports?
  – Yes in UK conditions – but scope is crucial, so too is design
• Auctions are very valuable – competitive pressures remain important
  – Better than government decision at cutting costs / finding options
• Institutional complexities
  – contracting bodies and their governance
• Transmission and distribution – new frontiers?

Reference

This presentation is based on the working paper

Acronyms

CfD  Contract for Difference
CP  Capacity payment
CPF  Carbon Price Floor
DG  Distribution-connected Generation
DN  Distribution Network
EMR  Electricity Market Reform
G, L  Generation, Load
LoLP  Loss of Load probability
PPA  Power Purchase Agreement (long term contract)
RES  Renewable energy/electricity supply
RO  Reliability option
ROC  Renewable Obligation (i.e. green) Certificate
SMC/P  System Marginal Cost/Price
T-4  Auction 4 yrs before delivery at date T
T&D  Transmission and Distribution
TDR  Transmission demand residual
TG  Transmission-connected generation
TNuoS  Transmission Network Use of System, G =Generation, L=Load
VOLL  Value of Lost Load
Acronyms

CfD Contract for Difference
CP Capacity payment
CPF Carbon Price Floor
DG Distribution-connected Generation
DN Distribution Network
EMR Electricity Market Reform
G, L Generation, Load
LoLP Loss of Load probability
PPA Power Purchase Agreement (long term contract)
RES Renewable energy/electricity supply
RO Reliability option
ROC Renewable Obligation (i.e. green) Certificate
SMC/P System Marginal Cost/Price
T-4 Auction 4 yrs before delivery at date T
T&D Transmission and Distribution
TDR Transmission demand residual
TG Transmission-connected generation
TNuoS Transmission Network Use of System, G =Generation, L=Load
VOLL Value of Lost Load

Spare slides

Michael Grubb, University College London
David Newbery, EPRG, University of Cambridge

41st International IAEE Conference
Groningen, The Netherlands
12th June 2018

T-4 auction Dec 2016 for 2020/21

Cleared at £22.50/kWyr

Of which 500 MW battery storage derated as pumped storage!

Efficient tariffs

- Distinguish efficient price and short-fall in required revenue
  - Efficient peak T price is marginal expansion cost
  - At best 30% average cost, less if demand falling
- Ramsey-Boiteux pricing => “tax” inelastic demand
  ⇒ equi-proportional reductions in all types of demand
  • incl. option to take up to $N$ Kw
- Diamond-Mirrlees: tax only final consumers
  ⇒ T&D revenue shortfall on final consumption not net demand
    (at network connection)
  ⇒ reduces embedded G benefit from £60 to < £10/kWyr
  ⇒ Regulators need to compute efficient T&D tariffs
  ⇒ and move faster. Auction in 1 day grants 15-yr contract
GB TNUoS (Network) charges

Generation and Load TNUoS 2016/17

- G range £25/kWyr