The Final Hurdle? Security of Supply, the Capacity Mechanism and the role of interconnectors*

David Newbery

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http://www.eprg.group.cam.ac.uk

* Based on Newbery and Grubb EPRG WP1412
Outline

• Security of supply
  – What is the problem?
  – Misperceptions
• The EMR Capacity Mechanism
  – Design, impact assessment, amount announced
  – Prequalification results
  – Criticisms: interconnectors, optionality
• Consequences

Who should decide on capacity adequacy?
Are there other ways of delivering security?
What is the problem?

• 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 prohibited by EPS

• 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
When is the problem?
Ofgem’s derated capacity margin

System Operator’s problem
First Capacity Auction delivery

Source: DECC IA

- Reference Scenario 2013
- Low Supply
- High Demand
- Conventional Generation High Availability
Measuring SoS

• SoS Measured by Loss of Load Expectation, LoLE
  – 3 hours per year => Value of Lost Load = £17/kWh
• But spot and balancing prices capped
  – Balancing actions costs will increase to £6/kWh
• Missing money = (£17-£6/kWh) x 3 hrs/yr =£33/kW yr
⇒ Auction to pay for missing money

But what does a “Loss of Load” mean?

Demand exceeds offered market supply
What does “Loss of Load” mean?

Market supply
Exceeds demand

Supply available in the normal market operation up to Balancing Mechanism

Demand exceeds Market supply

New Balancing Services
Voltage Reduction – up to 500 MW
Maximum Generation – up to 250 MW
Emergency Services from interconnectors – up to 2000 MW (depending on direction and size of flows)
Controlled Disconnections

Actions that would take place during loss of load events

These actions have lower cost/value than £17/kWh


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Supply curve of options

- Domestic disconnections
- Industrial disconnections
- Running plant above rated capacity
- Frequency reductions beyond normal range
- Load differentiation / reduced demand activities
- Active storage (e.g. batteries, electric vehicles)
- Industrial backup
- Passive storage (e.g. inherent thermal demand-side response)

VOLL £17/kWh
Price cap £6/kWh

Costs below price cap but cant participate in market

Residual capacity surplus

VOLL c. 200 times normal market price;
Pay-as-clear descending clock auction in 2014 for 2018/19

- New build gets 15 yr contract at auction price
  - existing plant: 1 yr contract unless major refurbish
    - must be price taker unless good cause, entrants set price
    - existing plant can delay until later auction (2017)
- DSR auctioned from 2016: 1 yr contracts
- Need to forecast amount of capacity likely at T-1
- And capacity that is available but not paid
  - Renewables, \textit{interconnectors}? passive DSR, etc.
Net benefit is difference between large producer surplus and large consumer loss.

Initially adverse.

Figure 13: Change in producer and consumer surplus as a result of a Capacity Market.
### Table 3: Estimated costs and benefits of a Capacity Market

<table>
<thead>
<tr>
<th>2012-2030</th>
<th>£m (2012 prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>October 2013</td>
</tr>
<tr>
<td>Carbon cost(^{38})</td>
<td>854</td>
</tr>
<tr>
<td>Generation cost(^{39})</td>
<td>176</td>
</tr>
<tr>
<td>Capital cost(^{40})</td>
<td>-1415</td>
</tr>
<tr>
<td>System cost(^{41})</td>
<td>1184</td>
</tr>
<tr>
<td>Interconnection cost(^{42})</td>
<td>44</td>
</tr>
<tr>
<td>Energy System Costs</td>
<td>843</td>
</tr>
<tr>
<td>Institutional costs</td>
<td>32</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>231</td>
</tr>
<tr>
<td>Energy System Benefits (Reduction in unserved energy(^{43}))</td>
<td>1,290</td>
</tr>
</tbody>
</table>

Source: DECC modelling
New plant sets high price for all

No new plant and price is low

£75/kW year

£49/kW year

£25/kW year

Source: DECC IA
Results of prequalification

- Total procurement: 53.3 GW incl. future DSR, STOR, etc.
- Auction requirement: 50.8GW (derated)
- Prequalified offers: 71.2GW = 62.6 GW (derated)

Source: National Grid
Derated capacity by type

Source: National Grid
Most nuclear refurbishes

Summary of capacity by owner

LCP/Frontier October 2014
Cost of “energy unserved” = £17/kWh

Figure 12: Combined cost of energy unserved and procured capacity against capacity to procure

Amount to procure = 53.3 GW

But these cost less than £17/kWh

Source: National Grid (2014, p50)
GB coupled to NWE 4/2/14

SWE coupled to NWE 13/5/14

Interconnectors and coupling - status 2014

Existing

Due 2016-19
Interconnectors and capacity markets

- Interconnectors increase security of supply
  - provided they are free to respond to scarcity
  => they should displace domestic reserve capacity
  - Pöyry estimates 50-80% for GB
  - France imported 9 GW at 2012 Feb stress moment

- EU Third Package aims at Single Market
  - Single auction platform for day ahead and intra-day

- But GB is aiming at autarky for capacity!
  
  Reluctance to rely on imports => over-procure
  ⇒ reduce cross-border price differences
  ⇒ undermine interconnector investment
Trading with capacity markets

- Day-ahead supply and demand bids to Euphemia
  - Adjustments via intraday and balancing
- Efficient capacity design drives out inefficient design if no price cap
  - If price reflects scarcity value then willing to trade
    - If not face inefficiencies – your problem!
  - But DA Euphemia capped at €3,000/MWh
- Critical to ensure efficient rationing

Ensure spot price or allocation is efficient
=> Hedge with reliability options
Optionality

- 2014 auction is for delivery in 2018/19
  - Allows time to build CCGT
- But information about future D & S uncertain
  - Especially DER and DSR

=> retaining flexibility has option value

- If planning and connections secured CCGT can be built in 2 years (2,000 MW Teeside in 27 months)
  - OCGTs can be built even faster

=> procure less now, more later
Consequences of excessive procurement

- Excess capacity in auction depresses prices post-2018
- Lower prices => higher payments for CfDs => LCF exhausted, reduces finance for renewables
- Auction bid price for capacity set by Net Cost of New Entry
- Net CONE is total fixed cost less (revenue – opex)
- More capacity => fewer running hours => less revenue
- Lower price => lower revenue => higher net CONE
- Higher CONE sets price for all plant => paid by consumers
- Consumers not happy, not persuaded future wholesale price will reduce their bills
- Select Committees, NAO => big fuss
Belated response

- June 2014 PTE published *Final Report on National Grid’s Electricity Capacity Report*
  - Criticizes National Grid for assuming no net IC capacity contribution
  - Could have left room for IC contribution in 2018?
- Nov 2014 DECC consults on IC eligibility for capacity payment
  - 2nd Dec 2014 Treasury’s *National Infrastructure Plan* confirms IC to be included in 2015 T-4 auction

=> estimated unpaid 2018 IC displaces T-1?
Assessment

• Unstable policy environment and uncommercial low-carbon generation make investment risky
• Capacity markets can reduce investment risk
• GB capacity auction seems a good design
• Except that nervous politicians decide quantity

=> Amount procured seems excessive
  – Influenced by bogy of “Loss of Load”?
  – Ignores interconnectors and optionality of waiting
Problem

• National Grid is System Operator
  – Charged with security of supply
  and advises on capacity volume to procure
⇒ Advice to over-procure as consumers pay?
⇒ Politicians nervous about “lights going out”
• Would an ISO do better? What role for politicians?

Can we do without central capacity procurement?
Assessment of capacity markets

• Theory of scarcity pricing clear
  – leads to $CP = LoLP \times (VoLL - SMC)$
  – energy-only markets could do this in theory
    • and hedge with reliability options

• Main failures: policy uncertainty and price caps
  – and lack of credible distant futures markets

• Capacity markets can address these
  – but potentially large transfers from consumers
  – Political choices may be expensive

Need much higher Euphemia Intraday price cap
And ways of handling stress situations
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<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>CCGT</td>
<td>Combined cycle gas turbine</td>
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<tr>
<td>CfD</td>
<td>Contract for difference</td>
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<tr>
<td>CMU</td>
<td>Capacity market unit</td>
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<tr>
<td>CONE</td>
<td>Cost of New Entry</td>
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<tr>
<td>CP</td>
<td>Capacity Payment</td>
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<tr>
<td>D &amp; S</td>
<td>Demand and Supply</td>
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<tr>
<td>DER</td>
<td>Distributed Energy Resources</td>
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<td>DSR</td>
<td>Demand Side Response</td>
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<td>EMR</td>
<td>(UK) Electricity Market Reform</td>
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<td>EPS</td>
<td>Emission Performance Standard</td>
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<td>ISO</td>
<td>Independent System Operator</td>
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<tr>
<td>LCF</td>
<td>Levy Control Framework</td>
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<tr>
<td>LoLE</td>
<td>Loss of Load Expectation = sum of LoLP</td>
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<tr>
<td>LoLP</td>
<td>Loss of Load probability</td>
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<tr>
<td>NAO</td>
<td>National Audit Office</td>
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<td>NW E</td>
<td>North West Europe</td>
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<tr>
<td>OCGT</td>
<td>Open cycle gas turbine</td>
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<tr>
<td>RES</td>
<td>Renewable energy supply</td>
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<tr>
<td>SMC</td>
<td>System Marginal Cost</td>
</tr>
<tr>
<td>SWE</td>
<td>South West Europe</td>
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<tr>
<td>STOR</td>
<td>Short term operating reserve</td>
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<tr>
<td>VOLL</td>
<td>Value of Lost Load</td>
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</tbody>
</table>
Appendix

Energy-only market solutions
Theory and reality

• Efficient pricing of electricity requires prices varying in response to supply and demand each second
  – Australia has 5 minute pricing in real-time market
  – Frequency response needed in 1-5 seconds
  – Tender auctions may be cheaper than spot markets for some services
  – Contracts needed to hedge risk and incentivise responses
• Investment needs forward prices for 15-20+ years
  – Or ability to predict confidently and hedge
• Investment needed is either capital-intensive (low-C) or has low capacity factors for balancing = risky

How to allocate risk to incentivise and reduce cost?
Energy-only markets

• If generators can (and are allowed to) bid scarcity prices no problem?
  – France (*de facto* monopoly) bids high peak prices
  – GB has adequate capacity and flat prices

• Wind, PV, cheap coal, low C prices drive clean spark spreads negative (in Germany especially)
  – electricity prices affected by policy

  => *policy uncertainty undermines peaking investments needed*

  **So policy clarity on carbon price may help**

  **But long-term contracts backed by state needed?**
France much peakier than GB

European power exchanges 2012

Euros/MWh

percent time price higher than

France
UK MIP (Euros)
Germany 2012
Netherlands
Pool prices 1998-9 and System Buy Price 2008

Price duration curves Pool 1998-99 and Balancing 2008 at 2013 CPI prices

Balancing prices peakier than Pool
Imbalance prices not adequately marginal?

Price duration of System Buy Price 2013-4

£/MWh

Percent time price higher than

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400

£0 £50 £100 £150 £200 £250 £300 £350
Assessment

- Energy-only market might work with no price caps, no subsidized entry and adequate credible Carbon price
- US experience suggests missing money problem is significant given fears over price caps
- Long-term PPAs have capacity element
  - Long-term contracting with central body in developed countries likely to lead to more than adequate capacity
=> low prices fail to reward capacity without CP