UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Progress with the UK Electricity Market Reform (EMR)

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Outline

- Introduction and background
- Electricity Market Reform
- Analysing EMR
- Conclusions and Lessons

INTRODUCTION AND BACKGROUND

At privatisation in 1990: 3 electricity wholesale markets in UK

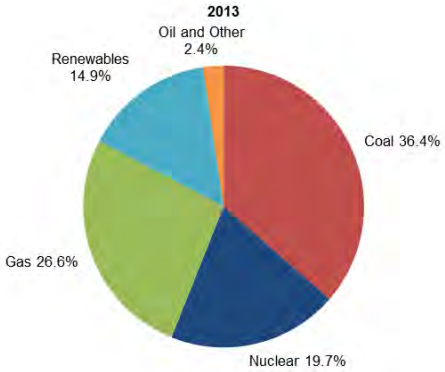
- England and Wales
  - c.60 GW, Revenue £16bn
  - 4 major generators, 1 TSO, 12 Regional Elect. Cos
- Scotland
  - c.9 GW, Revenue £1.9bn
  - 2 integrated cos, 1 nuclear generator
- Northern Ireland
  - c.1.5 GW, Revenue £0.5bn
  - 4 power stations (3 cos), 1 T,D and S co.

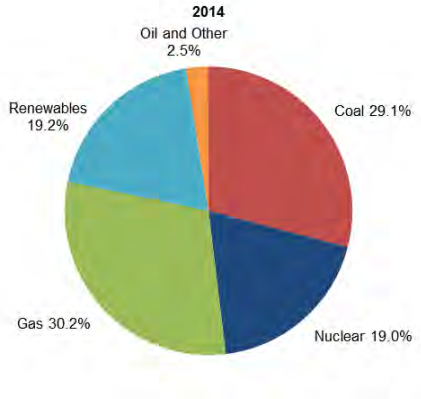
Design of the Market

- Separate generation, transmission, distribution & supply
- Free entry to Generation
- Supply opened in stages to 1998
- Limited vertical integration between them
- Price caps for transmission, distribution, and initially supply (except the largest customers)

UK Electricity Generation

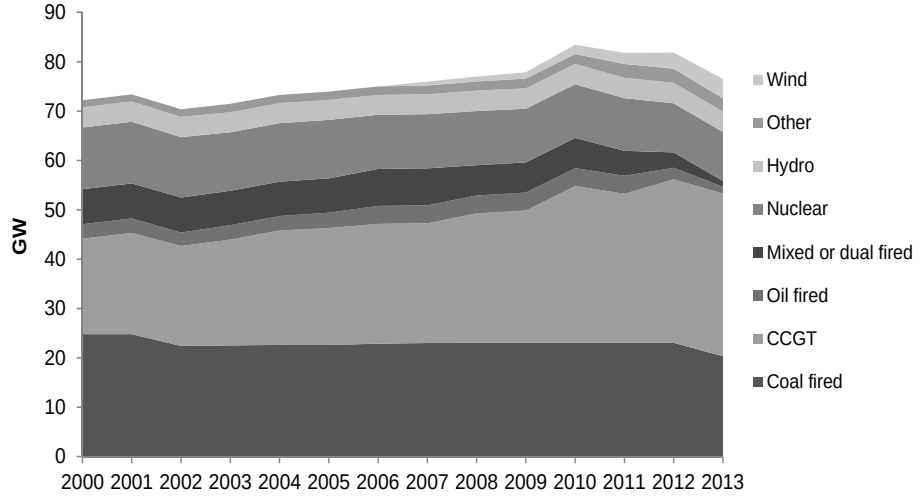
Chart 5.2 Shares of electricity generation





Source: Energy Trends March 2015, p.40

Chart 5.3: Generating capacity of major power producers 2000-2013



1. 'Other' includes: Gas turbines, oil engines and renewables other than hydro.
2. 'Hydro' includes Natural flow and pumped storage.
3. 'Mixed or dual fired' includes non-CCGT stations that can be fuelled by a combination of gas, coal and oil
4. Wind included from 2007

Source: DUKES 2014, p.121.

Context for recent reforms: what's new?

- Wholesale market
  - Increase investment to decarbonise
  - Renewables
  - Security of supply

- Retail market
  - Rising prices
  - Fuel poverty
  - Competition?

The objectives of UK energy policy

- The impossible trinity:
  - –Competitiveness
  - –Energy Security
  - –Decarbonisation

- The other ones:
  - –Elimination of (energy) poverty
  - –Renewables
  - –Green jobs/economy/technology

UK Decarbonisation targets

- UK in 2014 GHGs: -35.7% relative to 1990
- Kyoto Target: -12.5% by 2012; UK Target -34% by 2020

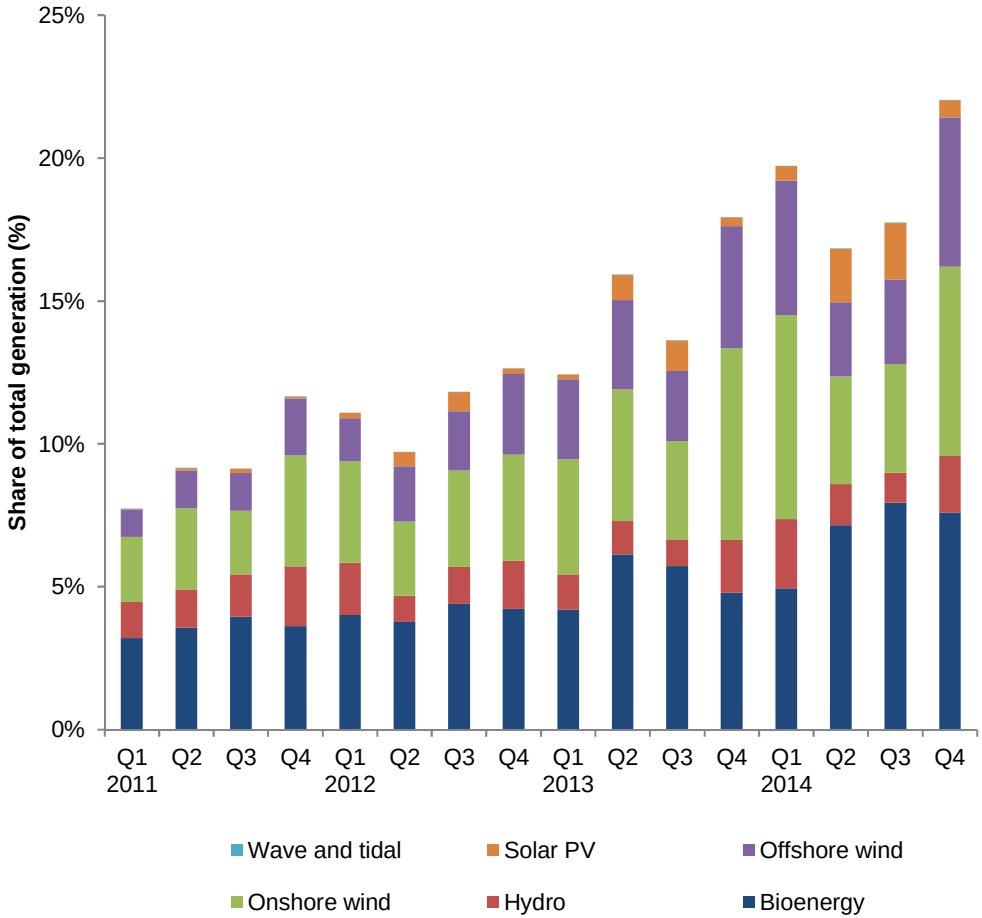
- 2008 Climate Change Act:
  - 80% reduction by 2050
  - Climate Change Committee
  - Five Year Carbon budgeting
  - Latest projections: 90%+ decarbonisation of electricity by 2030
  - Latest target: -50% relative to 1990 by 2023-27.

UK Renewables Targets

- UK committed to 15% target for renewables contribution to total final energy consumption in 2020 (2009/28/EC) (5.2% in 2013)
- The 'target' is for c.30% of electricity from renewables by 2020 as part of the above (19.2% in 2014).
- Previous 2010 target of 10% for electricity from renewables (2001/77/EC) missed. Only 7.3% was achieved.
- Clearly, strong policies are required.

Growth of Renewables in UK

Chart 6.1 Renewables' share of electricity generation



Source: Energy Trends March 2015, p.48.

ELECTRICITY MARKET REFORM

EMR – Electricity Market Reform

- Four elements proposed in December 2010:
- 1. Fixed prices for low carbon generation (CfD-FiTs)
- 2. Carbon Price Support (CPS)
- 3. Capacity Market (CM)
- 4. Emissions Performance Standard (EPS)

- Draft Energy Bill issued in May 2012, legislated in 2013.

Origins of EMR proposals

- Nov 2008: Climate Change Act (passes 463-3 on third reading in HoC).
- December 2008: First report of Committee on Climate Change:
  - sets up electricity as lead sector for decarbonisation, with 90% per kWh decarbonisation by 2030.
  - Electricity identified as key to decarbonising heat and transport.
- 12 October 2009: Committee on Climate Change First Progress Report details key EMR elements.
- May 2010: Coalition Agreement, somewhat surprisingly, specifies 4 elements of EMR.
- Dec 2010 DECC publishes EMR proposals…
- It is absolutely clear that motivation for EMR lies with Committee on Climate Change, 5 year carbon budgeting and the Climate Change Act.

Opening remarks on the electricity market

- Fundamentally, the question behind the EMR is *what sort of market it would take to deliver secure power, renewables and carbon reduction simultaneously?*
- Economists can design *a set* of markets to do this, so there is a more markets, not less solution. Including:
  - Complete power markets
  - Supplier non-delivery penalties for residential customers
  - A comprehensive carbon market (within the EU)
  - An EU green certificate market (for 'learning')
  - Nodal pricing of network access
  - Merchant transmission links
- However markets do produce certain risks and raise (solvable) distributional issues.

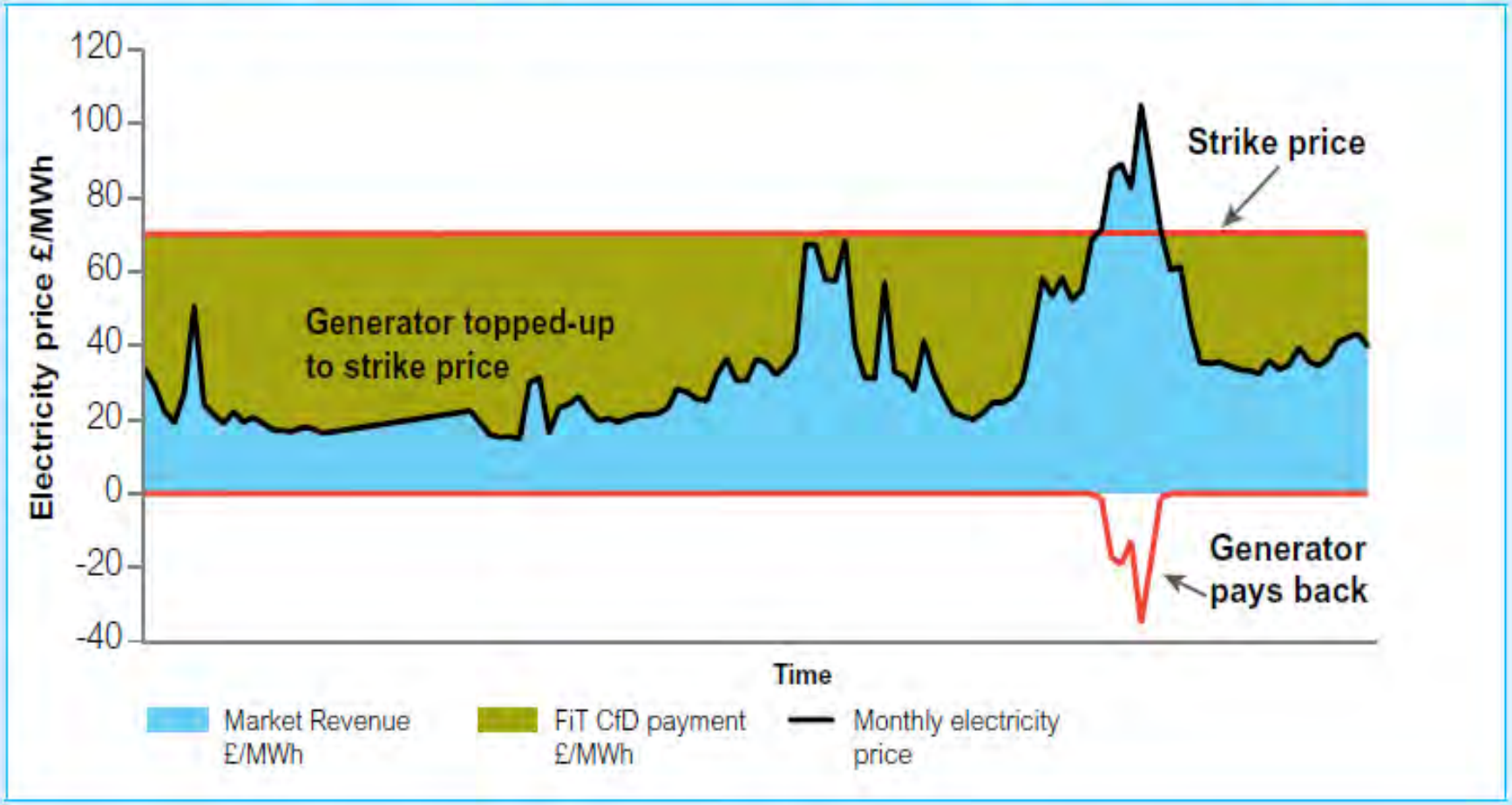
How the four EMR elements fit together

- Need to achieve carbon and renewables targets. Electricity is first sector in line for large scale decarbonisation.
- CfD-FiTs offer price (energy+carbon) certainty and are high enough to support low carbon generation such as nuclear etc.
- CPS needed to raise price of carbon for fossil generation to encourage switching and have added benefit of reducing CfD payments *and* raising some tax revenue.
- Under CfD-FiTs and CPS, fossil generation gets pushed to margin and has low plant utilisation, but is needed to back up intermittent sources such as wind, therefore needs an availability payment, via capacity market.
- Then just in case, we don't get price based incentives right, EPS ensures that high CO2 fossil plants do not get built.

ANALYSING EMR

(1) CfD-FIT

Figure 5: The operation of an intermittent Feed-in Tariff with Contract for Difference



Source: DECC (2011), *Planning our electric future: a White Paper for secure, affordable and low-carbon Electricity, p.38.*

(i) Support for Low Carbon Generation

The reform sets up of a system of contracts for differences (CFD-FITs) whereby the government would contract with low-carbon generators to supply electricity at fixed prices for a prolonged period. These contracts pay the generators the difference between the average wholesale price of electricity and the contract price.

The argument for CfDs

- The argument is around the volatility of the EUETS price for CO2. EUETS is not volatile if hedged by a simple buying strategy, but the average price is low.
- CfD-FiTs will raise the average price of generation, however no real evidence that it will reduce the cost of capital (as is claimed).
- Any remaining risk is transferred to the consumer, but ultimately the government. It does not go away.
- The main risks for nuclear are construction risk and appropriation of cash flows once built (as in Germany) these are not addressed.
- CfD-FITs are still subject to uncertainty around the strike price of future plants (e.g. second and third nuclear plants).
- In the end the theoretical argument for CfD-FiTs versus a price of carbon does not pay sufficient attention to the theory of finance.

- New CfDs for 15 years indexed to general inflation (CPI).

Progress with CfDs

- Hinkley C, 35 year contract agreed with EdF and Chinese investors at £92.50 / MWh (2012) for delivery in 2023.
- Est. £1844m p.a. cash flow net of running cost and decommissioning fund (DECC, 2013, costs)
- NPV of Hinkley C discounted cash flow from 2023:
  - £19564 m, at 10% p.a. for 35 years
  - £31707 m, at 5% p.a. for 35 years
- This implies a refinancing gain of £12bn if on budget opening of plants.
  - This is equivalent to a £28 / MWh
  - i.e. Strike price could be £64.50 / MWh
- EU did push back on refinancing of project.
- Project now on hold.

Draft strike prices… (£1 = 9 CNY)

	Levy Control Framework – Upper Limits on Spend (£m) (2011/12 prices)[1]						
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
	3,300	4,300	4,900	5,600	6,450	7,000	7,600
Renewable Technology	**Draft Strike prices (£/MWh) (2012 prices)**					**Potential 2020 Deployment Sensitivities (subject to VfM and cost reduction) (GW)[2]**	
	2014/15	**2015/16**	**2016/17**	**2017/18**	**2018/19**		
Advanced Conversion Technologies[3] (with or without CHP[4])	155	155	150	140	135	**c. 0.3**	
Anaerobic Digestion (with or without CHP)	145	145	145	140	135	**c. 0.2**	
Biomass Conversion[5]	105	105	105	105	105	**1.2 – 4**	
Dedicated Biomass (with CHP)[6 7]	120	120	120	120	120	**c. 0.3**	
Energy from Waste (with CHP)[8]	90	90	90	90	90	**c. 0.5**	
Geothermal (with or without CHP)[9]	125	120	120	120	120	**< 0.1**	
Hydro[10]	95	95	95	95	95	**c. 1.7**	
Landfill Gas	65	65	65	65	65	**c. 0.9**	
Offshore Wind	155	155	150	140	135	**8 – 16**	
Onshore Wind	100	100	100	95	95	**9 – 12**	
Sewage Gas	85	85	85	85	85	**c. 0.2**	
Large Solar Photo-Voltaic	125	125	120	115	110	**2.4 – 3.2**	
Tidal Stream[11]	305	305	305	305	305	**c. 0.1**	
Wave[12]	305	305	305	305	305		

Notes:

Source: DECC

1st CfD Auction results Feb 2015

Technology		2015/16	2016/17	2017/18	2018/19	Total Capacity (MW)
Advanced Conversion Technologies	£/MWh			119.89	114.39	
	MW			36	26	**62**
Energy from Waste with Combined Heat and Power	£/MWh				80	
	MW				94.75	**94.75**
Offshore wind	£/MWh			119.89	114.39	
	MW			714	448	**1162**
Onshore wind	£/MWh		79.23	79.99	82.5	
	MW		45	77.5	626.05	**748.55**
Solar PV	£/MWh	50	79.23			
	MW	32.88	38.67			**71.55**

Source: DECC

(2) Carbon Pricing

The **reform has already introduced a carbon price support (CPS)** based on the existing climate change levy (CCL). This involves increasing the rate and coverage of the climate change levy to effectively increase the price of carbon emissions from the electricity sector in the UK above that in the rest of the EU.

Began April 2013 with a target CO2 price is £30/tonne (in 2009 terms) – forward EUA price + CPS - by 2020 (possibly £70/tonne by 2030). *However CPS now capped at £18 /tCO2 (now binding).*

CPS – a theoretical analysis

- The CPS is fundamentally a tax policy. It needs to be analysed in the light of the principles of optimal tax theory.
- It is a carbon tax implemented on electricity, not on domestic gas or any other source of CO2, and hence distorts the use of electricity relative to other energy carriers.
- The CPS distorts international competition and trade in electricity. Energy intensive industry will shift to continental Europe and electricity imports (which cant be taxed on trade grounds) will be encouraged. This is simple tax arbitrage. Diamond and Mirrlees (1971) show that industry should be exempted from intermediate goods taxes for these reasons.
- The CPS directly impacts the wholesale price via raising the price of marginal fossil generation. In 2015-16 it will raise household bills by 5-11%, and revenue of £2bn, making it difficult to get rid of.

(3) Capacity Mechanism

The reform has introduced a capacity mechanism (CM) to contract for the necessary amount of capacity to maintain security of supply. This involves the introduction of payments to generators for maintaining availability, supplementing the market for units of electrical energy that exists at the moment. This deals with predicted low capacity margins by 2018.

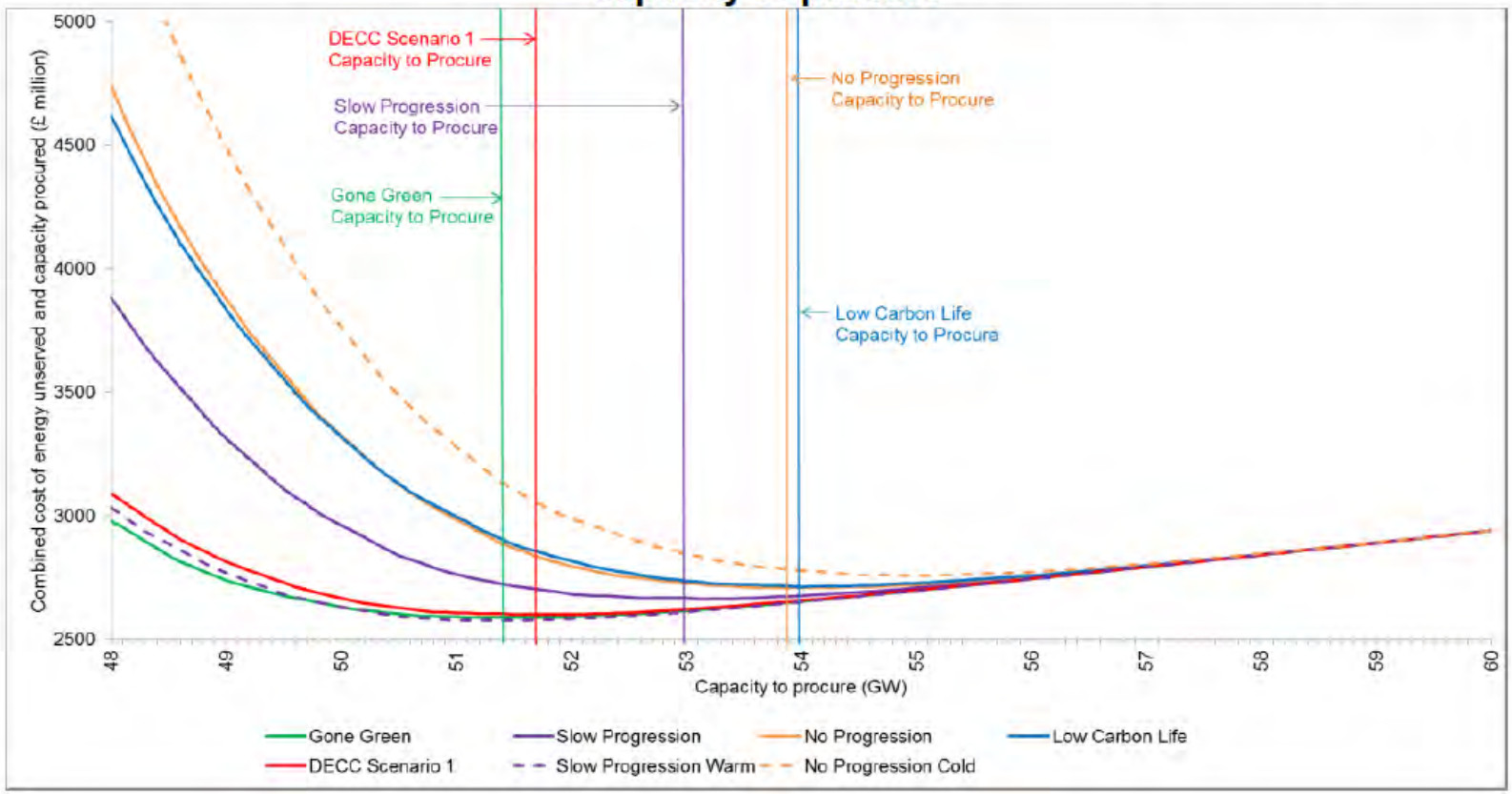
Note: The amount of capacity to be contracted for is decided by the government.

Theory of Capacity Markets

- This is the theory of supply and demand. In most capital intensive goods markets payment is for production, not capacity.
- Indeed competitive markets strongly incentivise excess capacity (while government owned industries, usually suffer from shortages due to unwillingness to raise finance for new capacity), due to strong non-delivery penalties and duplication of reserves.
- The actual issue is not capacity but willingness to pay to avoid interruption. This is not well expressed by households (in the absence of smart meters), but can be captured directly by regulatory non-delivery penalties.
- What is clear is that capacity mechanisms in electricity (e.g. in the US) only seem to be necessary when energy prices are capped at arbitrarily low levels (Texas considering raising its cap).
- A case for capacity payments may emerge at high levels of renewables but only to encourage entry of small intermittent generators who will find it difficult to contract with fossil generators directly for back up generation. In such cases a capacity market might emerge privately.

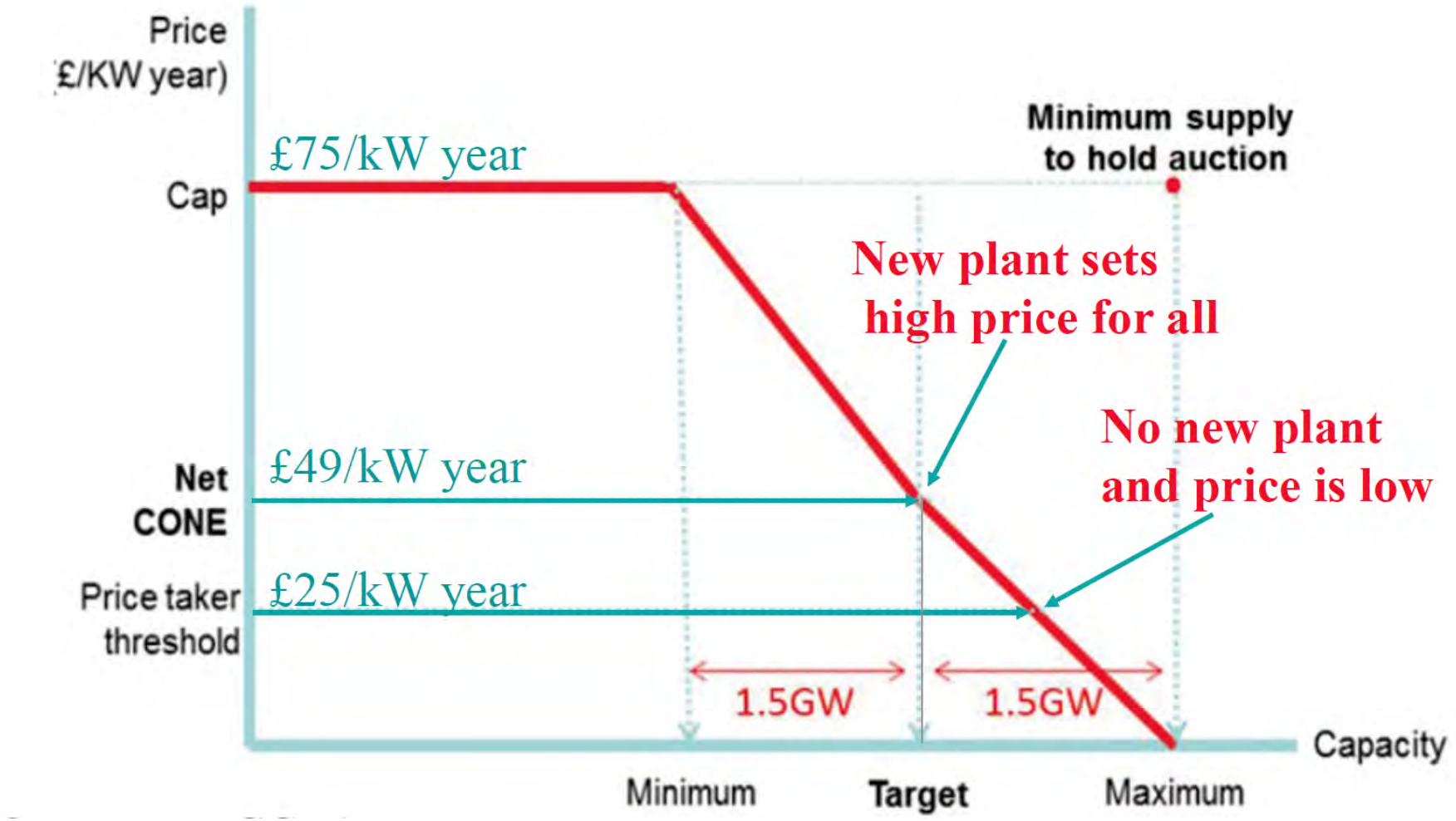
How much capacity?

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



Source: National Grid (2014, p.50)

Capacity Market auction design



CONE = Cost of New Entry
Source: DECC and David Newbery

GB Capacity Market Auction for 2018/19

Figure 1 shows the Demand Curve and the supply curve. The supply curve is found by cumulatively adding the Bidding Capacities of CMUs, according to their Exit Ranking. The supply curve meets the Demand Curve at a Price of £19.60 / kW.

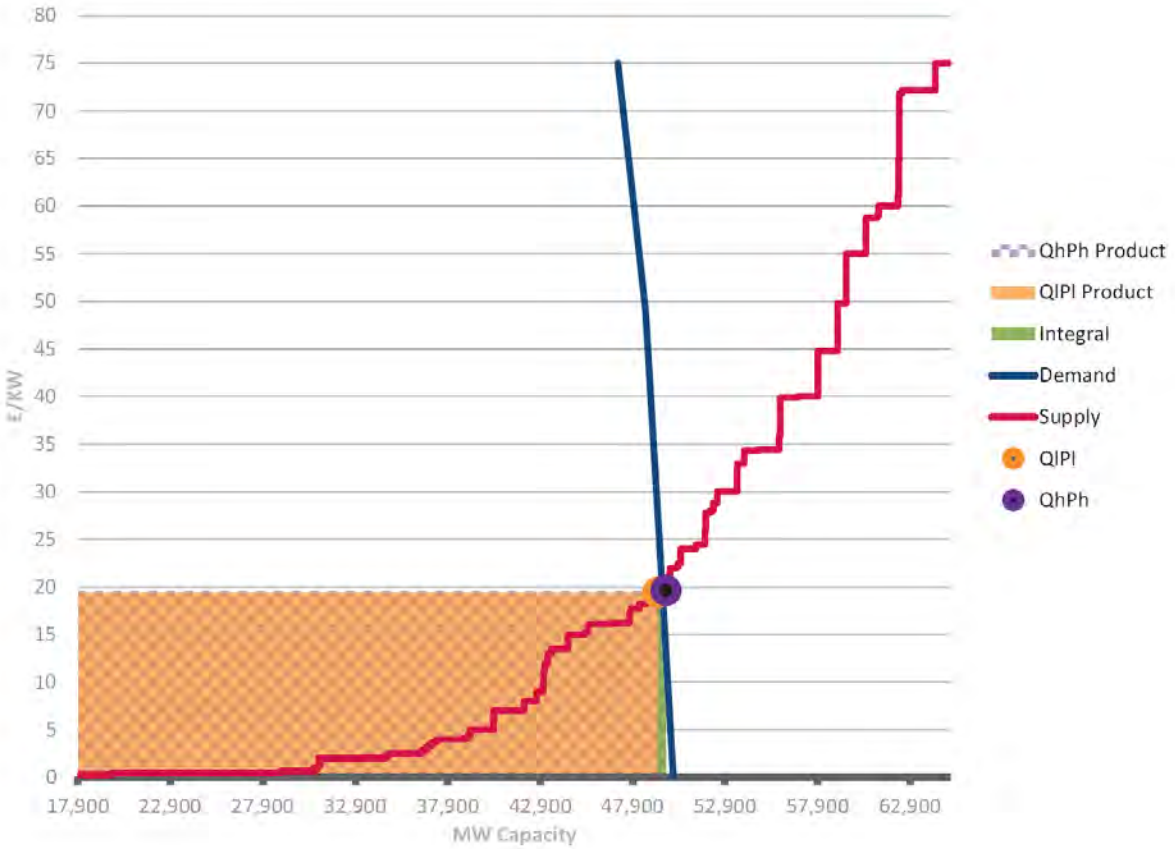


Figure 1: The Supply Curve

Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389832/Provisional_Results_Report-Ammendment.pdf

Capacity auction results

- Target 53.3 GW, with 2.5 GW acquired at T-1.
- EMR Expert Panel on capacity mechanism critical of calculation of capacity requirement. At least 2.3GW of interconnectors available
- Assumed that no capacity due to interconnectors. Actually should be 2.3 GW (or 62%), by 2018 this could be 3.3 GW.
- The Clearing Price is**: £ 19.40 / kW / year**
- The Aggregate Bidding Capacity of Capacity Market Units awarded Capacity Agreements is: **49,258.938 MW. Cost: £955m.**
- **So probably over paid by *at least* £260m.**

(4) Emissions Performance Standard (EPS)

New supercritical coal fired generation has average CO2 emissions of around 790g/kWh; a modern gas-fired power plant about 360g/kWh. The reform introduces an emissions performance standard (EPS) for all new power plants of 450g/kWh, designed to rule out the building of new coal-fired power plants without carbon capture and storage (CCS) technology fitted (to a substantial part of a new plant).

Note: that new peaking plant will be permitted as maximum emissions are calculated at an 85% load factor.

Emissions Performance Standard

- This is a backstop command and control approach to environmental regulation.

- However it does introduce an instrument which could be ratcheted up to eliminate the building of new gas fired power plants.
- However coal prices remain very low at 0.772p/kWh, with gas prices at 2.026p/kWh (DECC, QEP321, Q4 2014);
- At 45% and 60% efficiencies, the fuel cost of a kWh of coal and gas would be:
- 1.72p/kWh (coal) and 3.38p/kWh (gas) of electricity

- This would need an EUA price of c.£38/tCO2 / 52 Euro/tCO2 to make gas attractive.

CONCLUSIONS

What Consumers Will Get with EMR...

With EMR package (my view):

a. Total Welfare Impact	-ve
b. Distributional Analysis	-ve
c. Indirect Impact	-ve
d. Renewables	35%
e. Decarbonisation	None
f. Energy Security	-ve
g. Cost of Capital and Risk	Down?

Conclusions on EMR experience so far

- CfD auctions look good, administered contracts look bad.
- Carbon Price Support (CPS) has hit predictable problems of unsustainability.
- Capacity auction has been politicised as predicted and been unnecessarily costly.
- Emissions Performance Standard (EPS) may be preventing investment in coal.
- Pushing UK back towards government as 'single buyer' of generation…

Reading

- EMR Panel of Technical Experts' (2014) *Final Report on National Grid's Electricity Capacity Report*, London: DECC.
- National Grid (2014a). *Electricity Capacity Report,* at http://www2.nationalgrid.com/UK/Our%20company/Electricity/Market%20Reform/Announcements/June%202014%20Auction%20Guidelines%20publication/
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- Platchkov, L., Pollitt, M. and Shaordhadze, I. (2011), *The Implications of Recent UK Energy Policy for the Consumer: A Report for the Consumers' Association*, 2011 at http://www.eprg.group.cam.ac.uk/wpcontent/uploads/2011/05/ReportforCAFinal100511EPRG.pdf
- Pollitt, M. and Haney, A.B. (2013), 'Dismantling a Competitive Electricity Sector: The UK's Electricity Market Reform', *The Electricity Journal*, Vol.26, No.10, pp.8-16. *Critique of government EMR.*