Electricity Market Reform:
Will it work and if so how?

Michael Pollitt[1]
Cambridge Judge Business School
and
Electricity Policy Research Group
University of Cambridge
m.pollitt@jbs.cam.ac.uk

Beesley Lecture
8 November 2012

Outline of talk

There are five sections: Setting the scene (behind EMR); Proposed Electricity Market Reforms in the UK; EMR impact analysis; Is EMR a model for other countries to follow?; If not EMR, then what?

1. Setting the scene

There are four elements Electricity Market Reform (EMR) 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 was issued in May 2012 and is due to be legislated in 2013.

Summary of talk: Q. Will it work? A. No.

UK energy policy is characterised by:
The impossible trinity of objectives, which find it difficult to coexist:
–Competitiveness;
–Energy Security;
–Decarbonisation.[2]

[1] This talk reflects my own analysis and should not be taken to represent the views of any other member of the EPRG or any other organisation with which I am associated. I do however gratefully acknowledge the extremely helpful comments of David Reiner and Stephen Littlechild. All errors are my own.

In addition there are other policy objectives which are often mentioned:
–Elimination of (energy) poverty (possibly in conjunction with competitiveness);
–The roll out of Renewables;
–The creation of Green jobs/economy/technology.

UK Decarbonisation targets:
UK in 2011 GHGs: -28.3% relative to 1990.
Kyoto Target: -12.5% by 2012; UK Target -34% by 2020.

2008 Climate Change Act mandated: an 80% CO2e reduction by 2050; the creation of the Climate Change Committee; and Five Year Carbon budgeting. The latest projections from the CCC suggest 90%+ decarbonisation of electricity by 2030; and their latest published five year budget suggests -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) (3.8% in 2011). Currently support regime only envisages 15.4% renewables in electricity by 2015-16. (8.6% in 2011). 2010 target of 10% for electricity from renewables (2001/77/EC). 7.3% was achieved.[3] Clearly, current policies on renewables are not working (see Figure 1). It is also clear the current EU price of carbon dioxide allowances is too low to support more renewable or nuclear new investment (see Figure 2).[4]

---

[2] DECC's four main policy goals are currently: saving energy, secure energy, decarbonisation and managing their energy legacy (e.g. nuclear waste). Thus low energy prices per se are not a policy goal. See: http://www.decc.gov.uk/en/content/cms/about/our_goals/our_goals.aspx

[3] Renewable electricity shares from DECC (2012, p.161), on a 2001 Electricity Directive basis.

[4] Every 10 Euros on the price of an EUA increases the price of gas generation by c.0.4cent/kWh (@400g CO2/kWh). An EUA price of 60 Euros thus raises the price of gas relative to nuclear by 2.4cent/kWh or 1.9p/kWh.

Figure 1: Renewables Obligation

	Target renewable share in GB	% Delivery in UK	Nominal Buyout Price £/MWh	Total Cost £m
2002-03	3.0	59%	30.00	282.0
2003-04	4.3	56%	30.51	415.8
2004-05	4.9	69%	31.59	497.9
2005-06	5.5	76%	32.33	583.0
2006-07	6.7	68%	33.24	719.0
2007-08	7.9	64%	34.30	876.4
2008-09	9.1	65%	35.36	1036.2
2009-10	9.7	71%	37.19	1108.6
2010-11	10.4	72%	36.99	1285.4
2011-12	11.4	85%*	38.69	1457.7
2012-13	12.4		+ inflation thereafter	
2013-14	13.4			
2014-15	14.4			
2015-16	15.4			Estimated: ~£1969m at 2011-12 prices prices) assuming no demand growth

Total electricity expenditure in 2011 = £31.4bn

Note: *Calendar year 2011 estimate. NI targets lower.

Figure 2: EUA CO2 price

Source: Bloomberg

Ground clearing…Are the lights going to go out?

Ofgem (2012) shows lack of attention to internal consistency of economic analysis and history. Period before 2012/13 not shown: in 2002 de-rated capacity margin 7%. Demand reduction – no elasticity on demand due to high prices. Apparently 2.8 GW of mothballed CCGT assumed not brought back, even if wholesale prices or coal generation costs rise. Only 5.5GW of wind is assumed against 11GW of wind under construction and planned. Finally, in 2012-13: National Grid (NG) predict 17-19% de-rated capacity against 14% assumed.[5] So Ofgem central estimate can already be revised up to 7%+ (above 2002 level)..[6].

Ground clearing…Green growth important
Green jobs: BIS (2012) report suggests 939,000 'green' jobs in UK in 2010/11. However this includes water, windows and forestry and lots of other non-subsidised jobs…unrelated to renewable subsidies. Apparently there are 94,000 jobs in the UK wind industry. There are only 102,000 in *German* Wind, of which, only 40,000 in manufacturing and supply of turbines) (see Wind industry in Germany, Economic Report, 2011). Significant general equilibrium effect of rise in electricity prices across industry (e.g. Hughes, 2011), implying job losses elsewhere. Constable (2011) estimates the subsidy per wind industry job in the UK at £57,000 p.a..

Energy is important for economic growth. Low energy prices have been central to UK historical economic growth (Allen, 2009), and our historic economic development. Positive energy price shocks do reduce GDP and induce recessions (Killian, 2006). So don't engineer one!

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.

At the other extreme we have a more interventionist solution, this would see the re-emergence of integrated companies capable of simply undertaking investments imposed on them by regulators/government (the 'bad' 'old' days).

In between, achieving renewables and carbon targets without proper market incentives requires some variant of a single buyer model for low carbon generation.

The fundamental problems with this are: how to put market ideas back in box; and that more explicit government direction of the industry is likely to result in political paralysis of investment.

Markets are not dead in single buyer world. However the single buyer does remove some of the functions of the market: The ability to quickly react to new information; long term

[5] This seems to be the result of more realistic assumptions about interconnector availability.

[6] See Appendix 1.

commodity price risk management; decentralised portfolio optimisation; competition in planning for the future; reduction of technology based lobbying; responsibility for long term planning failures. Clearly single buyers pick winners (or losers).

2. An analysis of proposed Electricity Market Reforms (EMR) in UK

Origins of EMR proposals:

Key dates in publication of EMR elements:
Nov 2008: Climate Change Act (passes 463-3 on third reading in House of Commons).
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.
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.

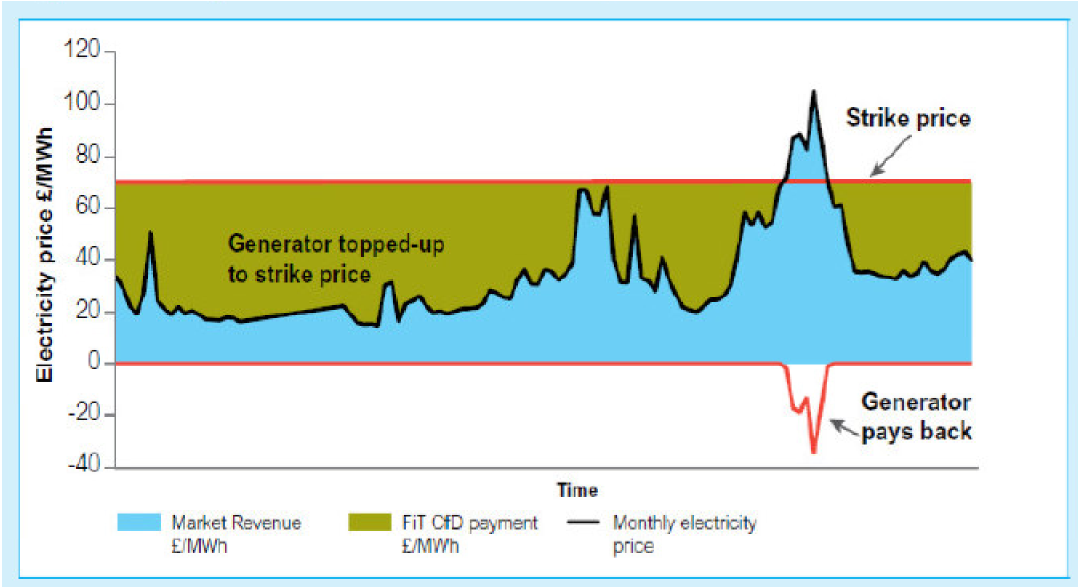
How the four EMR elements fit together:

If one starts with the need to achieve carbon and renewables targets, then 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 is 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 a capacity market. Then just in case, we don't get price based incentives right, EPS ensures that high CO_2 fossil plants do not get built. There is a logic, is it good economics?

EMR Element 1: Support for Low Carbon Generation

The reform proposes the setting 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 would pay the generators the difference between the average wholesale price of electricity and the contract price (see Figure 3).

Figure 3: CfD-FIT



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

The argument for CfDs:

The argument is around the volatility of the EUETS price. EUETS is not particularly volatile if hedged by a simple buying strategy, but the average price is low. CfD-FiTs will raise the average price, however no real evidence that it will reduce the cost of capital (as is claimed). Any remaining risk is transferred to the counterparty. This will be the electricity consumer, and ultimately the taxpayer. It does not go away.

The main risks for nuclear are construction risk and the risk of 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, which suggests that all risks need to be taken into account and the exact nature of product price risk needs to be examined carefully.[7]

Some Practical Problems with CfD-FiTs:

What will be the reference price? Over 40 years it is not at all clear that there will be one meaningful market price for residual fossil generation.

Who will be the counterparty? The System Operator (NG) has apparently refused to take this

[7] See John Parsons (2011), *Helpful Tips on Risk and Investment in Low Carbon Generation*, Cambridge-MIT conference. http://www.eprg.group.cam.ac.uk/wp-content/uploads/2011/09/110922-CEEPR-EPRG.pdf

role. It seems that it will be the government and CfD payments will be a state aid.

How will there be competition in the CfD-FiT market for low carbon generation, especially if there is technology banding? Only one company is still in the first nuclear power plant competition.

EMR Element 2: Carbon Pricing

The **EMR 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. This was legislated for in the 2011 UK budget (to begin in April 2013), with a target CO2 price of £30/tonne (in 2009 terms) by 2020 (possibly £70/tonne by 2030). The CPS is a electricity fuel tax which when combined with the forward EUA price raises the CO2 price for electricity to an annual target level. Note: that with inflation CO2 price in UK could easily be 50 Euros per tonne by 2020.[8]

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 can't be taxed on EU 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 will directly impact the wholesale price via raising the price of marginal fossil generation. In 2014 it will raise household bills by 3-6% on top of CfD-FiT effects (see Appendix 2).

Practical problems with CPS:

There is also a political problem, it is unlikely that the UK Treasury will want to reduce the total revenue from the tax to zero from its initially highly significant level, so the rate may not be increased as expected. CPS also complicates the economics of CCS and CHP which will require more subsidy at higher carbon prices. CPS will lead to messy exemptions with arbitrary cut off points for energy intensive users. CPS, like CfD-FiTs, by reducing the number of EUA permits required by the UK undermines the EUETS.

EMR Element 3: Capacity Mechanism

The reform proposes the introduction of a (market wide?) capacity mechanism (CM) to contract for the necessary amount of capacity to maintain security of supply. This would involve 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 (though Ofgem now suggesting this will happen sooner).

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

[8] See Daniel Radov (2011), *The UK Carbon Price Floor*, EPRG Winter Conference. Available at: http://www.eprg.group.cam.ac.uk/wp-content/uploads/2011/12/Radov-Carbon-Price-Floor-111209-FINAL.pdf

date of introduction could (in theory) be in the 2020s!

Theory of Capacity Markets:
This is based on 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 due to strong non-delivery penalties and duplication of reserves. By contrast government owned industries, usually suffer from shortages due to unwillingness to raise finance for new capacity. 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 has raised its cap and proposes to do so again)[9]. 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.

Practical problems with Capacity Markets:
Who decides what the required level of capacity is? Is it the government and if so, how? Recent US experience suggests that far from guaranteeing revenue for generators, capacity markets can be used by governments to appropriate revenue from generators by licensing new capacity to drive down capacity market prices (e.g. FERC vs Maryland/New Jersey, who was accused of monopsony activity in the capacity market)[10]. National capacity markets are problematic in the EU. It may not be possible to stop EU generators bidding into the capacity markets via interconnectors (who are also avoiding the CPS), thus supporting capacity in other countries rather than the UK (if for instance capacity markets are deemed a form of public service obligation).

EMR Element 4: Emissions Performance Standard
New supercritical coal fired generation has average CO2 emissions of around 790g/kWh; a modern gas-fired power plant about 360g/kWh. The reform proposes 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, so peaking oil or open cycle gas plants are not ruled out.

The EPS is a backstop command and control approach to environmental regulation.
It appears to be innocuous in that no-one currently wants to build the plants that it rules out. However it does introduce an instrument which could be ratcheted up to eliminate the building of new gas fired power plants. Given the problems that California, Italy, Germany and Japan have had from environmental standards ruling out 'any' timely new build/operation of large conventional power plants. It is a significant threat. It serves no useful function in terms of

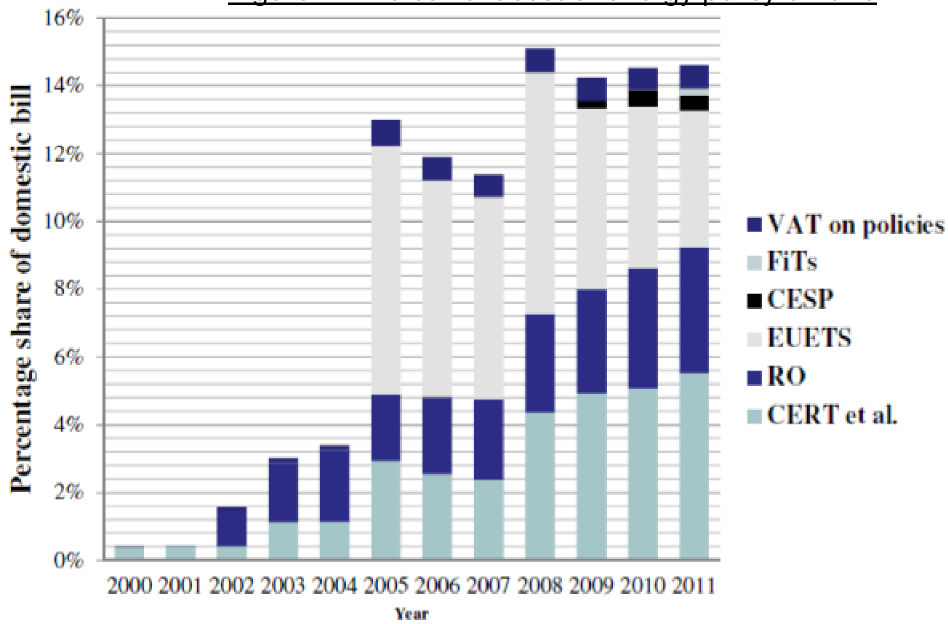
9 Texas has recently raised its electricity wholesale price cap from $3000 to $4500 and is considering raising it to $9000. See http://www.texasenergyfoundation.org/in-bid-to-encourage-new-power-plants-texas-utility-commission-raises-wholesale-electricity-price-cap/.

10 See Appendix 3.

renewables or decarbonisation, therefore it has no place in the EMR package.

3. EMR Impact Analysis

Figure 4: The current cost of energy policy on bills



Note: Generation based only, excludes transmission and distribution policy costs. 3300 kWh consumption. Source: Chawla and Pollitt (2012).

Household electricity bills already reflect a significant portion of policy related costs – this is the starting point for EMR bill impacts (see Figure 4).

Household Bills (DECC, 2010, IA):

The original DECC impact analysis assumes reduced household consumption from 2010 to 2030 (10% decrease). This is the direct result of current and planned government policies. Wholesale electricity prices increase by 69% from 2010 to 2020 under the preferred EMR package. The consumer bill goes up, but not as much as the wholesale prices, because of demand reduction and the impact of non-wholesale costs in dampening the relative impact. The household electricity bill increases 33% by 2030 under preferred EMR package. The household bill is reportedly 1% higher than in Baseline in 2020, but 7% lower in 2030. However, this Baseline assumes ambitious adjustments in Renewables Obligation (RO) bands to meet increased Renewable Obligation target...[11]

Proposed Reforms and Bills:

EMR modelled real bill impacts (July 2011):
Households: +32% by 2030

[11] See Platchkov et al. (2011) for a detailed discussion.

Medium Non-Dom: +56% by 2030
Energy intensive industrial: +69% by 2030

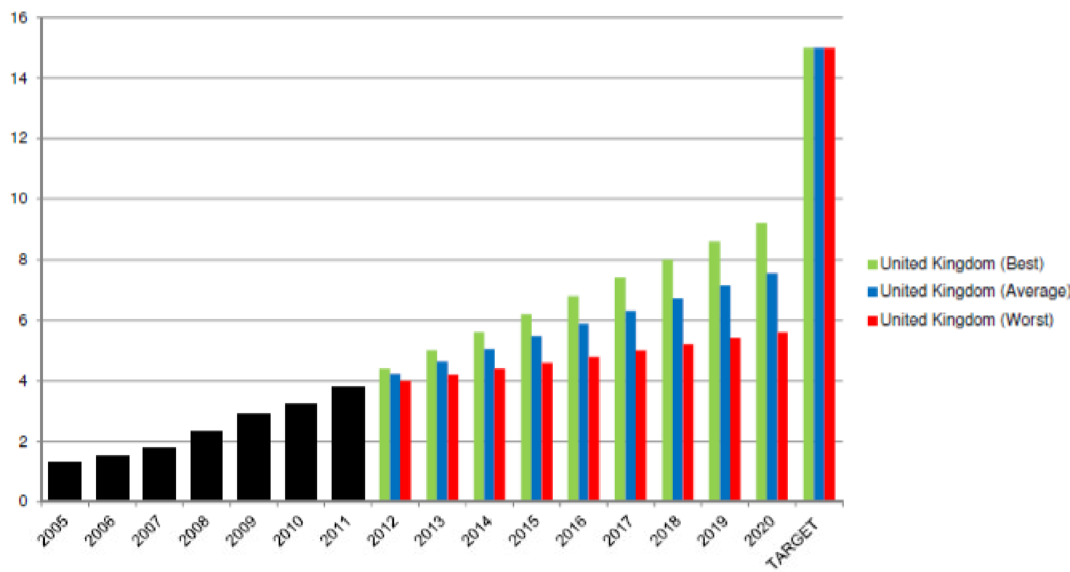
Wholesale price elements rise by higher percentage. Even assuming higher gas prices (as in EMR) 82% of domestic bill rise is policy induced (see Appendix 4).

What Consumers Will Get:
EMR policy package yields (my view of DECC's impact analysis):

a.	Welfare Impact	*-ve NPV*
b.	Distributional Analysis	*-ve*
c.	Indirect Impact	*Not analysed*
d.	Renewables	*35% by 2030*
e.	Decarbonisation	*No at EU level*
f.	Energy Security impact	*-ve NPV*
g.	Cost of Capital and Risk	*Goes down?*

A key part of EMR costs is the cost of renewables for achieving the renewable target for 2020 and beyond. It is important to be clear that this target is not achievable on any likely scenario (see Figure 5).

Figure 5: Is the UK renewables target credible? (% renewable energy)



Methodology for three scenarios: Using the highest, average and lowest differences in figures between 2005-2011, we project the best, average and the worst cases from 2012 onwards.

Does EMR reduce risk?
Does EMR reduce risk relative to pre-EMR risks (not all EMR elements equally significant)? We look at each element in turn.
CfD - Feed in Tariff:
There is inherent risk in setting the optimal level due to information asymmetry & unknowns –

if strike prices are too low there is risk of undersupply; if too high, risk of windfall profits and hence unnecessarily high prices for consumers.
Carbon Price support:
Longevity and policy commitment is a problem with all tax measures. There is the difficulty of raising it to an adequate level if this compromises its tax raising function.
Capacity mechanism:
There are risks around the uncertainty of delivery of capacity, monopsony buying and the politicisation of capacity market price.
Emission Performance Standard:
This is superfluous, but its presence on the statue book introduces the risk of it being arbitrarily tightened.

None of these mechanisms would seem to reduce overall risk/uncertainty for energy investments.

If EMR is specifically about reducing the risk of nuclear investment, then it does nothing for the nuclear technology specific risks: nuclear costs are high and rising e.g. MIT 2009 study on nuclear costs has doubled its estimates compared to 2003 study. Recently costs have been escalating construction costs due to higher commodity prices. History clearly shows that estimated costs are less than outturn costs:
Olkiluoto 3 in Finland: reported contract price in 2004 was 3 billion of Euros. Today it is estimated at 5 billion (+). It is now due to take 9 years to construct (against 4 planned). The design of this deal in fact makes consumers' bear the risk (Schneider et al. 2009).
Flamanville 3 in France: Cost estimated at 3.3 billion Euros in 2006, 4 billion in 2008, 4.5 billion in 2009, 6 billion in 2011 and now due to take 9 years to construct.

There is also historical evidence that the nuclear programme in France is subject to negative learning effects (Grubler, 2010).[12]

4. Is EMR a model for other countries to follow?

Combining subsidies and the market via EMR:
Policy impacts are significant, but largely fail a social cost benefit analysis (SCBA) test: *Bills rise substantially, large welfare transfers to companies, risks transferred to consumers, no impact on global carbon emissions, but more renewables (in UK, but not necessarily elsewhere). Public support for climate change and renewables policy is undermined.*

Policy consistency is not addressed for investors: *EMR increases policy complexity and undermines international carbon reduction strategy. Policy specific risks increased.*

Individual policy design not same as a consistent strategy:
EMR is not a fundamental redesign of the market based on sound economic principles. Two of the four elements are redundant (the EPS and the capacity market). There is some movement towards comprehensive set of carbon taxes, but RES support not rationalised, energy security

[12] See Appendix 5.

costs are partly socialised. Meanwhile some of the fundamental tenets of optimal tax policy are violated, and EU and global decarbonisation policies are undermined.

Combining subsidies and market via EMRs:
The macro-economic impact of EMR for UK is not analysed by DECC, but the impact on real consumption (rather than GDP) high. Headline rise in bills suggests extra expenditure for household electricity of 33% of £14.495 bn and 62% for non-household electricity of £15.315 bn = £14.275 bn of extra energy expenditure (from Dukes 2012, Table 1.4). This is 1% of GDP (*some* of this is tax and profit transfer). Effect on jobs, 225k jobs in energy intensive industry not assessed. Long term effect on GDP and consumption per head likely to be negative for no benefit (see Krupnick and McLaughlin, 2011).

Is EMR a model for other countries?
A key issue is whether national EMRs could be part of a global solution to climate change. This would be true if EMR can (even approximately) replicate the cooperative solution in equilibrium. However the following undermine this: seams issues – how national policies interact; free riding – how is cheating reduced without an international agreement; and an inability to calculate (in the absence of an agreement) national share of global solution.

Conclusion on EMR:
EMR displays a huge amount of economic illiteracy: on the theory of finance;
on the theory of optimal taxation; on the nature of supply and demand in markets; and on economic instruments for reducing externalities…EMR also suffers from a host of practical and implementation problems and has little empirical efficacy basis. EMR, if it is ever seriously implemented in the UK, will fail to deliver at reasonable cost.

The contrast between the UK government's unwillingness to accept economic analysis vs. its willingness to accept climate change science is striking.

5. If not EMR, then what?

The Impossible Trinity of energy policy needs to be honestly admitted. Decarbonisation is expensive even if we keep costs to a minimum (Stern Review was wrong to imply it was cheap!)[13]. Some combination of higher prices and higher taxes are necessary to decarbonise and have lots of renewables. Admitting this, will be the starting point for hard choices to be faced in energy policy. Most likely this will lead to the scaling back of our current ambitions to a more economically sustainable level.[14]

Four key starting principles for a new more honest and likely to succeed approach are:

1. Cost is important: we already spend c.0.3% of GDP on environmental/efficiency measures for electricity and gas and we have just started![15]

2. We need to **abandon our current renewable energy target** if we are to preserve our 80% CO2 target.

[13] Elections are won and lost on expenditure programme differences of less than 0.5% of GDP.

[14] This is not certain: the UK does spend more than other comparable countries on (inter)national defence and on overseas aid as a percentage of GDP. Clearly UK voters could choose to do so for climate change. However the differentials on defence and overseas aid in total are about an extra 1% of GDP.

[15] See Appendix 6.

3. The **EUETS has to be at the centre of UK decarbonisation strategy** for now, with the tightening of the quantity cap and the widening of sectors covered negotiation priorities. Only when / if EUETS collapses should we contemplate going it alone with a UK only decarbonisation strategy.

4. Properly functioning market mechanisms, not government planning must be allowed to drive delivery.

While the EUETS is the only serious pan-EU mechanism available, we need to put some effort into **addressing any windfall profit issues arising from tightening the EUETS**. Should the EUETS fail to be strengthened appropriately, this will signal that a serious coordinated EU approach is over and that a Global Deal[16] (as modelled by the EU) on emissions reduction is further away than ever. We can, of course, attempt to pursue a 'go-it-alone' / 'coalition of the willing' strategy but this will be much less effective and costly, and subject to its own negotiation strategy. **Going it alone necessarily implies a much lower initial target level of decarbonisation**, consistent with affordability and maintenance of sensible conditional climate mitigation negotiating position.

A new more sensible approach would refocus efforts away from unrealistic targets and expensive investments.

What we need instead is policy refocused on:

A. Innovation, experimentation and service provision where the UK economy, as a whole, has comparative advantage, not on vain hopes of green mass manufacturing.

B. Allowing for ***positive surprises***, such as cheap gas, demand innovations, or technological fixes, not lock in overly expensive technologies now.

C. A commitment to ***transparency, reducing technology based lobbying*** *and* ***shutting off subsidies if not delivering fast enough cost reductions***, i.e. reducing the scope for 'corruption'.[17]

What we need now is the ***political courage to admit that the current EMR is part of a pre-crisis policy that is no longer deliverable…***

---

[16] See Nicholas Stern, *Key Elements of a Global Deal on Climate Change*. Available at: http://www.cccep.ac.uk/Publications/Other/Global-Deal-Climate-Change.pdf

[17] See for example Chris Charles (2010), *Corruption and fraud in agricultural and energy subsidies: identifying the key issues*, IISD. Available at: http://www.iisd.org/gsi/sites/default/files/pb10_corruption.pdf and Sara Noble (2011), *Subsidies & Corruption in the Wind Power Industry,* The Independent Sentinel. Available at: http://www.independentsentinel.com/2011/10/subsidies-corruption-in-the-wind-power-industry/

Selected References

Allen, R.C. (2009), *The British Industrial Revolution in Global Perspective*, Cambridge: Cambridge University Press.

BIS (2012), Low Carbon Environmental Goods and Services, Report for 2010/11, Commissioned from KMatrix, May 2012, London: BIS.

Chawla, M. and Pollitt, M. (2012), *Energy-efficiency and environmental policies & income supplements in the UK: Their evolution and distributional impact in relation to domestic energy bills,* EPRG Working Paper, forthcoming.

Constable, J. (2011*), The Green Mirage: Why a Low-carbon Economy May be Further Off Than We Think,* London: Civitas.

DECC (2010), *Electricity Market Reform: Impact Assessment*. London, Department of Energy and Climate Change.

DECC (2010a), *Electricity Market Reform: Consultation Document*. London, Department of Energy and Climate Change.

DECC (2010b) Estimated impacts of energy and climate change policies on energy prices and bills. London, Department of Energy and Climate Change.

DECC (2011a) *Electricity Market Reform: Impact Assessment*. London: Department of Energy and Climate Change.

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

DECC (2012), *Digest of United Kingdom Energy Statistics*, London: Department of Energy and Climate Change.

Diamond, P. and Mirrlees, J. (1971), 'Optimal Taxation and Public Production I: Production Efficiency', *American Economic Review*, 61 (1): 8-27.

Du, Y. and Parsons, J.E. (2009), *Update on the Cost of Nuclear Power*, CEEPR Working Paper 09-004.

Grubb, M., Jamasb, T. and Pollitt, M. (eds.), *Delivery a low-carbon electricity system,* Cambridge: Cambridge University Press.

Grubler, A. (2010), 'The costs of the French nuclear scale up: a case of negative learning by doing', *Energy Policy*, 38 (9): 5174-5188.

Hughes, G. (2011), *The Myth of Green Jobs*, GWPF No.3, London: Global Warming Policy Foundation.

Killian, L. (2006), *Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the U.S. Economy?,* mimeo.

Krupnick, A.J. and McLaughlin, D. (2011), *GDP, Consumption, Jobs, and Costs: Tracking the Effects of Energy Policy*, Resources for the Future, Issue Brief, 11-08.

Lange, R.J. (2010), Optimal support for renewable deployment: A case study in German photovoltaic, Presentation at EPRG Spring Seminar, May 14th, http://www.eprg.group.cam.ac.uk/wp-content/uploads/2010/05/Lange.pdf

MIT (2003), *The Future of Nuclear Power – An interdisciplinary MIT study*, Cambridge MA: MIT.

MIT (2009), *Update of the 2003 Future Future of Nuclear Power – An interdisciplinary MIT study*, Cambridge, MA: MIT.

Noel, P. and Pollitt, M. (2010), 'Don't Lose Power', *Parliamentary Brief, Vol.12, Issue 11, pp.6-8.*

OECD (2011), *OECD Economic Surveys: United Kingdom 2011*, Paris, OECD Publishing.

Ofgem (2012), *Electricity Capacity Assessment*, London: Ofgem.

Platchkov, L., Pollitt, M. and I. Shaorshadze (2011), *The implications of recent UK energy policy for the consumer: a report for the Consumers' Association*, Available at: http://www.eprg.group.cam.ac.uk/wp-content/uploads/2011/05/ReportforCAFinal100511EPRG.pdf

Pollitt, M. (2010), *UK Renewable Energy Policy since 1990, EPRG Working Paper No.1002.*
Pollitt, M. (2011), 'Thumbs up? A little early for that Mr Hulne', *Parliamentary Brief*, http://www.parliamentarybrief.com/2011/01/thumbs-up-a-little-early-for-that-mr-huhne#all

Stern, N. (2007), *The Economics of Climate Change*, Cambridge: Cambridge University Press

Latest EMR information from DECC is available at:
http://www.decc.gov.uk/en/content/cms/meeting_energy/markets/electricity/electricity.aspx

Appendix 1: Base capacity assessment calculation

Ofgem (2012) base de-rated margin in 2015-16: 4.20%. National Grid starting point de-rated margin 17-19% in 2012-13 vs. 14% from Ofgem. Difference in de-rated margin: +3-5%. This implies an adjusted base de-rated margin: 7.2%-9.2%.

CCGT under construction for 2013-16: possibly 1.35GW vs 1GW from Ofgem (Abernedd is ready to start construction). Variance: +0.35GW, derated to 0.86*0.35GW (peak 56GW). Difference in de-rated margin: +0.5%. Thus there is still some scope for more construction in the period.

Appendix 2: CPS impact analysis in 2014

CPS rate from April 1 2014	£9.55	per t CO2
Typical domestic consumption	3300	kWh
Coal emission factor	912	g/kWh
Gas emission factor	392	g/kWh
Average electricity emission factor	443	g/kWh
So best case CPS impact (gas sets wholesale price all the time)	£13.50	
Worst case impact (coal sets wholesale price all the time)	£31.41	
Typical bill 2012	£470	
Best case impact per cent bill	**2.9%**	
Worst case impact per cent bill	**6.7%**	
Note also as CPS is paid by companies it is passed through in wholesale prices so will then have VAT on top.		

Appendix 3: Capacity markets and monopsony

See: http://energy.aol.com/2011/12/19/pjm-capacity-market-faces-uprising/

Both New Jersey and Maryland have tried to defy FERC and build state supported new generation (2000 MW in NJ and up to 1500 MW in Maryland) in constrained zones of the PJM market in order to reduce consumer capacity payments. FERC has opposed this on the grounds that this will have market wide impact on the price in the capacity market and therefore is a form of monopsony.

Appendix 4: Price impact of EMR (July 2011)

Key issue is what is business as usual (BAU)? We need to look at EMR Fossil Fuel Assumptions impact (in DECC July 2011 impact assessment) on today's energy mix. Taking the DECC assumptions on prices: assume coal cost: £70 per tonne *40m tonnes =£2800m; gas cost: £0.6 per therm /29.3 KWh per therm * 342,000m KWh = £5889m. Actual costs for coal appear to be higher and gas lower. If coal falls to £50 per tonne and gas rises to £0.761 per therm then total fuel cost rise is £1089m if households take 37.4% of this, then cost per household (25m households) should be an extra £16.30 per household at constant consumption. This is a baseline for the absence of climate/renewable policy. This ignores market modelling (+ve or –ve) and household demand reduction (-ve).

Even assuming wholesale prices rise by 27% (the rise in the gas price) and demand falls by 10%, the wholesale component of the household bill (assumed to be £190 in 2010) would only rise by £26.90. This is an upper end of (a moderately EMR consistent) BAU. Under the EMR central case rise bills (2009 prices) with energy saving is £485 to £642 from 2010 to 2030 (32%). Thus 82-100+% of this can be taken to be policy induced, though some of this policy is related to the tightening of the Renewables Obligation to 2015 and increasing network charges.

Worth pointing out that 2012 price of gas at 65p therm is below the central base price (of 60p) in 2009 money.

Appendix 5: Costs of Nuclear

Du and Parsons (2009) provide an estimate of latest costs of nuclear proposed in US for MIT (2009): $4000 / kW in 2007 USD overnight cost. They suggest that at 10% WACC, cost of nuclear power is 8.4c / kWh (2007 prices).[18] This translates to say 6.5p / kWh with inflation and exchange rate in 2012.

Grubler (2010) estimates the cost of all the reactors built in France during their new build programme from 1970s through to 1999. He finds negative learning, his best guess construction cost (FF98) for some indicative plants are:

1977 Fessenheim 1, 920MW, 5.0bn FF
1982 Blayais 2, 951MW, 5.5bn FF
1987 Cattenom 2, 1363MW, 10.2bn FF
1992 Penly 2, 1382MW, 13.4bn FF
1997 Civaux 1, 1561MW, 18.7bn FF
1999 Civaux 2, 1561MW, 31.6bn FF or 6.1 bn Euros in 2012 money, just shy of Flamanville 3's last estimate.

So the historical record of the nuclear programme in France in terms of cost control is actually very poor. Unfortunately Flamanville 3 apparently picks up where Civaux 2 left off.

[18] See helpful associated MS Excel spreadsheet.

Appendix 6: Total Nominal Policy Budgets in Million Pounds (2000-2012)

Year [1]	CERT et al. [2]	CESP [3]	EU ETS [4]	FITs [5]	RO [6]	WFS [8]	Total Policy Budget [2] to [8] [9]	Nominal GDP [10]	Budget as % of GDP [9]/[10] [11]
2000-01	95					72	167	976282	0.017
2001-02	95					197	292	1021625	0.029
2002-03	324				282	163	769	1075368	0.072
2003-04	324				416	164	904	1139441	0.079
2004-05	324				498	166	988	1202370	0.082
2005-06	419		2432		583	192	3626	1254292	0.289
2006-07	419		1437		719	320	2895	1328597	0.218
2007-08	419		872		876	350	2517	1405796	0.179
2008-09	1067		2708		1036	397	5208	1433870	0.363
2009-10	1067	35	1825		1109	369	4404	1393854	0.316
2010-11	1067	105	1438	14.4	1285	366	4276	1463734	0.292
2011-12	1319	105	N/A	N/A	1487	143	N/A	1507585	N/A

Source: Chawla and Pollitt, 2012)