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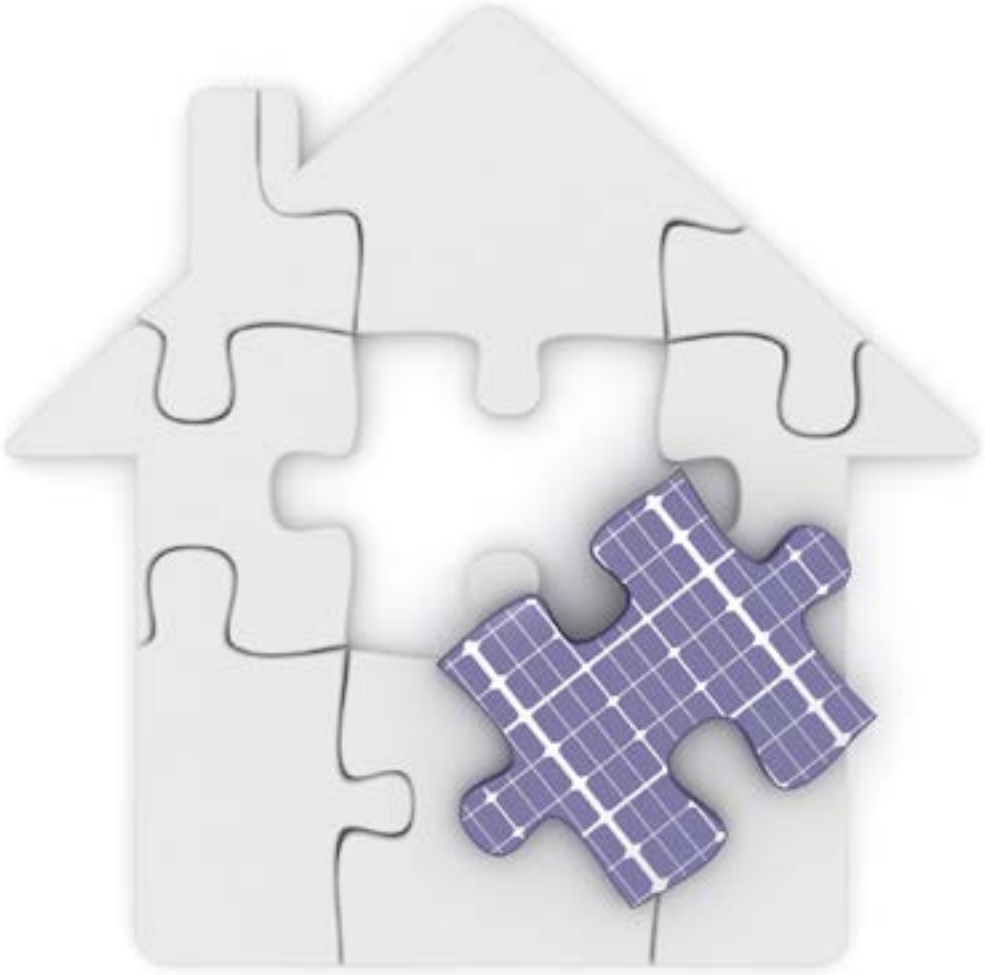
UK ENERGY POLICY:

POLITICISATION OR RATIONALISATION?



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Executive Summary

The first 100 days of the Conservative government brought wide-ranging cuts to renewable energy supports, energy efficiency programmes, and relevant tax structures, prompting concern that the new government had embarked on a politicised attack on 'green energy'. The government defended its decisions as a necessary and overdue corrective to a system that had become overly expensive and complex – a "hard reset" precursor to a rationalisation of the UK energy policy landscape. UCL launched a series of blog post contributions from its experts on the theme. This report brings together these contributions and offers tentative conclusions about the policy direction and key outstanding issues in UK energy policy.

With her major 'reset' speech of 18 November, Secretary of State Amber Rudd has reaffirmed the government's commitment to the 'trilemma' goals of security, affordability and decarbonisation. The latter includes the legally binding framework of UK carbon budgets and the mid-century 80% reduction under the Climate Change Act, underlined by commitment to phase out coal within a decade. The Paris climate conference is expected also to embed the EU reduction goals for 2030.

To solve the 'trilemma', effective and efficient energy policy requires three main pillars: efficient consumption with informed consumer choices; effective markets with full cost pricing; and strategic investment in innovation and infrastructure. Particularly when set in a strong framework of directional clarity, these together these can form the essential package to transform energy systems over time to meet. Concerning the policy decisions to date:

Pillar 1: Efficient consumption

Overall, energy efficiency policy over the past 15 years has been a remarkable success: it has improved living standards for millions and cut energy bills and overall energy demand substantially. The biggest of these programmes, CERT, contributed substantially to declining national energy demand; we estimate the value of its energy savings at more than £2bn annually - far exceeding the costs of the programme even after allowing for gaps between modelled and monitored impact.

Enhanced energy efficiency has also helped to 'keep the lights on', and forestalls the need for new investment: without the impact of energy efficiency policies on demand, the cost of the Capacity Mechanism could have been several billion pounds annually, rather than less than one billion realised in the last auction. Declining energy demand has also significantly reduced the amount of renewables investment required to meet the UK renewables target, since that is specified as a percentage of national energy consumption.

However the 'Green Deal' approach to energy efficiency introduced by the coalition had largely failed; there was a case to scrap its approach of relying on consumer-led energy efficiency through loans. Its failure, predicted by many experts, reflected a niaive approach to the nature, scale and complexity of the challenge – the 'web of constraints' that impede efficient energy consumption.

The plausible concern – albeit far from adequately documented – that the zero carbon homes target would drive up the cost of new houses suffered from exaggeration of costs and neglect of many of the benefits. Its removal has not only disrupted an industry that had spent 10 years preparing for the challenge, but leaves occupants of these new homes more exposed to higher energy bills – and the likely costs of later refurbishment. With its rhetoric about removing 'regulatory burdens', it is also unclear whether the government has recognised the benefits that British business has gained from the government-led energy efficiency programmes.

A new mantra of focusing energy efficiency on the most vulnerable households suggests that government is not yet recognising the wider strategic role of energy efficiency in meeting the UK's energy policy goals. This may indeed reflect, if not politicisation, a somewhat ideological approach based on simplistic assumptions about what the market can (and cannot) deliver. In short, the first 100 days have left a big gap in energy efficiency, which has yet to be filled by new, evidence-based policy. The main remaining programme, ECO, is due to expire in 2017; much may hinge on whether and how it is extended, developed to fill the gaps created, or replaced. If this final supplier-led policy is terminated – perhaps on the grounds that many dwellings have now been insulated - the main remaining option for buildings would seem to be minimum performance standards or equivalent incentives applied at times of major refurbishment or sale.

Pillar 2: Markets, pricing and subsidies

Competitive forces are vital to efficient policy, but markets can come in different forms and only deliver well if prices reflect full costs and benefits. In coalition, the government had introduced the carbon floor price, but then froze the level due to concerns about the gap with European CO_2 prices. It also delivered the Energy Market Reform, which established a new structure of long-term Contracts for Difference (CFDs) for renewables (and nuclear and CCS) combined with a Capacity Mechanism to ensure Security of Supply. Competitive auctions under both mechanisms held in the final months of coalition delivered substantially lower costs than expected. However, by then the huge surge in renewable energy had fuelled opposition to onshore wind, and led to total support costs exceeding the Levy Control Framework agreed with the Treasury. This set the stage for the dramatic cutbacks noted – the 'hard reset' on renewable energy.

Individually the measures taken were understandable, in the light of cost overruns. But the addition of the Treasury requiring renewables to pay the climate change levy (even though the contracts awarded only six months earlier had no indication of or allowance for this) amplified the appearance of a war on renewables – fuelled further by continuation of huge subsidy for the Hinkley Point C nuclear station underwritten by additional Treasury loan guarantees.

It seemed that in coalition the Conservatives had help to construct a powerful vehicle in the EMR, but had now switched the engine off except for nuclear and increasing taxes on renewables, whilst protesting a philosophy that governments should not be involved in choosing particular technologies. The sense of a generalised attack on the environmental agenda was enhanced further by removal of Vehicle Excise Duty incentives for low carbon vehicles.

Six months in to the new government, these changes may best be viewed as a mix of politicisation, rationalisation, and over-reaction:

- The cutback on onshore wind was politicised, but legitimately so since it was written in to the Conservative manifesto and reflects the narrow desires (and wider misconceptions about costs and variability) in the Tory heartland. The fact that it increases the cost of energy for all is increasingly recognised as a headache, though government crack-down on planning for wind whilst easing it for shale gas would appear to betray a more deep-rooted inconsistency.
- The rush of renewable energy – breaching overall budgets despite major unit cost reductions - did point to an urgent need to rationalise supports which had proved overly generous.

However, the requirement for renewables to pay the CCL has appearance of an ill-considered grab by the Treasury with scant regard to either the environment purpose, or to the damage done to investor confidence – a sense of 'payback time' for breaching the agreed limits. Continuing with Hinckley Point, a technology far from the 'market' and with the least prospect for cost reduction, can only be understand as a decision driven largely by inertia, a niaive view around the need for 'baseload' power, and/or considerations outside the energy sector (such as perceived needs of the Chinese economic relationship).

Along with its wider reaffirmation on the 'energy trilemma', Amber Rudd's "reset" speech underlined the vital importance of increasing the carbon price, reiterated support for the EMR and indicated that up to three auctions for renewable energy will be held during the Parliament,

subject to cost reductions. Marking the end of a turbulent period of transition, this potentially offers a good basis from which to move forward. Options to rationalise policy and restore investor confidence will need to include:

- A consistent approach to decentralised energy, including whether cuts to small-scale PV (now not far from competitive with retail electricity prices) will provide a glide path for an industry which hardly even existed in the UK a mere 5 years ago - or be set at a level which risks choking off the industry entirely.
- A credible approach to onshore wind – its claim to be seeking 'cost-effective' renewables appears hollow unless it structures a market that at least allow the cheapest renewable energy a fair chance for investment without subsidy. This report suggests a structure which retains long-term contracts, backed by compensation for the carbon savings valued according to the government's own estimate of this value.
- A systems approach to renewables overall, where the volume has risen so fast that its impact on overall system operation will soon become significant (though still lower than several EU countries). The value of renewables may depend increasingly on when (and where) they generate. This report suggests ways in which these costs (and benefits) can start to be reflected within the structure of CfD contracts introduced in the Energy Market Reform, suitably modified.

There are, in short, rational ways to move forward after the reset, taking account of the concerns raised and moving to restore confidence in the wider direction of travel.

One thorny issue will be the UK's 2020 renewables target. The explosive growth of renewables in electricity means that that component can now readily be met, but the renewables target is an aggregate across all sectors. The transport component would require stronger policy action, and heat is very problematic. The purpose of making the target legally binding under EU law was to enhance investor confidence; it remains unclear whether that can or will be delivered, and the extent to which electricity could or should pick up the slack left by the harder sectors.

The heat component in particular is highly problematic, though this is not helped by the discrepancy that whilst the cumulative charges on electricity equate to something close to the government's social cost of carbon, those on gas do not remotely do so. An era of falling wholesale energy prices would be the obvious opportunity to correct this long-standing anomaly, and to demonstrate that the government is not simply becoming beholden to the gas industry, and intends to live up to its rhetoric on using economically efficient and market-based approaches.

Pillar III: Strategic investment

The UK under-invests in energy sector research and development, and the private sector cannot on its own fill the gap. Private investment in energy R&D tends to be weak compared to other sectors, and is mostly directed along established, business-as-usual trajectories. Strategic investment and direction is critical to enable the innovation that is required for decarbonising the economy, and to do so in a way that delivers the best economic outcomes for the UK.

The UK could boost R&D and demonstration across a number of technologies including new solar and storage technologies, carbon capture and storage, and 'generation IV' nuclear. However there are no magic bullets: physics determines the energy resources we can draw on, including the fact that solar dominates our summer resources but wind does so in winter; extracting and disposing of CO2 from waste streams is inherently costly because of the sheer volume; and the world has already spent decades in the nuclear business.

R&D thus needs to be matched by strategic investment for innovation and infrastructure to extend cost reductions in the industries already growing. Most obviously, the UK has a major role in the offshore wind industry and – in contrast to the 1990s when the UK retreated from the global onshore wind business – has a strong stake in the supply chain and the economic benefits thereof.

As the biggest resource for renewable energy in winter, when we most need energy, offshore wind can be not only a major component of the UK energy system, but a platform from which UK efforts can contribute to global reductions. To achieve that, costs need to come down further. The engineering is challenging and investment, with mix of public and private investment, is needed across the innovation chain. The scale – and the potential benefits – seem analogous to the development of the offshore oil and gas industries during the 1970s, which brought down costs dramatically after a decade of sustained investment exceeding £5bn/yr (in present money).

An important dilemma is the difficulty of using competitive pressures particularly for the bigger, more challenging commitments, like moving from shallow to deep offshore, or reaching the major resource of Dogger Bank, and connecting to the value and balancing capacities of countries around the North Sea. This scale (and timescales) starts to look more like those associated with nuclear power.

After the next phase of CfDs, therefore, one intriguing option could be considered. To move away from 'picking winners' through government negotiations, and away from 'subsidies' by the mid 2020s, a longer term option could be to pit deep offshore and nuclear together in bids for providing low carbon energy to 2030 – perhaps even to the extent of competitive auctions for long-term contracts of common structure (eg. 25 years).

The government needs to ensure sufficient investment in offshore wind to bring it to the same stage of maturity as nuclear, but if it is serious about rationalisation, technology neutrality and the value of competitive forces, it could seek a pathway to a world in which nuclear and deep offshore wind offer a large enough pool to compete.

Conclusions

Energy policy involves long timescales. Stability derived from political consensus is therefore one of the most valuable attributes for energy policy and associated investment. Partisan instability is costly. After a post-election spasm that has mingled politicisation with rationalisation, Amber Rudd's speech of 18th November offers a tentative platform for sufficient renewed consensus: a reaffirmation of the 'trilemma' goal of security, affordability and decarbonisation set in a rational framework of carbon budgets, guided by the structure of the Climate Change Act. A recognition that government has to be involved, but needs a clear strategy to make best use of competitive forces and cost reductions.

Innumerable details still need to be worked out. A renewed strategy to reap the strategic as well as social benefits of energy efficiency remains to be charted. The politics of aligning economic incentives and prices, including between electricity and gas, have yet to be tested – as has the mechanisms and politics for restoring a credible carbon price, the backbone of a 'market based' policy for decarbonisation. A credible regime for onshore wind is needed. The emergent strategy recognises that gas has a crucial role in the low carbon transition; but concerns about security could portend a risk of over-subsiding gas and creating stranded assets, whilst the promise of both solar and offshore wind could yet be choked off by overly drastic cuts.

An integrated transport policy may start to interface with electricity, and new thinking will be needed to get to grips with heat. Accelerating innovation is not a separate challenge of R&D spend but needs embedding within the overall strategy, including its international dimensions. But if these and other challenges are now tackled; history may well judge Amber Rudd's "reset" speech as the points at which the UK managed to restabilise energy policy, and moved from the risks of politicisation to the opportunities of rationalisation.

Introduction

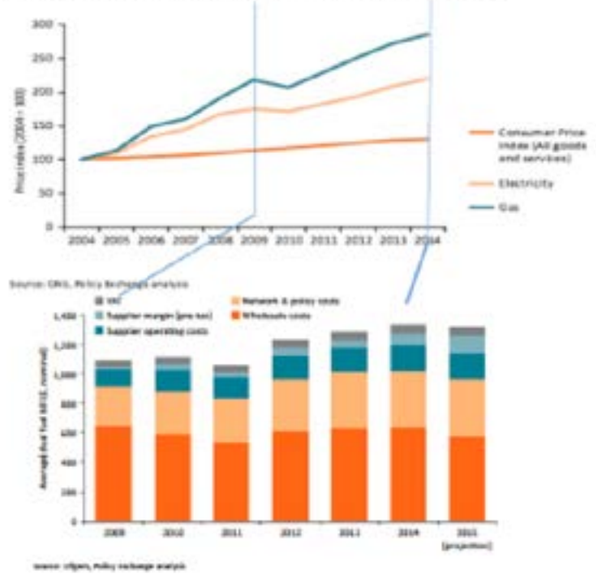
By Michael Grubb

The conservative government inherited a problem in energy policy. So did the coalition government before it.

As so often, the coalition's solution to the problems inherited from the 2000s have fed the concerns of its successor, and the new government has set about changes with zeal: the first hundred days saw the end of subsidies to onshore wind and changing planning laws, requiring renewables to pay the climate change levy, initiating drastic cuts to feed-in tariffs, scrapping the 'Green Deal' and zero carbon homes policies, removing ongoing Vehicle Excise Duty incentives for low carbon vehicles, and deferring this year's auctions for new renewable energy capacity.

This report brings together a series of contributions by UCL to the national debate published as blogs on the UCL Future Energy site over Autumn 2015. The report summarises the nature of problems the government inherited. We pinpoint two major mistakes in the Coalition's reforms – excessive emphasis on purely financial & market-oriented approaches to energy efficiency, and a failure to recognise or prepare for just how much renewable energy could respond to the incentives created. The latter in particular has set the scene for what is now being termed the 'hard reset' of energy policy.

Figure 1. (a) Residential energy prices since 2004 and (b) recent energy bills & components
Source: Howard R. (2015). *The customer is always right*, Policy Exchange, Figures 1.5 and 1.6



The political context was dominated by the trend of energy prices and bills in the previous Parliament, as summarised in Figures 1(a) and (b).

Energy prices had in fact been rising for a decade, this fed through into rising energy bills during the last Parliament. Gross 'policy costs' added about £60 (about 5% of total household bills) – though as indicated particularly in our analysis of energy efficiency it seems misleading to count costs without benefits. Politically however policy costs became a major focus of attention in the political panic over energy bills, which helped to set the scene for the rapid-fire actions of the government's first hundred days.

The official position of the new government is that it is engaged in a necessary and appropriate rationalisation of UK energy policy, in particular to enhance its economic efficiency. However the government's moves alarmed investors and created the impression that it is engaged in a war on renewable energy in particular, and potentially energy efficiency policy as well. If true, this in turn would create a fundamental inconsistency between the government's on-the-ground energy policy actions, and its high-level commitment to tackle climate change, take a strong stance in the EU and at the Paris COP21 climate change summit, and to support the Climate Change Act and deliver on existing targets (notably the Fourth Carbon Budget legislated by Parliament under the Act, and reaffirmed last year).

Is the new government correcting past flaws whilst taking a strategic view on how best to increase the efficiency and effectiveness of UK energy policy? Or is it becoming captured by the politicisation of energy and environmental debates that has bedevilled US policymaking, in which environment and sustainability issues become a political football, undermined as part of struggles between conflicting ideologies and interests?

Because energy is such a long term sector, politicisation – which caricatures the choices as being between economy vs environment, present vs future, individual vs social, and private versus government – would carry a high cost. Such divisions would inject fundamental uncertainty into the investment landscape, raising perceived investment risk and costs for all; and could in turn be exploited and enhanced by the vested interests of present incumbents.

At present the jury is still out on the question of where conservative UK energy policy is really heading, and the dominant motivations behind it. Many of the 'hard reset' steps initially taken are understandable in context. What really matters is what comes next, and whether the government bases its future policy on robust evidence, of the sort that can transcend the efforts of others to politicise the agenda.

In that vein, this report brings together a series of contributions from leading UCL researchers summarising key lessons and reactions to the changes. From a standpoint of economic and environmental efficiency, energy policy can be usefully understood in terms of three main decision-domains, each of them is closely tied to an area of policy:

- A domain dominated by multiple small-scale decisions, by consumers or small business units, which often pay little direct attention to patterns of energy use and may be replete with behavioural, contractual, or other 'failures' – these underpin the potential for enhancing energy efficiency;

- A domain characterised by calculated cost-benefit decisions of (usually larger) market actors based on existing technologies and infrastructures – this underpins the importance of energy markets and full-cost pricing if these markets are to deliver an economically efficient outcome;

- A domain characterised by the potential for innovation and structural change including infrastructure; this underpins the importance of strategic investment to lower the future costs, including the transformation towards low cost, low carbon energy systems.

We structure the report accordingly around the corresponding three main pillars of energy policy – energy efficiency, the use of economic instruments and design of markets, and strategic investment in innovation and associated infrastructure, and conclude with a closer look specifically at UK Energy Market Reform and renewables.

We do not agree with all the changes announced in the first 100 days, but acknowledge the legitimate concerns which drove many of them. We offer the analysis as UCL's contribution to a crucial national debate, and offer some key tests as to whether the government's 'hard reset' in reality heralds a rationalisation, or a politicisation, of the UK energy policy landscape.

UK energy efficiency policy: taking stock

By Ian Hamilton and Peter Mallaburn

Those with long memories look at the current uncertainty about energy efficiency policy with a strong sense of déja vu. To some extent these moments of uncertainty are natural, and perhaps inevitable. When energy prices or environmental concerns rise sharply, governments take action to enhance energy efficiency as amongst the best responses.

It is, however, rarely as exciting as supply-side 'big kit'; if concerns recede, energy efficiency tends to be neglected, sometimes in favour of a generalised assumption that markets should instead deliver. What matters is to ensure that each cycle is at least grounded in the understandings from previous efforts. What is surprising – and troubling - to those in the field is seeing energy efficiency being portrayed in some of the early commentaries and decisions after the 2015 election as a burden, rather than a benefit.

The traditional "neoclassical" assumption has been that if energy efficiency saves money, markets would deliver it, at least when given the right information ("if there truly are £20 notes lying around, why don't we pick them up?"). Amidst the oil shocks of the 1970s, energy efficiency policy was technology- and information-led: informing people and companies about the savings to be made. However it became increasingly apparent that such approaches only delivered a small fraction of the savings apparently available.

Governments of all colours have struggled with this for 30 years, slowly learning about a complex web of constraints and the ways of overcoming them, and often realising many of the benefits

Figure 2(a) Total primary energy consumption, unadjusted and temperature corrected, & mean air temperature UK (1970 to 2014)

Figure 2(b) Energy intensity indicators by sector, UK (1970 to 2014)

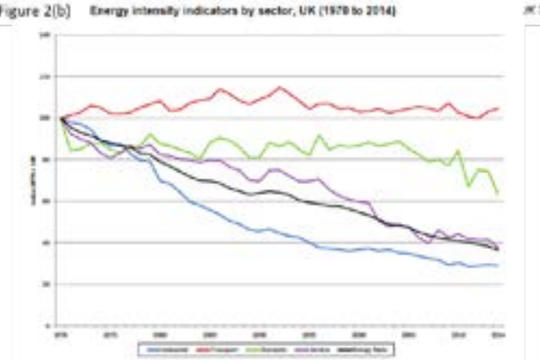


Figure 2: Long-run energy consumption trends in the UK, 1970-2014
Source: DECC (2015), *Energy Consumption in the UK*, Chapter 1, Charts 1 and 7

available. We know that varied programmes have resulted in energy savings (eg Hamilton et al 2013; Wyatt 2013). UK data shows that as the scale of efficiency programmes increased, and after more than three decades of stable or rising energy consumption, total UK energy demand since 2004 has fallen (Figure 2(a)), due particularly to energy intensity improvements in both service and household sectors (Figure 2(b)).

Policy has traditionally developed quite separately for residential and business sectors, and here we consider each in turn.

Residential energy efficiency

Over the past 25 years, the UK residential sector's energy efficiency policy has primarily been directed through a combination of: programmes requiring energy suppliers to retrofit efficiency improvements; building regulations; appliance efficiency standards; and more recently a short-lived market-based approach, the 'Green Deal'. These programmes have had multiple aims: to reduce general consumer exposure to rising energy prices (sometimes with other benefits, e.g. warmer and/or quieter homes from double-glazing); to reduce national energy dependence and environmental impacts; and to protect vulnerable customers.

Programme developments

Following the energy deregulation of the 1990s, energy suppliers were obligated to run programmes to improve the energy performance of their more vulnerable customers (Mallaburn and Eyre, 2013). Initially, the Energy Efficiency Standards of Performance (EESOP) scheme required suppliers to improve the energy performance of their household and business customers. The scheme focused on assisting 'disadvantaged' customers, along with determining supplier capability for delivering energy savings and their related environmental benefits.

In comparison with what followed EESOP was tiny, delivering measures estimated to have saved 18.5 TWh (lifetime savings) across the UK residential sector. Its successor, the Energy Efficiency Commitment (EEC) (2002-2008), had a similar rationale in terms of achieving multiple benefits, delivering about ten times as much energy savings (192 TWh of lifetime savings). This is the equivalent of reducing the UK's total annual energy demand by 1% for 15 years, or turning the UK's biggest power station (Drax) off for 7 years.

These different policy threads (i.e. building and appliance regulations, supplier obligations and market-based mechanisms) ran separately but in parallel until the mid-2000's when they began to interact – initiatives such as the ambitious zero carbon homes policy were shaped partly in the context of the growing push to tackle CO_2 emissions, that culminated in the Climate Change Act of 2008. The implication of the 80% mid-century reduction target enshrined in the Act is that some sectors (including the residential sector) would need to almost completely decarbonise to account for those that could not. The residential sector was identified as having many cost-effective abatement opportunities, though this has since been recognised as a greater challenge to achieve than some expected.

Subsequent energy efficiency programmes were consequently oriented to focus on carbon emission reductions in line with climate change mitigation goals, as well as energy efficiency. The supplier-led successor to EEC, the Carbon Emission Reduction Target (CERT) (2008-2012), raised the scale further, and was complemented by the Community Energy Saving Programme (CESP) (2009-2012) which focused more on communities and vulnerable households.

Based on the modelled impact of measures implemented, these delivered an estimated lifetime savings of almost 300 $MtCO_2$ – equivalent to around half the UK annual emissions or taking all passenger cars off the road for four years – and these programmes resulted in a number of improvements, including energy savings, greater thermal comfort, and wellbeing.

Whilst it is difficult to give the precise improvement, adding insulation into lofts

and cavity walls and replacing standard with condensing boilers will mean that housing need less heat energy to meet a desired indoor temperature. After more than three decades of almost stable household energy use, the decade since 2004 has seen energy consumption per household fall by about 20%, with gas and electricity following a similar trend, as detailed by DECC in Energy Consumption in the UK (2015).

The reductions in gas and electricity consumption since 2008 (when CERT started) are comparable with the accredited savings arising from that programme (Table 1) [1]. It seems reasonable to deduce that the energy efficiency programmes have played a large role in reducing national gas and electricity demand since then.

Moreover, this would correspond to over £2bn annual savings on energy bills, which is more than twice the average implementation costs during the scheme's lifetime – and of course, the savings last for much longer. Even allowing for some rebound and other factors indicated below, during its operation the savings from CERT in particular seem substantially larger than the programme costs, and of course extend for very much longer.

A much fuller evaluation would be desirable but it seems likely that over the lifetime of the measures taken, CERT will have saved consumers many times more than it cost.

These obviously are considerable savings. Yet, many programmes have not achieved the saving levels as predicted by the modelling. It is not clear whether this apparent 'delivery gap' is because of consumer choices, poorly installed measures, or poorly calibrated models. Very likely it is a combination of all three. Evidence from a number of government-sponsored and independent evaluations have shown that these programmes have impacted on more than energy performance, including increasing indoor temperatures and improving wellbeing (Gilbertson et al., 2012; Hong et al., 2009).

Many of these retrofits were delivered to vulnerable households, many of whom may have had unmet needs for heating and could be described as living in energy poverty. If this is the case, it is very likely that the models used to estimate the potential savings were not calibrated to estimate realistic energy (and CO_2) savings – the DECC 2014 Prices and Bills report revised down its estimate of consumer savings from the programmes significantly in the light of these findings – but some of the benefits emerged in other ways (e.g. warmer homes).

CERT lifetime savings			293	MtCO2	
			Gas	**Elec**	
Assume split gas:elec			75%	25%	
			219.75	73.25	MtCO2
Energy Savings					
Tonnes of CO2/MWh			0.1836	0.527	t/MWh
CERT lifetime TWh savings			1197	139	TWh
Assumed average lifetime of measures			25	10	Years
CERT average annualised TWh savings			47.9	13.9	TWh
Cost savings					Total
Assumed average unit price (household) £/MWh			22	100	
Value of annualised energy savings (£m)			£1,053	£1,390	£2,443
Implementation costs:	CERT (2008-11)	CERT Extension (2011-13)		Total over scheme lifetime	
Administration costs	£47.8m	£62.6m			£110.7m
Delivery Costs	£2.175m	£1.361m			£3.536m
Total costs over 5 years + 1 year extension	£2.222.8m	£1.423.6m			£3.646.7m
Source: authors estimates drawing upon:					
* https://www.ofgem.gov.uk/sites/default/files/docs/2013/05/cert_finalreport2013_300413_0.pdf					

Table 1: Indicative estimate of CERT costs and savings

During this same period, the building regulations that focused on energy performance were incrementally increased in order to reduce heat losses through the building fabric and glazing and sought improvements in heating system efficiency. The more stringent improvements were initially driven by a 2006 policy announcement that set a target of 'zero carbon' for all new dwellings built by 2016, which required 25% and 44% improvements in energy performance standards by 2010 and 2015 respectively, with Passivhaus standards (a voluntary standard for building a high performance building that requires very little (c. 15 kWh/m²/year) space heating or cooling) being approached by 2015.

The third thread of energy efficiency policy in the UK (along with the supplier-led programmes and building standards) over this period was implementation of improved appliance energy standards, which have largely been driven by EU legislation on minimum performance requirements. For example, in the mid 1990's, any domestic white good refrigerated appliances sold were required to achieve an energy rating of A-C, which achieved a 15% improvement within 15 months of implementation and a drop in consumer prices (Schiellerup, 2002).

The delivery of these product standards required the efforts of forward thinking legislators, leading product manufacturers, and consumers. In this instance, each entity acts in an interactive and inter-dependant manner that leads to a shift in the market place, with regulation being one of the most powerful tools available to enable the transformation (Boardman, 2004).

Recent developments and lessons

During the last Parliament, these programmes in turn were succeeded by the Green Deal (2012-2015), which aimed to empower consumer-led efficiency with financing package for costs to be recouped through long-term deductions from energy bills; and an Energy Company Obligation (ECO) (2012-present) to focus on deeper and more expensive retrofits like solid wall insulation.

However, take-up of the Green Deal was dismal (only 15,000 had been installed or near completion when the Green Deal Finance Company was shuttered). It reflected a classic assumption that the barriers were primarily financial, rather than structural or behavioural, and its limitations and risk of failure were indeed predicted (Rosenow and Eyre, 2013). Delivery of ECO was also smaller than anticipated and the programme was substantially scaled back in 2013.

Whilst the EC-led standards on appliances continue, the new government has closed the Green Deal, announced fuller reviews of energy efficiency including ECO (and programmes for business energy efficiency), and abandoned the targets associated with 'zero carbon homes', with the main concern being cited as both the cost and challenge of achieving the target on-site energy efficiency standards.

Concerns were highlighted early on when the performance standard targets were initially set out (Lowe and Oreszczyn, 2008), and that government needed to focus on: improving skills, knowledge transfer and procurement

1 Total gas consumption reduced by about 50TWh/annum from 2008-2014 and electricity consumption reduced by about 8.5TWh over the same period (both temperate corrected). The CERT credited emission savings imply energy demand reductions astonishingly similar to these numbers. If 75% of deemed emission savings came from the impact of household measures on gas demand (see Ofgem (2013, Figure 2.2), then the lifetime saving is 1200TWh; assuming an average lifetime of 25 years (the actual lifetimes assumed varied significantly by measure) then the annual saving is 48TWh/yr. The corresponding total for electricity-related measures would be 140TWh, and if the average lifetime were 10 years the savings would be 14TWh/yr. Over this period retail gas prices were typically over 2p/kWh and electricity prices around 10p/kWh, which would make the overall value of energy saving over £2bn annually given these simplified assumptions). The estimates are approximate and more detailed evaluation would be highly desirable but none was made available to the author; also note that the deemed savings were based on assumed savings per measure; as the text notes, actual in-situ savings may be less. The implementation costs of delivering these savings averaged substantially under £1bn / year (see Table 1).

mechanisms within the construction industry, achieving greater inter-government department cooperation, and more closely aligning carbon target with building regulations. These needed to be supported through research and rapid evidence base development using more in-depth and project planning-development and operation lifecycle research.

What have we learned from the above programmes and policies? First, we know that energy efficiency is not a simple economic process that responds easily to either straightforward price signals (like general energy prices) or even to measures addressed purely to financial barriers (like the initial form of the Green Deal).

Delivering energy performance improvements into the housing market through millions of retrofits is itself a complex process involving numerous actors and stakeholders. Yet, the evidence shows that these measures can be delivered and do have a real impact on energy performance, thermal comfort and wellbeing. We know that many of these retrofits under the supplier-mandated programmes were the "low hanging fruit", such as loft and cavity wall installation and boiler replacement, and that future retrofits will be more complex and require greater changes to the dwelling.

However, this knowledge has only been achieved through a combination of directed and ad-hoc evaluations. If a greater understanding of both the direct and indirect impacts are to be known, future policies must explicitly include both implementation and final impact and process evaluations, whether they are government or industry led. Evaluations are an essential part of understanding what works and what does not, they can help to avoid potentially millions of pounds spent on delivering ineffective efficiency retrofits or to improve ineffective delivery of sound efficiency retrofits.

We know that markets will respond to clear and challenging but achievable regulations when there is a large market available, such as the case white good appliances. We also know that incentives can work, such as the highly over-subscribed Green Deal Home Improvement Fund, which offered up to £4000 for solid wall insulation. However, achieving long term energy efficiency market stability through rebates is problematic given dependence on direct pubic finance. We also know that delivering very challenging energy performance and CO_2 targets without the necessary regulation, skills and supply chains can lead to uncoordinated efforts that are easily disrupted. Energy efficiency markets need both incentives to transform but should be supported through regulation that can avoid markets from becoming reliant on subsidy.

Abandoning the zero carbon homes policy has sent shock-waves through an industry which has spent almost a decade building the capability to deliver. The recently announced end of the Green Deal Finance Company means that the only energy efficiency policy remaining is the ECO, which will itself be subject to major changes. With the build regulation targets no longer being clearly defined, there is a gaping hole in domestic energy efficiency policy on a scale not seen for decades.

For housing, we know that the primary concern, as stated in the HM Treasury report *Fixing the foundation: creating a more prosperous nation*, is to build 'more homes that people can afford to buy'. The implied assumption is that delivering low-energy and low-carbon housing risks placing an undue burden on developers and thus home buyers. However, we cannot leave energy performance improvement to millions of existing homes to market forces alone. The evidence shows that most people when choosing to retrofit their home do so when they are planning otherwise considerable disruptions, e.g. selling or expanding their home, and that energy performance is not necessarily high among their motivations (Wilson et al., 2015).

One radical option, consequently, would be to apply energy efficiency requirements at time of private house sales, which would not directly impinge on first-time buyers, but would help to sustain improvement in the UK's building stock. Using the lending process as a means to incentive energy performance and add a price premium to efficient homes may be a part solution to motivating home owners to invest and mortgage lenders and help realise investment value. What is clearly needed is some mechanism that either requires or otherwise brings value to improving household energy performance during these change points through clear and cost-effective means.

What does UK residential energy policy need to look like going forward? We see energy policy needing to respond according to the different domains involved in the process of improving residential energy performance, this would mean:

- programmes funded directly by government should be more highly focused in their targeting, such as highly vulnerable households that may not benefit from broader eligibility programmes.
- policies acting through energy suppliers should be flexible enough to allow for some discretion for how savings are delivered but specific enough to ensure that actual results are achieved across a wide number of households.

An independent and accountable market of energy efficiency installers and investors who are able to compete in a well-balanced market must be allowed to develop. This means installers must see sound technical installation and high-performance as part of their value proposition and ultimately impacts their business activities. We must also ensure that households and funders see the value in investing in energy performance that pays through both operational savings but also through improved asset value over the medium to long term. Evidence of accountability, transparency and efficacy are essential to ensuring energy efficiency activities are effective and valued.

Energy performance must realise its value to homeowners, which means putting in place mechanisms that clearly incentivise actions that prioritise more efficient dwellings. This means sending messages out to where they are most likely to be well received. For example, retiring households may be open to a small investment in energy efficiency to reduce the cost of running their home as their income reduces, while people who are about to purchasing a home might make an investment in energy efficiency in order to improve their longterm asset value.

The policy approach of the past should not be abandoned outright. As suggested above, the government needs to understand why a policy was not successful to know whether it should be abandoned. For example, the concept of 'pay as you save', the underlying premise of the Green Deal, is not necessarily flawed and can be an effective method of incentivising action and realising value from energy efficiency. However, there were clearly features of the Government's enacted policy that limited its success, for example the high interest rates of the Green Deal compared to the low interest rates available from lenders.

In moving forward, we should expect the Government to look back on past energy efficiency policy experience in the housing market and to understand the opportunities and limitations of those policies in achieving their desired objectives. The complexity of the housing market and the multiple actors that interact within this environment means that setting targets and reaching them is challenging. However, with a decent understanding of the past and present, we can continue to aim for a sustainable future.

Business energy efficiency

It is more than thirty years since an Energy Efficiency Office was created inside the then Department of Trade and Industry. At one point, 20,000 businesses were involved with programme budgets of £70m pa in today's money. "Win-win" and "triple bottom line" were the mantras of the day. However the lesson, as with domestic energy efficiency, was that achieving the potential was more complex than it looked: only a quarter of apparently cost

effective measures were actually implemented. Expensive energy audit reports sat on company shelves. This fed an innate tendency for DTI to prioritise supply-side measures, and energy efficiency programme budgets were cut in half in the 1988/89 Spending Review.

The fact is that for most companies (other than energy-intensive companies) energy costs are small as a proportion of turnover. Investment in efficiency, as a strategic priority, is down there with paperclips and bike racks: at best an indulgence and at worst a distraction. It is only when energy costs rise above 2% or so that the Board and Finance Director get interested. Consequently, corporate energy efficiency tends to be just as subject to 'First Domain' characteristics – behavioural and organizational features that lead to untapped but highly cost-effective potential – as residential consumption. Governments however tend to be more skeptical of the idea that companies are also systematically wasting money on buying more energy than they need.

It is also, arguably, none of government's business – except when it is seeking the most cost-effective way of cutting emissions. Shifting responsibility for energy efficiency from the DTI to the environment department in the 1990s thus stimulated a major rethink in how energy, industry and climate policy interacted.

The outcome was a realisation that energy was not just about technologies, but about how they are used. A new discipline of energy management emerged in the UK and internationally, drawing on the wider corporate change management and quality benchmarking drive that began in the US in 1987. The mid-1990s saw a revolution in the number and range of energy management schemes and standards: EMAS, EDAS, ISO 14001 and so on. Also, armed with computers and reams of monitoring data, researchers finally began to get a handle on how companies really made decisions about energy. This, in turn, finally began to unpick the energy efficiency "paradox".

The crucial insight was that energy efficiency was not an end in itself, but embedded in a far wider range of corporate priorities and organizational structures relevant to the companies' strategic interests. This introduced policymakers to a whole new set of corporate levers: reputation, risk management, value, customer and investor satisfaction, competitor analysis and so on. This was the underpinning for the carbon management and industrial audit programmes that emerged in the early 2000s.

Policies and programmes became highly sophisticated, deploying a wide range of sticks and carrots designed to maximise the salience of energy efficiency in the markets they work with. Including other examples drawn from the across the EU:

- Interest-free technology loans coupled to supply chain networks and mentoring for small manufacturing SMEs.

- Capital allowances coupled to energy management standards and benchmarking advice for medium sized manufacturing companies.

- Large-scale energy audit and ESCO-funded retrofit programmes for large, non-energy intensive manufacturing and process companies.

- Energy management standards for companies struggling with product differentiation (finance, legal, accounting).

- Recycling or interest-free loans coupled to technology procurement and accounting advice for large public sector organisations.

- Energy performance data collection tools and mandatory reporting for commercial real estate developers and landlords.

- Information on investment patterns on energy efficiency measures for technology fund managers and capital finance institutions.

- Government and public sector procurement to drive market penetration of specific low carbon technologies, goods and services.

The experimental phase of the late 1990s/early 2000s also delivered a UK emissions trading pilot, the Climate Change Levy and the Carbon Trust's corporate energy efficiency programmes. The UK came to be seen as having the most innovative package of policies anywhere in the world.

However most of the effort had been focused on manufacturing industry, and a mid-decade review identified an important gap, in the lack of an operationally effective incentive covering the service and public sectors (principally, buildings-related energy & emissions). The evidence gathered demonstrated that for these sectors, energy costs alone (even with the CCL) were largely written off at site level as an unavoidable cost of doing business. The CRC – originally, 'carbon reduction commitment' - was introduced to require full reporting of corporate emissions along with requirement to purchase corresponding emission allowances.

This prompted Chief Finance Officers (or University, local government or other public sector authorities) to take an interest and provide the capital required to improve buildings efficiency, so as to reduce published energy & emissions and associated operating costs – the link between investment and operational costs which had hitherto been missing.

For good or bad however, the last years of the Blair / Brown government had made the CRC far more complicated by linking recycling of the revenues raised to a league table of performance, which proved highly controversial and managerially onerous. In its first year of operation the CRC was credited with a sizeable reduction in emissions from the covered sectors (contributing to the improvement shown in Figure 2(b)); it remains unclear how much of this was due to the original proposition (combining economic and environmental incentives at corporate rather than site level), or the added motivations of the revenue recycling and league table.

Recent developments and lessons

The coalition government removed funding from the Carbon Trust (which after a difficult transition is growing again, both domestically and internationally, due to growing recognition of the value of its energy efficiency services). The ESOS audit scheme, as it stands, is a pale imitation of schemes operating in many other countries. The UK is one of the few western countries without a dedicated energy agency.
Under the coalition, the Treasury removed the revenue recycling from the CRC – leaving the CRC as largely another tax albeit levied at corporate rather than site level – and league table requirements. With the original intent largely lost in the maze of subsequent complications, revisions and retreats, it is likely that the CRC will be scrapped by the new government, though the reporting requirements are expected to remain in place so that companies still have to collect and publish data on their corporate energy and CO2 emissions.

The trend of declining incentives for corporate energy efficiency already initiated under the coalition thus seems set to accelerate. It would however seem exaggeration to say we are going back to the naivety of the 1980s: there is simply too much demand-side momentum and infrastructure for it to be unpicked now. The Treasury consultation on business energy tax is quite open-ended. It may be more of a blank sheet of paper rather than a hidden agenda.

The UK is sitting on a wealth of policy experience - perhaps more than any other country. The problem is that no-one in government has sat down and worked out what to do with it all. Without a clearer idea of intentions, it is hard to offer much advice beyond the need to learn from experience and avoid ideological simplifications of a complex issue. However some broad ground rules would include:

• Policies must be integrated. It is no good having clever incentives and smart regulations if they aren't managed together for maximum impact. It doesn't have to be complex: make subsidy contingent on doing an audit, or adopting a standard for example.

• Policies also have to be flexible because energy efficiency means different things to different companies and sectors. The right policy will also change over time as capacity builds, so policies need to be responsive. This is complex, but it can be mapped.

• "Framing" is also important: how energy efficiency is "sold". What is the right mix of drivers in the company or sector? Payback time, net present value or internal rate of return for the financial drivers; environment, climate, generic quality or wider corporate social responsibility for the non-financial drivers?

• Regulation simply cannot be ruled out. Indeed many companies and sectors demand it. Of course the usual caveats apply - it must be smart and proportionate. But there are many proven cases where the most cost effective policy is to make something mandatory.

• Local networks, particularly for SMEs, have great value by exploiting peer, utility and supply chain relationships and using local resources without government having to chip in too much.

There remains, in short, significant scope to dovetail a wider business simplification-oriented agenda with continued incentives to help reduce the energy and environmental impact of UK corporations and public sector.

Re-setting UK energy policy: What role for Economic Instruments?

By Paul Ekins

There is growing bewilderment practically everywhere about what the still relatively new UK Government is doing is respect of energy policy. The mantra since the election is that energy policy is to be re-set to achieve decarbonisation targets, to which the government says that it is still committed, in a more cost-effective way that will benefit the 'hard-working families' to which the government says that it is also committed.

Unfortunately it is quite impossible to recognise this laudable objective in the policies that have so far been implemented, especially those which use those policies called economic instruments – basically taxes, charges and subsidies – which are the subject of this blog.

Firstly, relatively low subsidies for the cheapest low-carbon energy source, onshore wind, are to be removed early, and planning permission has been made more difficult to secure even for those plants that do not need subsidy.

Secondly, subsidies for the second cheapest low-carbon energy source, solar PV, seem likely to be drastically cut, just when industry sources thought that they were only a few years from being able to be subsidy-free, but depended on continuing support to get there. Over 1,000 jobs in the solar industry have already gone, with more losses predicted if the subsidy cuts are followed through. These once hard-working families at least will find it difficult to discern the government's concern for their welfare.

Of course, it is right that mature industries should be subsidy-free, and one might applaud the government for its aspirations, if not its timing, on this point, were it not for the fact that it is storming ahead with giving a very large subsidy to Hinkley Point C nuclear power station, including a price guarantee that will cost consumers an extra £4.4 bn to £20 bn, on the government's own figures, with various credit guarantees, insurances and derisking subsidies on top. Yet nuclear power is a mature industry if ever there was one, and one whose costs, unlike those of renewables, resolutely refuse to fall and in this case will impact hard-working families and other energy consumers for 35 years from the date of first generation. It now looks almost certain that when power from Hinkley Point C finally comes on line, it will be substantially more expensive, and therefore more heavily subsidised, even than offshore wind, which was once thought to be unassailable as the most expensive low-carbon energy source.

In short, the government's subsidy policy is anything but cost-effective, and will maintain a burden on hard-working families for decades and everyone else, whilst eschewing energy sources that would seem only to need a few more years' support. The credibility of the government's repeated stated commitments to both cost-effectiveness and emissions reduction is fatally undermined by its removal of the specific tax incentives for energy efficiency and renewables, which score at the top of the range on both counts.

So to the tax side of economic instruments, concerning which there have been two major changes from the new government in its Summer Budget 2015. First, the exemption from the Climate Change Levy (the tax on the business use of energy) which was accorded to renewable electricity sources has been removed. This was announced in July and took effect from August 1st, without any prior consultation, thereby depriving renewable generators of a source of revenue (currently £5.54/MWh) which they will certainly have factored into their business plans when these were created – and bidding competitively for government contracts.

While perhaps not technically retrospective legislation, such a change is devastating for business confidence in the stability and predictability of government policy, something which this government, as others before it, claims to be committed to. For example, a recent government consultation paper relevant to this blog, 'Reforming the business energy efficiency tax landscape', states: "The government is committed to developing an effective framework that provides businesses with certainty and encourages business investment in energy

efficiency and carbon saving" – an assurance that might be expected to attract the cynical riposte from renewable generators at least: "At least until the next Budget" – this change is expected to increase government revenues (if current investment plans still proceed with the corresponding added cost) by about £900 million by 2020.

The other energy-related tax adjustment in the Summer Budget was the abolition, apart from in the year of purchase, of the gradation of Vehicle Excise Duty according to the vehicle's calculated carbon dioxide emissions per km travelled. Before the Summer Budget this ranged from £0 (for 0-100 gCO_2/km) to £505 (for over 255 gCO_2/km) per year. The Summer Budget changed this such that all new registrations from April 17 will pay a flat rate of £140 per year (with a £310 supplement for cars with a list price of more than £40,000), including vehicles with emissions of 1-50 gCO_2/km per year. The new first-year rates range from £0-2,000, compared to £0-1,100 under the current system. The change is expected to increase the tax take by about £1 billion per year by 2020, with the main losers the drivers of low-emission vehicles.

In sum, this is a very strange way for a government to proceed when it claims to be interested in business investment in energy efficiency and carbon saving, both of which require some confidence in the stability of government policy which this government's actions over the last six months have done much to destroy. What does this say about the likely outcome of the consultation on the 'business energy efficiency tax landscape'?

One tax from the last government that has so far survived the energy policy activism of this one is the carbon price support (CPS). This was originally intended to rise at a rate reflecting the Treasury's estimated 'social cost of carbon', but in the face of political concern about energy bills this 'escalator' was halted in the 2015 budget, with the CPS at around £18/tCO_2 until 2020, . Apart from earning the Treasury around £2 billion a year, this tax plays a crucial role in reducing emissions from UK coal-fired power stations, with the removal of the CCL exemption for renewables the government seems to be drawing a distinction between taxes for climate policy, such as the CSP, and taxes for energy efficiency, such as the CCL and the other instruments mentioned in the consultation paper. As far as these instruments are concerned, some simplification of the tax landscape can surely be expected. The main question is whether this will level up or down the effective rate of energy taxation.

Even though these taxes will be denominated in energy, it would be desirable for their rates to be based on the energy's carbon content. The government's carbon price trajectory for firms outside the EU ETS suggests that this price should now be around £60/tCO_2, increasing to £76/tCO_2 by 2030. For electricity, the CPF, CCL and CRC (Carbon Reduction Commitment) together add up to about £55/tCO_2. For gas, the CCL and CRC add up to much less, only around £22/tCO_2. Taxing both these energy types at £60/tCO_2 (about £14/MWh for electricity and £11/MWh for gas) would therefore both simplify the tax rates and tie them explicitly into climate policy.

The Climate Change Agreement rebates on the taxes for so-called energy-intensive sectors would probably need to be maintained for political reasons. Such an outcome to the consultation would do little to rectify the inconsistencies on the subsidy side of energy and climate highlighted above, but it would at least show that with tax policy the government was more committed to tax efficiency than its predecessor, without being less committed to emissions reduction, as it states.

Is Amber Rudd's energy policy 'reset' innovation-friendly?

By Will McDowall and Andrew ZP Smith

Innovation is one of those uncontroversially good things that politicians love to champion. For those worried about the economy, innovation is agreed to be a fundamental driver of long-term economic growth. For everyone worried about the environment, innovation is crucial for decoupling that growth from environmental damages, and achieving the deep reductions in emissions that are necessary.

So far, so much agreement. But academics, policy analysts and commentators have often disagreed about the detail of how best to drive innovation, particularly in clean technologies. There are some economists who argue that, beyond some support for basic R&D, government should be involved as little as possible. They argue that innovation is too uncertain for governments to engage in: it's private actors that should take on the risks and rewards of developing the technologies and systems of tomorrow. After all, who other than businesses can really know what consumers will demand?

It's presumably a belief that government should 'get out of the way' and let competitive forces to do the job that led Amber Rudd to declare recently that energy sector privatisations and deregulations of the 1990s "encouraged innovation" (Rudd, 2015). Unfortunately it seems Amber Rudd was repeating a highly misleading classical mantra. Certainly, privatisation injected innovation in business models and spurred investment in gas plants. But on practically any other measure, energy innovation fell dramatically following privatisation. Patents, research publications, R&D spending: all collapsed, as the previously nationalised energy companies closed down their research labs and focused on nearer term profits. Leaving energy innovation to the competitive market was a comprehensive failure of those 1990s reforms.

Our own research (Ekins et al. 2014; Grubb et al. 2014), and that of many others, makes clear that for innovation in general—and energy innovation in particular—a role for government is essential, since the pay-offs of investment in innovation are hard to monopolise, and they are often on a longer time scale than investors are willing to accept. In the energy sector, private investment into R&D tends to be particularly weak (Grubb et al. 2014): measured as a proportion of total turnover, energy sector R&D spending is around a 20th of that seen in highly innovative sectors like IT and Pharmaceuticals.

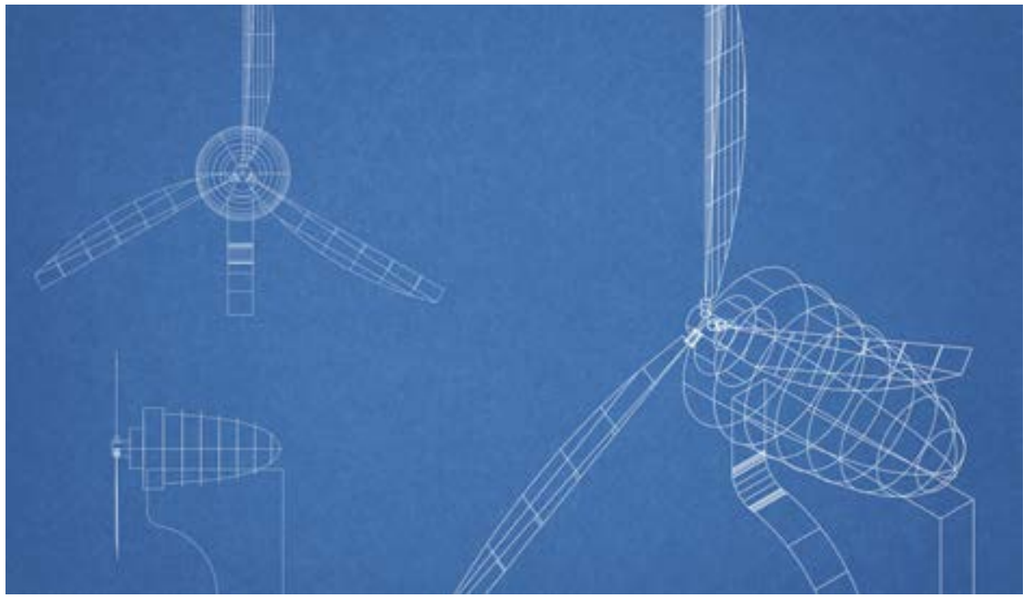
Competitive markets will deliver energy innovation along established, business-as-usual trajectories, as with fossil fuel extraction (deep water oil drilling or oil sands refining come to mind), though even here government support has often been crucial. But strategic investment and direction is critical to enable the innovation that is required for decarbonising the economy, and to do so in a way that delivers the best economic outcomes for the UK.

All of this is particularly important for offshore wind.

The UK has pioneered the offshore wind industry we see today, driving into deeper waters, further offshore, and to larger scale than any other country. Coming from a weak starting point, the UK has established a large and growing domestic supply chain, bringing more and more of the economic benefits of offshore development into the UK economy. But offshore wind is still far from mature. While early turbines were essentially onshore models planted in the inter-tidal area, the industry today is seeing huge innovation across the supply chain, from the heavy equipment of installation vessels and turbine foundations to the high tech design of software control systems.

It is no exaggeration to say that the UK's investments in offshore wind have revolutionised the prospects for offshore wind globally. The UK accounts for only 2% of global emissions, and in that sense our emissions reductions are a marginal part of the global story. But contributions to real technology progress, as we have achieved in offshore wind, are potentially just as significant.

The longer term prize remains huge: the North



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Sea represents a globally unparalleled resource both for deployment and for innovation. Within UK waters, the most recent estimates (Cavazzi & Dutton 2016) find that an astonishing 650GW of offshore wind capacity (many times UK peak electricity demand) is in principle available at a cost of power below £120/MWh, even when taking account of the various exclusion zones and shipping lanes. That's just the UK's resource, and it represents more than total European peak demand (ENTSO-E 2014).

The wider North Sea represents a still larger opportunity not only for offshore wind deployment, but also for offshore wind innovation and cost reduction. The relatively benign conditions of the North Sea enable experimentation and learning at a lower cost, providing the UK and our North Sea partners with opportunities to lead the developments of offshore wind technologies for other markets.

As Rudd and her team develop the policy reset, we suggest three key lessons to ensure that innovation in offshore wind continues to be promoted, and not stalled:

- Focusing on cost reduction above all else can backfire. In the 1990s, the UK support mechanisms for onshore wind were highly competitive, and designed to yield the very cheapest and most cost-effective projects. This provided strong incentives for wind companies to innovate to cut costs: but the industry and technology were simply not mature enough. The pressure on costs stifled the "nursing" and "bridging" markets that are essential for the establishment of a new industry that is characterised by significant public goods. As we have argued above, offshore wind is maturing rapidly, but it is not yet out of that critical bridging phase. Certainly, it is vital to ensure that pressure to reduce costs is built into support mechanisms: through competition and through a clear process for support degression. But prioritising cost reductions above all else will hamper investment and industrial development.

- Maintaining confidence in the direction of travel is critical to success and to cost reduction. Investors and project developers are increasingly concerned that the priorities are shifting away from offshore wind, despite Rudd's protestations to the contrary. Certainly, the government's assault on existing renewable energy support measures (for biomass, solar and onshore wind), and talk of an ill-defined 'reset', have rattled the sense that the UK is committed to developing a renewable energy system. Yet it is clear that confidence drives investment and supply-chain development. For the UK, this is particularly important: confident long-term signals will mean that the UK role in the European offshore wind industry will continue to grow, bringing economic benefits alongside carbon reductions.

- Both deployment and R&D support matter. At a time when public finances are under pressure, some have argued (e.g. Helm 2015) that it would be a better use of money to direct it towards more basic energy research. There is certainly a case for more energy R&D funding. The UK spends relatively little on energy R&D, both in terms of international comparisons and with respect to our level of ambition for decarbonisation. But innovation requires learning-by-doing as well as research: they are complements, not substitutes. While we can argue about the precise balance of the two, it is clear that if the reset results in an investment hiatus, the damage to supply chains and real world learning will not be offset by technological silver bullets emerging from the lab.

And as has recently been pointed out (Gross, 2015), R&D results take time to mature, which means that when we are looking to deliver solutions in ten years' time, these won't come from diverting funding from deployment into basic research on blue-sky technologies today, but in evolving and refining technologies that have already passed proof-of-concept.

It's worth remembering why the UK got into offshore wind in the first place. Meeting energy policy goals and decarbonising electricity requires success in at least two of four big challenges: only nuclear power, offshore wind, CCS and energy efficiency each have the potential to contribute several tens of gigawatts of zero carbon energy supplies in Britain. All have their drawbacks, but of the generation options it is offshore wind that has proved the easiest to deploy at scale in the near term.

It is also worth recalling that when the UK took its first tentative steps into North Sea oil in the late 1960s, much of it looked hopelessly uneconomic. The combination of government support and the oil price shocks of the 1970s promoted an industry that was projected to produce oil at a cost well over $50 per barrel. It took more than a decade of capital investment exceeding £5bn/yr in todays prices, before it proved able to produce at a small fraction of that cost, with huge benefits to the UK economy.

As the direct result of strategic investments in offshore wind, Britain has a burgeoning offshore wind supply chain that has to date been willing to invest in novel processes and technologies, driving the innovation that the government is so keen to promote. Having made such progress, a badly handled reset could result in precisely the outcome that Rudd fears: expensive investments in offshore wind with neither the cost reductions nor UK supply-chain benefits that she hope the reset will achieve.

Reform for Renewables in the EMR (Energy Market Reform)

By Michael Grubb

The UK's Energy Market Reform was introduced for two main reasons: concern that inadequate private investment under the liberalized system was eroding the UK's security of supply, and growing recognition that the existing system of Renewables Obligation Certificates (ROC) support was an inefficient way to support capital-intensive, low carbon investments like renewable energy.

The EMR was intended to address these concerns. Contracts-for-Difference (CfDs), providing a long term fixed-price contract, were introduced to enhance investor confidence and thus reduce financing costs; CfDs were seen not only as a preferable way to support renewable energy, but also one applicable to nuclear energy. The Capacity Mechanism introduced fixed payments to all plants guaranteeing power available when needed.

Following a first set of negotiated CfD contracts, the coalition proceeded to use competitive auctions, in December 2014 (for capacity contracts) and January 2015 (for CfD contracts). By most standards, this auction experience proved successful: the targeted volume under the Capacity Mechanism was procured for total system payment under £1bn (annual payment starting in 2018), much less than predicted, and prices under the CfD auctions proved substantially lower than the negotiated contracts prices the previous year.

Indeed, the Cambridge economist David Newbery (2015) estimated that the value of long-term confidence associated with the CfD contracts reduced the average weighted cost of capital by 3.3 percentage points compared to the previous ROCs system. If total low carbon investment over the next decade amounts to £60bn for example, this would imply a saving of around £2bn compared to the previous policy frameworks.

Challenges

Despite the apparent effectiveness of the EMR package, the incoming government faced several challenges. The first was an obvious tension between its two main headline energy manifesto commitments, namely "to deliver clean energy as cheaply as possible", and to "remove subsidies" from onshore wind energy, the cheapest large-scale renewable source.

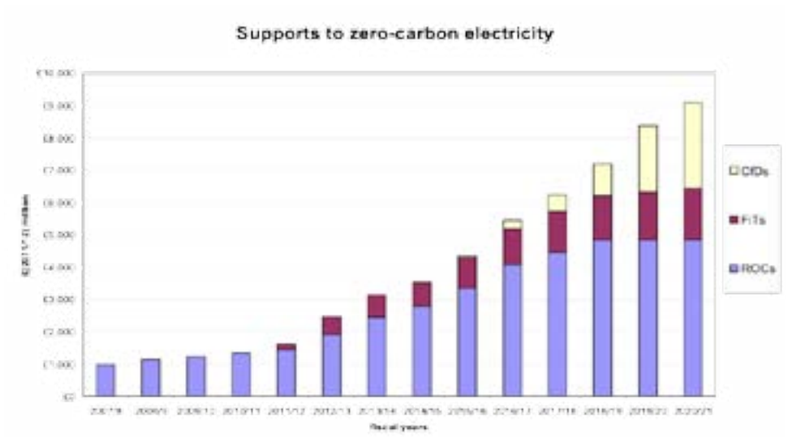

Figure 3. Support costs for renewable energy to 2020

But the issue which grabbed the headlines within weeks of the government taking office, was that the renewable energy supports were breaching the Levy Control Framework, agreed with the Treasury to cap supports at £7.6bn/yr by 2020; projections for 2020 suggested that commitments already made or advanced in the pipeline would take the cost over £9bn (Figure 1).

Paradoxically, this partly reflected success due to the volume of renewable energy far exceeding expectations. Installed solar energy capacity by 2015 had grown to five times the level projected, at half the cost per unit. Wind turbines have also been producing more power than expected, in particular with higher load factors offshore. Both increase the volume of renewable energy receiving subsidies.

At the same time, the Treasury's earlier decision to freeze the carbon floor price, the subsidies to conventional power through the capacity mechanism, and the falling gas price have all combined to increase the bridge that CfD payments will have to span, to pay the contracted prices. To an important degree the cost overrun is a symptom of renewables success, but a classic failure of policy to plan for this. [2]

These two factors primed the stage for a major reset. In addition to the measures on energy efficiency and fiscal measures described in earlier chapters, the government confirmed the removal of subsidies to onshore wind, shelved the CfD auctions due for later in 2015, and announced drastic cuts to feed-in-tariffs. The 'reset' had been launched with determination.

Policy needs to move forward, not backward. As Gross (2015) emphasises, investor confidence is partly about contracts, but also and crucially about the wider stability of policy direction. Ripping up the EMR is neither credible (the problems that led to it would merely be exacerbated), nor necessary (the sizeable cost savings from moving to long term contracts, already demonstrated, clearly support the manifesto commitment to deliver renewables as cheaply as possible).

Academics have long argued that gas will have an important role in low carbon electricity systems, in part to balance variable sources. Security is paramount and Amber Rudd's reset speech underlined this. The Capacity Mechanism response so far has revealed that backup may be much cheaper than most people thought. Yet to the extent that Capacity Mechanism subsidies depress the wholesale electricity price, they increase the cost of CfDs.

With the new government keen to bring new gas onstream, careful thought should be given to how best to do so, without falling into this trap.

In fact, as Figure 3 illustrates, the Levy budget overrun is mostly due to the policy support systems in place before the EMR came in. The reset is, however, an opportunity for further reform. The rest of this chapter indicates some options.

What's in a subsidy? A framework for fully mature renewables

The commitment to 'remove subsidies' for onshore wind, and progressively reduce those for others, begs an apparently simple question: what is a subsidy? That sounds like a simple question, but it is in fact fundamental. The key to continue expanding renewables whilst cutting subsidies is to understand that it about risk allocation and full-cost accounting.

In Brazil for example, in recent years wind has beaten fossil fuel generation in open competition,

2 It reflected a classic tendency to underestimate economics of scale and innovation in improving performance – a common inability to recognise the central importance of 'Third Domain' economic processes in the energy transition (Grubb, Hourcade and Neuhoff 2014, 2015). The flaw in the EMR was not failure to anticipate the future, but to not be robust to its uncertainties: most notably, to fix feed-in tariffs and the Levy Control Framework without the flexibility required to cope with unexpected success. The fixed FiTs with periodic revision were intrinsically vulnerable to this kind of miscalculation; moreover, with periodic revisions leading to unpredictable degrees of tariff reductions, they also tended to lead to a rush of investments before the deadlines.

with no subsidy. Of course, land is cheaper and so are planning and permitting costs, but the real key lies elsewhere: how the system allocates the economic risks. Fossil fuel plants are relatively cheap to build, but expensive to run. Renewables are the opposite way round. Brazil auctions 20 year fixed-price contracts for electricity, which means that windfarms know exactly how much money they can generate, making them low risk and hence cheap to finance. Fossil fuel plants face the opposite risk, since they don't know how much they may be needed or what their (fossil-fuel-driven) input costs will be.

UK and European electricity wholesale markets place price risks precisely the other way round. Fossil fuel generators largely set the price of electricity, including any carbon pricing. If renewables sell into this market they face the irony that our wholesale market places the risks of fossil fuel (and carbon) price uncertainty on renewable energy generators, not on the fossil fuel plants. Hence the large savings in financing costs identified in Newbery's analysis of the CfD auctions. Similarly if CO2 is not properly priced, it is renewables that suffer.

The other big problem in defining subsidy concerns the extent to which environment and other 'external' costs are factored in to energy prices. A recent report of the IMF (2015) grabbed headlines by estimating that fossil fuels enjoy a whopping $5trn global subsidy. Others cried foul: the IMF was counting in 'subsidy' the unpaid cost of environmental damage they estimated from fossil fuel emissions, which dwarfed the direct financial subsidies. The UK already has its own way to estimate the damages associated with CO2 emissions: the Treasury's 'social cost of carbon', which is used in government cost-benefit calculations and rises to over £70/tCO2 by 2030.

The Brazilian model itself is not a realistic option for the UK energy market. If the new government wants to take onshore wind out of procured CfD auctions, it needs to find a way to separate subsidy from the legitimate value of long-term contracts and carbon reduction – unless it really intends to tilt the playing field directly against its expressed desire to deliver renewables as cheaply as possible.

So here is a modest proposal to consider, closely aligned to proposals for 'carbon contracts' by Helm (2004) and by Newbery (Grubb and Newbery 2006) a decade ago. A 'subsidy-free CfD' could be developed for new, unsubsidised onshore wind. The government would compensate the wind generators for any difference between the government 'social cost of carbon' (already established as its estimate of the cost of carbon damage) and the amount that fossil fuel generators actually pay for CO2 emissions. This would not be subsidising wind, but merely ensuring that wind generators gained the value already officially accorded to reducing CO2 emissions: at the Treasury social cost of carbon for 2030, the value of the CO2 displaced by renewable energy could be on the order of £30/MWh. [3]

Given the anaemic state of the European carbon pricing system and the freezing of the UK carbon price floor, no investor currently can rely on this value purely from wholesale market prices. Drawing on the demonstrated financial efficiency of contractual certainty, underwriting the carbon value in a long-term contract – a contract for difference on the carbon price, not the electricity price – would be the natural evolution to create a 'subsidy free' CfD.

Moreover, this speaks to the government's emphasis on consumers, who could then choose to buy green in ways that really mean something. Wind energy investors will get the environmental value of saving emissions, as they should. And none of these will be subsidised. If and when the carbon price is sufficient to ensure that fossil fuel generators pay this cost, there would be no underwriting cost, just the carbon price revenues to government.

Containing costs and reflecting value

Whatever steps are taken regarding onshore wind, continued support for other renewables will be necessary to continue their industrial development and cost reductions and to help deliver the UK's renewable energy and carbon targets. As the scale rises, containing the costs becomes ever more crucial. Reflecting the explosive growth and cost reductions, the government review of solar feed-in-tariffs proposes big reductions, along with further automatic degression of tariffs as the installed capacity rises, the solution adopted in Germany If FiTs are maintained, history may well judge the changes to solar supports in particular as rationalisation, not politicisation – particularly if this is combined with a negotiated extension of the LCF to avoid the cliff-edge that renewables may otherwise face. For larger scale renewables, auctioning CfDs address directly the challenge of cost reduction through competitive pressures.

The fact that the UK's biggest resources are solar and wind (both onshore, and offshore as considered in the previous chapter) points to a crucial factor which is glaring by its absence from incentives in the EMR – namely concerning the variability of most renewables. They are available as the weather dictates, not when power is most needed. With renewable contributions at 20-30% of supply these costs are modest (Skea et al 2006), but as capacity rises higher, the economic impact of variability will become rapidly more important.

In part, this underlines the potential value of biomass-based electricity, ranging from various waste-to-energy plants to the biomass conversion of coal units in light of the coal phase-out. The removal of renewables exemption from the Climate Change Levy dealt this a heavy blow, and concerns about the overall environmental footprint of various biomass chains underline the need for full life-cycle assessment. But there is no inherent reason why importing biomass is any more problematic than importing fossil fuels. Continuing CfDs could support improvements throughout the supply chain, with their value as firm capacity also factored in.

DECC has launched a study of the wider costs of the variability of other renewables, and the policy challenge will be how to reflect these costs efficiently in incentives.[4] One proposal – to force renewables into the capacity mechanism – would be a cure far worse than the problem. But the challenge remains that the fixed price contracts of CfDs, whilst useful for enhancing investor confidence, fails to send any signals for more efficient choices of source and sites, or for the most efficient integration of renewable energy into the UK power system.

Both seasonal and shorter term patterns are relevant. Solar output in summer is several times that in the winter, and in the next few summers we will start to see the impact on the system when high solar output combines with low summer demand. Storage can help to alleviate this (though at a cost) but it cannot solve the seasonal disparity: average electricity demand is twice as high in the winter, a profile which wind energy matches well. Of course, wind energy is also variable, and there is value in more diverse deployment of windfarms to reduce the aggregate variations.

The CfD system of fixed payments does not incentive this; nor does it reflect the costs of fluctuations on the system imposed by wind and solar, which have to be managed. Moreover, by giving a fixed payment to all output, it risks

3 As well as the carbon price, the value depends upon the carbon intensity of the fuel displaced by renewable generation. If this is taken as an advanced gas plant at 400 gCO2/kWh, this equates to £28/MWh. If there is any coal still on the system, the value would be substantially higher. Even if the EU ETS were to remain anaemic and the UK carbon floor price remained close to its present level, the cost differential underwritten by government in such contracts would be about £20/MWh. For comparison the clearing price for wind in the last CfD auction was around £80/MWh.

4 Helm's (2015) suggestion that renewables support should be transferred to the capacity mechanism would be fantastically inefficient, since it would require individual renewable projects to have their own backup rather than pool backup capacity for the system overall – losing both the benefits of source diversity and leading to huge redundancy in 'backup' investments. It would be logically analogous to expecting the UK system to have enough capacity to insure against the possibility of every kettle and other appliance being on at the same time – at vast expense for redundant 'backup' capacity that is never needed.

over-paying the best sites, and projects which substantially out-perform expectations (as with the recent offshore wind experience).

To address the last of these problems, Newbery (2015) suggests payments based on installed capacity (rather than actual output) or capped at a certain level of output.[5] A related idea might help also to start reflecting some other aspects of variable output. The wholesale electricity price reflects the cost of conventional generation at a given time. As the capacity of renewables rises (and as capacity margins tighten), variations in renewable energy output will increasingly also impact the wholesale price, and prices in the balancing mechanism which matches supply and demand over short periods.

CfD contracts could hence be paid on a basis of "deemed output" – notionally, an average expected output – with payments then being adjusted according to the actual wholesale value of the power generated at a given time. This would preserve much of the investment efficiency properties of the existing CfD contracts, but adjust it with reference to the actual dynamic value of the renewable output in the system operation.

Conclusions

The first of the 'four simple steps to maintain investor confidence ..' suggested by Gross (2015) is to 'provide longer term clarity and continuity'. This is a difficult balancing act, since policy also needs to learn from experience and evolve. Some of the suggestions in this chapter could take a long time to work through in detail. The government has already aborted the Renewable Obligations for onshore wind from 2016 and ensured that any remaining FiTs would have automatic degression.

The upside of the LCF overshoot however is that the volume of renewables being contracted is already close to the initially targeted contribution of electricity to the overall renewables 2020 target. This contrasts sharply with the heat and transport sectors, where progress has proved more difficult.

Amber Rudd's recent reminder that the renewables target is legally binding, precisely to enhance investor confidence, could aid rationalisation. The target could include a higher share of renewable electricity if deployment continues. There is a strong case for pressing ahead with the next round of both Capacity auctions, to ensure security, and another round of CfD auctions, to help maintain industrial momentum and deliver the 2020 renewables target, and to buy time for deeper reforms needed for the post 2020 era.

This chapter has indicated that there are solutions to the longer term challenges. In addressing these problems creatively and reasserting the renewables target, the government has the opportunity to make important improvements to the EMR whilst preserving its essential features: to go forwards, with a more efficient supporting framework for renewables, rather than backwards.

5 Newbery (2015) offers a number of other suggestions for improving the CfD structure, including that contracts should be denominated in nominal rather than indexed-linked payments; this could also be important to facilitate the tradability of long term renewable energy contracts.

Conclusions

This report has brought together contributions from several leading researchers at UCL, to comment on the changes wrought in the first 100 days of the conservative government. In general the impression left is one of a spasm of activities which mixed rationalisation and the politicisation of energy and climate policy, driven more by a sense of what the government did not want (including the budget overrun), rather than a considered view on what it does believe forms rational policy.

Perhaps the most striking feature is the near-void that now surrounds energy efficiency. The abrupt termination of the zero carbon homes policy, and the changes to the Vehicle Excise Duty, appear to have been driven significantly by Treasury antipathy to carbon-related policies that do not accord with neoclassical market assumptions or the wider deregulatory agenda. The Budget of 25th November, just as this report went to press, does not suggest this has significantly changed. [6]

After a decade of declining energy demand, this approach appears to risk exposing UK consumers to higher energy costs than needed, and increase the costs of decarbonisation. Quite how policy will develop as the government confronts this evidence remains to be seen. With Amber Rudd's reset speech cementing the broad aims, tension between the instincts of the Treasury and the evidence-base of DECC may only heighten. If the government is serious about energy (and cost) efficiency, our contributors have put forward plentiful options.

Naturally our report could not be comprehensive. Beyond energy efficiency, we have focused mainly on the electricity sector, where the issues are well developed. If the 'reset speech' has helped to stabilise expectations, the major test will lie in whether the government creates a structure for capital investment with declining subsidies, in ways that maintain the pace of cost reductions without wholly disrupting the still fast-evolving solar and offshore wind industries.
More generally: whether the government moves to a level playing field onshore with appropriate market and planning regimes for onshore wind and shale gas; whether and how it encourages decentralised and community energy schemes; whether it pursues a framework for economically-driven choices between nuclear and offshore wind; and how, more broadly, it supports the transformation of the electricity system to adapt, as it can, to the efficient integration of variable power sources and storage.

Beyond energy efficiency and the electricity sector, there is clearly much to be done. Transport policy is a field in its own right, though the apparent pace of vehicle and battery technology creates the potential for transport to be slowly integrated with the electricity system. Heat appears much harder, and at present threatens to become the Achilles Heel of the UK's long term decarbonisation strategy. Innovation remains crucial across all fronts, and needs to be better embedded in an overall strategy of transformation that combined efficiency, markets, and innovation with associated structural changes.

In recent years, the markets agenda has suffered with the malaise of the EU ETS and the political strain of globally unprecedented energy prices. As the International Energy Agency has long noted, falling international fossil fuel prices are partly a consequence of progress towards a low carbon economy. They also in turn create a better context for the drive to use market-based instruments, in particular carbon pricing, across the economy.

In this sense, the government does indeed have an opportunity to rebalance the effort towards market-based instruments. To realise its ambitions in this area however, the government will need to ensure that Treasury drives for tax efficiency also address carbon efficiency; and that it truly embodies an integrated strategy across all three pillars of a coherent and evidence-based energy policy. If the government is serious about the 'hard reset' being a rationalisation of UK energy policy consistent with the strategic goals mapped out, there is valuable scope to do so.

6 The Chancellor's speech of 25th November 2015 states: "we will reform the Renewable Heat Incentive to save £700 million. I can announce we're introducing a cheaper domestic energy efficiency scheme that replaces ECO. Britain's new energy scheme will save an average of £30 a year from the energy bills of 24 million households." It is obviously easy to state reductions in costs; the issue is what benefits one loses along with that. As illustrated in Chapter 2's analysis of CERT, spending a billion pounds annually on energy efficiency has delivered twice that in the value of reduced energy consumption – a saving which, moreover, continues after the scheme itself expires.

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