Driving innovation through continuity in UK energy policy

Four simple steps to maintain investor confidence, boost innovation and reduce costs in the UK power sector

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Overview

A series of energy policy changes announced since the May election have led to concerns about increasing political risk faced by prospective investors in the UK energy system (ECCC 2015). It has also been suggested that policy needs to be 'reset', with less technology-specific intervention and increased resources for longer term research into new technologies (Helm 2015).

This paper draws on a large body of analysis from UK Energy Research Centre (UKERC) and Imperial College. A list of the main reports and papers that inform the analysis is provided in Annex 1.

The paper argues that a 'reset' approach is unnecessary, will create delays to investment, increase political risks, and hence costs to consumers. Simply put, the government already has the levers it needs to encourage investment in a secure and lower carbon system. Policy can be made more effective by providing investors with greater clarity and a longer term perspective, using the policy framework that is already in place. Auctions for Contracts for Difference (CfDs) have already brought forward significant reductions in the prices paid to low carbon generators. CfDs could be moved progressively to a technology neutral basis, combined with price caps to bear down further on costs.

The paper discusses the infrastructure implications of new sources of energy and notes that government will need to balance the benefits of technology neutral CfD auctions against the need to develop strategic infrastructure in a timely fashion. It also discusses the impacts of variable renewables and explains that whilst it is important for system costs to be allocated cost effectively this does not mean that variable generators should be obliged to self-balance and invest in dedicated back up.

The paper also explains that whilst greater investment in innovation would be welcome, forthcoming research shows the timescales associated with invention, demonstration and deployment of technology are long. Whilst improvements to technologies are hugely important, the emergence of entirely new technologies remains very uncertain. Support for innovation should not be premised on wishful thinking about silver bullet technologies. Many of the technologies we need to decarbonise already exist and have done so for several decades. The challenge is to drive costs down and encourage network innovation to better suit new sources of power.

Finally, the paper argues that whilst more effective carbon pricing would bring many benefits it is not a sufficient condition for significant energy system change. Regulation of emissions from existing coal fired power stations after 2025 would aid investor clarity and improve the prospects for investment in both low carbon and gas-fired generation.

Setting the scene: The power sector matters and decisions are urgent

There are many diverse views on energy policy but one area of consensus is in *what needs to happen* in order to decarbonise the energy sector over coming decades. Technology rich decarbonisation scenario modelling has been developed in the UK and internationally by a wide range of expert bodies (E.g. National Grid 2014, CCC 2013). These scenarios all come to similar high level conclusions about the importance of key low-carbon technologies and the policies that are needed to drive their development and deployment. In the UK all the analysis points to the need to decarbonise electricity generation, and improve efficiency in buildings, appliances and cars (Maclean et al 2015). The focus here is on the power sector.

A key feature of energy systems, one which has perhaps received rather less attention in scenarios and modelling, is the time needed for change. Typically it takes about five years for a new wind farm or gas-fired power station to go through consenting and construction, and closer to a decade for new nuclear power stations or large offshore wind farm (Maclean 2015, Gross 2015). Timelines for carbon capture and storage (CCS) are currently rather uncertain but there is clear evidence that new infrastructure in the form of pipelines and power lines take at least a decade, and full-blown re-engineering of energy infrastructure usually runs over many decades. It also takes many years for the stock of appliances or cars to turnover and new devices to penetrate the market (Hanna et al Forthcoming).

If there is a desire to stay on track with decarbonisation goals in 2030 there is an increasingly urgent need to signal what the objectives are *after* 2020. Otherwise companies cannot plan their investments in a timely fashion. At present there is little clarity about the post-2020 policy environment for most forms of low carbon generation, which means that the development pipeline is already drying up. This is quite independent of any changes to investment plans that might result from recent policy changes or concerns about the levy control framework (LCF) cap.

Four steps to provide continuity, promote innovation and drive cost reduction

1. Providing longer term clarity and continuity

The ‘reset’ agenda has included discussion of alternatives to the Contracts for Difference (CfDs) created through the Energy Act in 2013. Alternative propositions include integrating low carbon goals with the capacity market (Helm 2015), or treating some forms of low carbon generation as regulated assets, possibly procured directly by government, allowing investors to treat them as infrastructure investments and hence access lower costs of capital (Blyth et al 2014).

New approaches may have advantages but these need to be weighed against the long delays and large uncertainties engendered by a further period of consultation and regulatory reform. As a key challenge for policy is to provide reassurance to investors that UK energy policy takes a long term view, has clear goals and has not become unduly politicised it would not appear helpful to scrap the CfDs so soon after inception, when only one auction round has been run.

The strengths and weaknesses of CfDs have been widely discussed, but they have already proven effective in attracting investment (Blyth et al 2014). For reasons discussed in more detail below CfDs offer investors a secure and stable long term environment. Properly managed, they have the potential to attract finance at relatively low risk premiums, which should benefit consumers by reducing financing costs (Ibid). Concerns about cost effectiveness arise in part from high prices provided to some technologies before prices were determined by auction. Any failings therefore relate to the early administration of the scheme rather than the CfDs per se. In addition, the broad principles of fixed price support schemes are well proven; over 100 countries have feed in tariffs of some form (REN21 2015). They are familiar to investors, effective, and remain the principal policy used to promote the deployment of low carbon generation globally (REN 21 2015, IEA 2008). Many countries are also moving to use tenders to provide feed in tariffs (REN 21 2015).

On balance therefore there are good reasons for the UK to maintain auctioned Contracts for Difference (CfDs) as the primary policy to promote low carbon generation. The government should stick with the CfDs and move quickly to determine its approach to auctions going forward. Two broad possibilities appear possible: The first would be to retain the current system of 'pots' distinguished by technology maturity, the second to move to a single series of technology neutral auctions. If the former approach is followed, payments to the most mature technologies could be capped at a 'subsidy free' level, defined so as to represent the price of the least cost new entrant (likely to be gas fired CCGT). The government may also wish to set overall price caps on auctions for all technologies, declining over time, to further encourage innovation and control costs. Whatever the precise approach it will be important to signal to developers that CfD payments are expected to reduce substantially over time; that continued support is contingent on cost reduction; and that this is non-negotiable.

If the CfDs are to deliver in terms of risk reduction and provide lowest cost to consumers, then developers and investors need clarity about policy goals over a timeline consistent with project development and construction (Blyth et al 2014). These typically run from around five years to around a decade, depending on the size and complexity of the project. For this reason, CfD auction plans and timetable should be set out to 2025. A successful and clear sighted CfD regime would boost low carbon infrastructure investment and cost reductions over the coming years. The timing of auction rounds need to be set clearly in advance, and ambition for each auction specified as far in advance as possible, subject to clear criteria for adjustment to the volume of capacity to be auctioned as costs become clearer and deployment levels for different technologies emerge from auctions.

The research evidence suggests that important sources of low carbon power – CCS, nuclear and offshore wind – will require some degree of subsidy in the period to 2025 (Gross et al 2013, Harris et al 2014). Whilst auctions and cost caps can drive costs down it is unlikely to be possible for these substantial sources of low carbon power to be entirely subsidy free for a number of years yet, particularly in the absence of a strong carbon price and if gas prices are low. For this reason the government also needs to provide an indication of the size of the LCF beyond 2020.

Fossil fuel prices are volatile and have a direct effect on the financial flows through the LCF. This creates uncertainty for investors, since the policy changes made over the summer result from the anticipation that the LCF will overshoot. Whilst this arose in part because of higher output from renewables than was anticipated (due to the popularity of solar schemes and better than expected performance from offshore wind farms), it also stems in large part from recent falls in wholesale power prices. The government could take steps to help prevent short term, unpredictable and cyclical factors undermining investor confidence by rebasing the benchmark wholesale power price against which the LCF is assessed. The government will need to consider carefully how best to do this, for example by moving to a rolling five year average index for wholesale prices rather than short term spot market price.

Finally, government needs to weigh carefully the balance between requiring industry to absorb pre-consenting costs at risk (of not securing a CfD contract) and the Danish and Dutch auction models where aspects of pre-development have already been completed by the System Operator or other agency, funded centrally (winning bidders then reimburse these costs) (Norton Rose 2014, Danish Energy Agency 2013). Site and grid connection are then auctioned, leaving the developer responsible principally for development and construction. Both approaches have advantages and disadvantages, but the latter approach appears to have delivered lower costs of energy (Ibid, & Gross 2015).

2. Define infrastructure needs and system balancing cost allocations

Different technologies have different infrastructural needs. For example, the power system upgrades needed for large amounts of offshore wind are different from those for widespread use of solar. There is also strong evidence that a pipeline network for carbon capture and storage (CCS) would be most cost effective if focused upon clusters of CCS plants linked to 'hubs' for North Sea disposal (CE 2014, CE CSSA and DECC 2013). The network would be oversized relative to the needs of early projects but realise economies of scale over time. Developing infrastructure at least cost requires a complex trade-off between allowing investment to respond flexibly to CfD auction outcomes and strategic planning to ensure investment is forthcoming in a timely fashion. Alongside increasing capacity neutral auctions to 2025 the government needs to take advice from bodies such as the Committee on Climate Change, academia, National Grid and Ofgem to determine an action plan for networks.

A key consideration for network planning and operation is integrating the variable output of some renewables, particularly if the share of such renewables rises to a significant level. The costs and impacts of variable generation are well understood, but complex and context dependent (Skea et al 2006). Over-simplistic analyses that suggest that variable generation should 'bid as firm power' (which implies dedicated back up) will lead to a sub-optimal and over-expensive power system (Ibid). This is because demand response, flexible generation, storage and interconnection offer benefits to the system as a whole and building them as if they need to be dedicated to each specific variable renewable installation will result in over-investment. System costs should be charged to generators as cost-effectively as possible, but on the proviso that they are assessed at a system wide level rather than on an assumption that variable renewable installations need to self-balance. Flexibility in all forms should also be incentivised as effectively as possible in the wholesale power and capacity markets.

3. Provide appropriate support for innovation

There is a large literature on the complex interaction between public support for R&D, private enterprise and market opportunities in promoting innovation (Foxon et al 2005). This literature highlights a need for *both* market pull (in the form of market opportunities for innovative products) *and* supply push (in the form of state-funded RD&D) in encouraging innovation. Unfortunately perhaps, there is no single answer to the question as to how to determine the most effective mix of such policies (or indeed exactly which policies to use at different innovation stages). However, the empirical literature on past innovations demonstrates clearly that innovation is unlikely to succeed in the absence of what are sometimes called 'niche' or 'lead' markets. The lack of such markets is sometimes referred to as the 'valley of death' for new technologies (Foxon et al 2005). Overcoming death-valley for emerging options provides the principal, and ongoing, justification for subsidy through CfDs (there may also be a case for ongoing unsubsidised long term contracts, see below).

A facet that has received less attention in the literature is the amount of *time* required for a new technology to emerge from fundamental research, go through demonstration and diffuse into the market place. If any new low carbon technologies are to play a substantial role in reducing carbon emissions then it will be necessary for them to be proven, available and *deployed at a scale that is sufficient for them to make a material impact.* In the case of many end-use technologies (such as smart, efficient products, insulation, electric cars) then in order to make a material impact on carbon emissions they will need to be deployed in very large numbers, usually of the order of tens of millions of units in the UK alone. In the case of some new energy supply technologies such as new nuclear power stations, carbon capture plants, or offshore wind farms the number of units that need to be deployed may be quite small. However each individual unit usually represents a large, complex construction/infrastructure project that will take many years to build.

Forthcoming UKERC research has systematically reviewed the literature on innovation timescales for a wide range of products (Hanna et al forthcoming). The research finds that almost all technologies spend between one and two decades at the research stage and take at least a decade to diffuse widely into the market. For many technologies these timelines run over several decades. Almost all technologies in current use were first invented many decades ago, and many can trace their origins to the early twentieth century. This suggests overall that whilst efforts to step up innovation are welcome (and all technologies benefit from ongoing research that can improve performance or open up new uses) history does not offer much support for the idea that entirely new technologies will rapidly emerge to solve the climate problem. The search for silver bullets is likely to prove elusive.

Building on the work of the Energy Strategy Fellowship[1], government could review the innovation funding system with a view to rationalisation where appropriate but keeping a strong focus on the need to retain intellectual capacity within grant making institutions. Also in line with the recommendation of the Strategy Fellowship, government could review the level of funding for innovation through to demonstration with a view to increasing the overall funding for energy innovation. However a substantial move to refocus energy policy on research-led innovation at the expense of market creation is unlikely to accelerate innovation and could prove counter-productive.

4. Understand the role of carbon pricing

Carbon pricing can send a technology neutral signal across the economy and encourage fuel switching between coal and gas and industrial energy efficiency. Many economists regard carbon pricing as the cornerstone of low carbon energy policy, on the basis that the damage costs of CO_2 are almost entirely externalised at present. However, there are many market failures in the energy system quite independent of the carbon externality.

[1] https://www.imperial.ac.uk/a-z-research/rcuk-energy-strategy-fellowship/

In the electricity generation arena, the principal limitations of carbon pricing can be found at the interface between politics and the needs of investors in low carbon generation (Gross et al 2012). Carbon price support cannot offer the same degree of investor security as a legal contract through a CfD. Carbon pricing has distributional and (if pursued unilaterally) industrial competitiveness impacts (Ibid). To be effective in promoting zero carbon power, carbon pricing requires that the cost of *all* energy rises to the cost of the marginal least-cost low carbon option – otherwise no low carbon generation can possibly be built (Ibid). This is more expensive for consumers than targeted payments to low carbon generators. Because of these concerns, carbon pricing is perceived by investors to be politically risky, since investors will be aware that carbon taxes can be lowered as well as raised (Ibid). The hope or expectation of a carbon price several years hence is unlikely to engender large amounts of costly pre-consenting and development activity.

Carbon prices do not offer the same degree of insulation from wholesale power price volatility provided by CfDs. An important aspect of this is that it is difficult for certain categories of investor in smaller scale technologies, and arguably *all* prospective investors in very large projects to adequately hedge against wholesale power price volatility. This is the principal argument for 'subsidy free' CfDs for mature low carbon technologies. Carbon pricing has a place in energy policy but cannot substitute for CfDs, an infrastructure strategy, or support for innovation.

Carbon prices have a significant impact on coal to gas switching; previous research by this author and colleagues demonstrates the sensitivity of investment in upgrades to existing coal to carbon prices (Gross et al 2014). This research also suggests that a regulatory approach to coal closure/load factors after 2025would give greater clarity to investors in low carbon and gas-fired plant.

Summary of key recommendations

Provide a statement of intent to decarbonise the UK electricity sector as cost effectively as possible, linked to the carbon budgets and in the light of energy system cost optimisation scenarios.

Provide a plan for CfD auctions running out until 2025. This would not need to specify the precise mix of technologies far in advance and would make maximum use of technology neutral auctions.

Signal to developers that CfD payments are expected to reduce substantially over time. Payments to the most mature technologies could be capped at a 'subsidy free' level, defined so as to represent the price of the least cost new entrant. The government may also wish to set overall price caps on auctions for all technologies, declining over time, to encourage innovation and control costs.

Ensure that the levy control framework cap provides a stable environment for investment beyond 2020. The baseline against which the LCF is assessed should not allow short term cyclical factors such as fuel price volatility to undermine investor confidence.

Develop a network infrastructure strategy. Working with National Grid and independent experts government needs to develop a vision for the power network that is consistent with the use of competitive auctions to select low cost technologies but also creates a robust and resilient system.

Maximise incentives for system flexibility through flexible generation, demand response, storage and interconnection. It is important that the system evolves to provide a least cost approach to integrating low carbon generation.

Ensure system charges are cost reflective, including the costs of variability but without requiring developers to provide economically inefficient dedicated back-up.

Provide effective support for innovation. This requires a mix of funding for RD&D and ongoing support for deployment to avoid the valley of death for emerging technologies. Innovation funding needs to provide ongoing support for cost reduction in existing technologies and innovations that reduce system costs.

Consider a regulatory approach to controlling emissions from existing coal fired generation. A strong carbon price would have benefits for decarbonisation but may be perceived by investors as politically uncertain. The principal driver of low carbon investment will continue to be CfDs. This can be complemented by regulatory approach that offers investors greater clarity about the long term role of the most polluting forms of generation.

Annex: Supporting analysis and documentation

The analysis above draws upon the following reports and papers by the author and colleagues:

Innovation timescales – forthcoming from UKERC

Hanna, R, Gross, R, Heptonstall, P, Speirs, J, Gambhir, A (forthcoming at www.UKERC.ac.uk)

There is a substantial literature on 'innovation systems' but a key consideration that has received less attention in the literature is the amount of *time* required for a new technology to emerge from fundamental research, go through demonstration and early stage deployment and diffuse into the market place. If any new low carbon technologies are to play a substantial role in reducing carbon emissions then it will be necessary for them to be proven, available and deployed at a scale that is sufficient for them to make a material impact. This project therefore asks exactly how long new innovations take to reach commercial maturity. It will seek to compare and contrast technologies with different characteristics and scales of deployment, from household appliances to large power stations.

Energy system crossroads - time for decisions: UK 2030 low carbon scenarios and pathways - key decision points for a decarbonised energy system

Maclean, K, Gross, R, Rhodes, A, Hannon, M, Parrish, B, 2015. ICEPT Discussion Paper available at http://www3.imperial.ac.uk/icept/publications/workingpapers

This paper reviews a broad spectrum of recent UK energy system scenarios and seeks to provide an explicit linkage between the outcomes that the scenarios envisage (for 2030 and beyond) and the policy choices and investor actions that will be needed in the coming years. The paper looks at the challenges from a whole-system perspective and recognises that an overall framework of decisions will be needed. It also analyses the sequencing of these decisions with a practical reflection on physical delivery and recognition of the interactions and interdependencies across sectors.

Approaches to cost reduction in carbon capture and storage and offshore wind

Gross, R, 2015 – a report for the Committee on Climate Change, available at https://www.theccc.org.uk/publication/gross-2015-approaches-to-cost-reduction-in-carbon-capture-and-storage-and-offshore-wind/

Dr Gross was commissioned expert Chair of expert advisory groups overseeing consultancy research into the prospects for cost reduction in CCS and offshore wind. Aspects of the technologies used in offshore wind and CCS are well proven, with offshore wind development in the UK now into its second decade of deployment and with components of the CCS system operational for several decades in parts of the world. Yet taken as a whole both are still emerging technologies that are at an early stage of commercial exploitation. They are currently expensive relative to more established low carbon options such as large hydro, onshore wind and new nuclear and a key challenge is to drive cost reduction. The CCC commissioned the Chair to produce a report that reflects on the consultants' work; the evidence base, key assumptions, methods, and areas for future work.

UKERC Energy Strategies Under Uncertainty - Financing the Power Sector: Is the Money Available? Blyth, W, McCarthy, R, Gross, R, 2014

UKERC Working Paper, available at http://www.ukerc.ac.uk/publications/ukerc-energy-strategy-under-uncertainties-financing-the-power-sector-is-the-money-available-.html

The electricity sector faces a level of investment in the coming two decades far higher than the past two decades. It needs to renew its ageing generation fleet, and shift towards capital-intensive low-carbon forms of generation. Over the past few years, various organisations and commentators have suggested that the sector may be unable to deliver, questioning whether there will be a sufficient flow of money into the sector to finance these investments. This report examines the evidence for these claims, looking at three key issues: The size of the gap between required and current levels of investment: The ability of energy companies to scale up their capital expenditures: The ability of financial institutions to provide the necessary funds, and the mechanisms by which they might do so.

Could retaining old coal lead to a policy own goal? Modelling the potential for coal fired power stations to undermine carbon targets in 2030.
Gross, R, Speirs, J, Hawkes, A, Skillings, S, Heptonstall, P. 2014. ICEPT Working Paper available at
http://www3.imperial.ac.uk/icept/publications/workingpapers

This study used the TIMES GB Power model to assess the implications of different scenarios for carbon price support, other policy changes and coal refurbishment costs for the likely future of existing coal fired power stations during the 2020s. The report find that the capacity and load factor of existing coal stations lie within a wide range and coal usage is very sensitive to carbon prices. The report recommends that government consider a regulatory approach to existing coal in order to provide investors with greater clarity about the long term role of coal and hence investment case for new gas and low carbon generation.

Presenting the Future: An assessment of future costs estimation methodologies in the electricity generation sector.
Gross, R., P. Heptonstall, P. Greenacre, C. Candelise, F. Jones and A. C. Castillo, 2013.
UK Energy Research Centre Technology and Policy Assessment Report. Available at
http://www.ukerc.ac.uk/programmes/technology-and-policy-assessment/electricity-cost-methodologies.html

This project considered the role and importance of cost estimates and the methodologies employed to estimate future costs in the UK electricity generation sector. It asked how robust these methodologies are, examined the circumstances under which it is appropriate to use cost estimates to compare between different technologies, and how the potential for cost reductions are represented.

The final synthesis report of the study was accompanied by six technology case studies assess cost trends in leading electricity generation technologies.

On picking winners: the need for targeted support for renewable energy
Gross, R, Stern, J, Charles, C, Nicholls, J, Candelise, C, Heptonstall, P, Greenacre, P. October 2012
ICEPT Working Paper, Imperial College London, available at
http://www3.imperial.ac.uk/icept/publications/workingpapers

This paper discusses the limitations of carbon pricing as a driver of investment in long lived, capital intensive assets. It argues that it is more economically efficient to provide targeted support in the form of feed in tariffs or similar 'investor friendly' policies that can provide stable and secure returns on investment.

Investment in Electricity Generation: The Role of Costs, Incentives and Risks
Heptonstall, P, Gross, R, Blyth, W, 2007
UKERC Technology and Policy Assessment Report, available at
http://www.ukerc.ac.uk/programmes/technology-and-policy-assessment/investment-in-electricity-generation-report.html

Journal Article
Gross, R., Blyth, W., Heptonstall, P. (2010) Risks, revenues and investment in electricity generation: Why policy needs to look beyond costs. Energy Economics 2 (4): 796-804.

The report finds that because policy goals can depend upon investment in particular technologies, it must be designed with the investment risks, not just technology costs, in mind. This is not because concern with costs is wrong, but because costs are only part of the equation. Policymakers cannot determine which technologies get built; they can only provide incentives to encourage a diverse and/or low carbon generation mix. And if incentives are to deliver such investment, they must be based on a clear understanding of how investment decisions are made.

The Costs and Impacts of Intermittency, Reports I and II
Skea et al, 2006. UKERC Technology and Policy Assessment Report, available at
http://www.ukerc.ac.uk/programmes/technology-and-policy-assessment/the-intermittency-report.html

Intermittency II Project: Scoping note and review protocol

Journal Article
Skea, J., Anderson, D., Green, T., Gross, R., Heptonstall, P., Leach, M. (2008) Intermittent renewable generation and the cost of maintaining power system reliability, IET Generation, Transmission and Distribution, 2 (1): 82-89

When the UKERC TPA team completed its first assessment of the evidence on the costs and impacts of intermittent generation on the British electricity system, the conclusion was that the additional costs would be relatively modest, adding around £5-£8 per MWh to the cost of the renewable electricity generated. Some commentators have suggested that renewable energy is made much more costly, or is drastically limited by intermittency. The report finds that these views are out of step with the vast majority of international expert analysis and that intermittency need not present a significant obstacle to the development of renewable sources.

The 2006 report was based on a review of the available evidence, most of which did not envisage (and therefore did not model) more than 20% of electricity to be sourced from intermittent renewables.
Since then, the UK's targets for renewable generation have been set considerably higher than this, and a number of significant new studies have been carried out into the likely effects of a much higher proportion of renewable electricity in the UK mix. The update, due in early 2016, will review the new evidence for the impacts associated with higher shares of renewable generation and assessing how projected impacts may have changed.

Other references

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