Cost of Energy Review: Insights from UKERC Research

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Introduction

UKERC carries out world-class, interdisciplinary research into sustainable future energy systems. It was established in 2004, and is funded by three Research Councils (EPSRC, ESRC and NERC). UKERC is a focal point of UK energy research and a gateway between the UK and the international energy research communities. UKERC's highly regarded research programme involves over a hundred leading researchers based in universities around the UK. We have a strong track record of academic excellence, as well as informing policy development and research strategy.

This note summarises insights from recent UKERC research that are particularly relevant to the independent review into the Cost of Energy, led by Professor Dieter Helm. In the remainder of this document we provide an overview of four key issues that are central to the review's terms of reference:

- the role of energy efficiency;
- innovation and technology cost reductions;
- a systems approach to costs; and
- the role of research, development and demonstration (R,D&D)

Our starting point is that the primary issue is the cost of energy bills for consumers, rather than only the unit price of energy. It is therefore important to focus on measures that can reduce the quantity of energy required for a given level of service as well as trends that could help to reduce or moderate prices. In line with the terms of reference, we have focused in particular on electricity costs since UK electricity prices are higher up the European league table than those for gas.

1. The role of energy efficiency

UKERC has a long track record of research on energy efficiency, including the potential for energy efficiency to reduce energy demand and emissions, the effectiveness of energy efficiency policies and implications for the economy. Notable examples include a systematic review of international evidence on what works in energy efficiency policy (Wade and Eyre, 2005), which found savings of around 10% from well-designed standards and investment programmes. Our past research also includes an influential review of the economy wide energy savings from energy efficiency (Sorrell, 2007). This showed that rebound effects need to be taken into account in policy appraisal, but they can be mitigated.

A recent UKERC report confirmed that the social benefits of cutting household energy use remain considerable (Rosenow et al, 2017). Using standard Treasury methodology, this report showed that a 25% reduction in household energy demand is possible using cost-effective measures. Furthermore, the social gains could be up to £7.5bn to 2030. This figure takes direct rebound effects into account.

This confirms that there is a clear rationale for further government intervention to realise these social benefits. There is a significant policy gap that has been left behind following the failure of the Green Deal. Previous supplier obligations made significant progress in helping to reduce household demand and energy bills, but the rate of progress has now stalled. There is also a need for more attention in energy efficiency policy to households on lower incomes (building on the current ECO scheme) and to SMEs that have not yet benefitted from significant policy attention.

2. Innovation and technology cost reductions

There is now significant evidence that a key driver for recent reductions in the costs of some energy technologies has been government intervention to create new markets. Policies such as feed-in tariffs, renewables portfolio standards, auctions and mandates have all helped to develop the market for technologies such as solar PV, onshore and offshore wind and electricity storage. These cost reductions are a product of 'learning by doing' due to cumulative deployment as well as scaling up of manufacturing. UKERC research has explored these drivers in detail, including through a review of cost reduction estimation methods that focused on six electricity technologies (Gross et al, 2013).

Some of these cost reductions have been driven globally, with benefits for UK consumers. Good examples are solar PV and onshore wind. Others have been substantially driven by UK policy. A particularly recent example is offshore wind, where the UK is leading global deployment and has achieved surprisingly low prices in the most recent CfD auction. The case of offshore wind in particular shows the value of patient government support, which may be needed for over a decade before significant cost reductions are achieved.

However, such cost reductions are not universal. Significant questions remain about how to bring down costs of large-scale nuclear power technology – a technology that has been consistently characterised by rising costs over time. Carbon capture and storage (CCS) technologies have also failed so far to deliver on industry promises of lower costs – though that may be a product of impatient and inconsistent policy rather than a lack of potential for cost reductions in the medium term.

In UKERC's response to the Industrial Strategy Green Paper (Bell et al, 2017), we argued that it makes sense to build on the existing set of policy instruments implemented as part of Electricity Market Reform a few years ago. Whilst alternatives may be desirable, our research on low carbon investment suggests investor confidence is already fragile, and radical policy change may make that situation worse rather than better.

However, some reforms to the implementation of the EMR framework are needed given the changes that have occurred since it was implemented. Recent experience from many countries including the UK, Mexico, Germany and the Netherlands have clearly demonstrated how competitive auctions can drive down the costs of renewable electricity technologies. For the UK, this means that there is a stronger case for moving as many low carbon technologies as possible into a single competitive auction over time – including energy efficiency measures, which could be deliverable at a lower cost than low carbon supply technologies.

There are limits to such a technology neutral approach due to the differences between the low carbon options that this policy framework is designed to support. It is well understood that purely technology- neutral policies only bring forward those technologies that are closest to market, and fail to develop those which are currently less competitive but which may be required for deeper decarbonisation or which may have the greatest long-term potential. For example, the cost reductions now being experienced by offshore wind would not have happened without some specific public support. More specific arrangements are also likely to be needed for technologies that are complex, capital intensive and characterised by high financial risks. A strong case has been made by the Oxburgh report on carbon capture and storage (CCS) that these technologies require a more state-led approach to investment that still leaves significant room for competition to minimise costs.

'Subsidy-free' contracts for difference are worth further consideration, especially given the magnitude of cost reductions in recent years. Such contracts would not provide additional funding for a low carbon project when compared to the lowest cost alternative (usually assumed to be a gas- fired CCGT). However, they would reduce political and other risks for investors. There is an important debate about what 'subsidy-free' could mean in practice, and how such contracts would differ from fixed-price power purchase agreements. Further investigation is needed to assess whether this approach could undermine the ultimate aspirations for technology neutral auctions where contracts are simply awarded to the lowest price bidders.

3. A systems approach to costs

As the terms of reference for the Cost of Energy review make clear, a systems approach to costs is required. It is not sufficient to only focus on the costs of particular technologies, or their system costs, in isolation from each other. This is particularly for the case of electricity where a range of mechanisms and markets are used to balance supply and demand in real time.

A recent peer reviewed UKERC report provides a systematic review of the international evidence on the system costs of 'intermittency' for electricity systems (Gross et al, 2016). It concludes that under UK-relevant conditions, the principal costs would amount to around £10/MWh of variable renewable output up to around 30% intermittent renewables. The report notes that renewable integration costs vary considerably, driven by different climatic demand profiles and energy system contexts. Future costs at higher penetrations of intermittent renewables depend crucially on the availability of cost effective system flexibility through demand response, storage, interconnection and flexible thermal generation.

A key policy implication for the Cost of Energy review is that incentives for all sources of flexibility may need to be strengthened in order to minimise the costs of integration. This means that reforms to the capacity market are required to ensure that it is more neutral with respect to different sources of flexibility. Whilst there may be a rationale for different capacity contract lengths for supply and demand side investments, offering equal terms to both would allow market participants to identify the most cost-effective sources of capacity, and would thereby minimise the amount of subsidy required. Any further reforms to the capacity market should also retain the principle that balancing of supply and demand is best achieved and paid for on a system-wide basis. Reforms may also be required to the balancing and services markets operated by National Grid.

We are aware of the recent recommendation by the House of Lords Economic Affairs Committee that suggests that there should be a single auction that meets both emissions reduction and security of supply objectives. The idea would be to combine the functions of the capacity market and contracts for difference, each of which was set up to meet a different policy objective. It is difficult to envisage how this could work in practice such that it would meet the needs of investors in zero marginal cost generation. It would not be economically efficient to require individual projects procure dedicated back-up capacity since this could result in over-procurement of such capacity when compared to a system-wide approach. Nevertheless, as the share of renewables increases it will be important for the government to consider how best to account for and allocate system costs, including the costs of intermittency.

4. The role of research, development and demonstration (RD&D)

The terms of reference asks the review to 'consider how technological change in the wider economy, as well as in the energy sector, may transform the power sector, and how energy policy can best facilitate and encourage such developments'.

As noted above, innovation in electricity technologies and systems has already been an important driver for cost reductions. However, it is not sufficient to create incentives for the deployment of near market technologies to drive such innovation. A systems approach is required that also includes more fundamental research and development (R&D) on newer technologies, and targeted support for demonstrating, trialling and scaling up these technologies (Watson, Kern and Wang, 2015). Policy makers have recognised for many years that innovation is not a linear process, and that there are important feedbacks between the different stages of technology development – and the policies that support innovation.

A recent UKERC systematic review showed that innovation in the energy sector tends to take a long time. The timescales from early stage R&D to significant commercial deployment typically take 3 – 4 decades for energy sector technologies (Hanna et al, 2015). The review provides some evidence that some consumer or demand-side products may have shorter timescales because they diffuse more rapidly.

Along with many other countries, the UK has signed up to the Mission Innovation initiative, and has pledged to double energy R&D spending between 2015 and 2020. UK energy R&D spending levels have already recovered from the lows seen in the 1990s, and the portfolio of technologies supported is more diverse. However, it is often argued that the amount of public spending by the UK and other countries is still much too low when compared to the scale of the challenged posed by climate change. Furthermore, the effectiveness of R&D depends heavily on how money is spent – and, as we noted above, whether such R&D spending is complemented by incentives for demonstration and market creation.

The recent announcement of further investment in the 'supply side' of innovation through the Faraday Challenge for energy storage is welcome. This may be joined by other energy innovation programmes under the Industrial Strategy Challenge Fund over the coming months. However, the recent Industrial Strategy Green Paper did not demonstrate how such initiatives reflect the evidence base on UK innovation needs.

Significant analysis has already been carried out by government to establish this evidence base – for example by the Low Carbon Innovation Co-ordinating Group, the Research Councils UK Energy Strategy Fellowship and by Innovate UK. This evidence base suggests a number of important criteria that should inform policy priorities, including:

- the potential UK and global market for different low carbon technologies;
- the potential for cost reductions, including the effect of UK policy on such cost reductions;
- the potential value to the UK-based components of supply chains; and
- the extent of existing scientific and industrial capabilities.

One drawback of this existing evidence base it that it tends to focus on discrete technologies, and pays less attention to the system innovations that will also be required (e.g. for smarter electricity grids and for low carbon heating systems). Such system innovation will be a key feature of successful low carbon transitions (Watson, Kern and Wang, 2015). Many demonstrations of such system innovations have already been carried out, supported by government and industry. However, there has been a lack of systematic evaluation of these demonstrations to learn and share lessons. In some cases, risk aversion has limited the amount of experimentation and innovation that has been possible (e.g. Frame et al, 2016).

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