Industry and Parliament Trust

Resilient Futures: Energy

European Commission

Contents

The Industry and Parliament Trust's Resilient Future's programme provided a forum for discussion to explore different perspectives on both our energy and financial futures. The energy strand of the Resilient Futures programme explored EU energy legislation, energy affordability, security of energy supply, diversification and innovation of sources, and carbon reduction. The energy strand of IPT's Resilient Futures programme was conducted in collaboration with the European Commission, supported by Energy UK and the University of Birmingham. Contributions to this report should be considered as the authors' own individual views, and are not necessarily the views of the Industry and Parliament Trust or other persons and organisations who have contributed to the booklet.

Introduction

It is fairly easy to argue that there has never been a busier time for energy in Europe. With the 2030 Framework underway, Energy Union beginning to take shape and a number of other initiatives behind all that, the Industry and Parliament Trust's Resilient Futures programme could not be more timely.

Domestically, we have seen a number of changes in the last few months with the new government moving early to end new subsidy to onshore wind and scaling back the feed-in tariffs for solar. The CMA has now presented its initial findings which sets out a number of issues for the retail market, not least tariffs and smart meters. Energy efficiency remains a major priority for industry and there are a number of ideas about how to most effectively progress this agenda.

The Resilient Futures programme has provided an excellent opportunity to discuss these issues and other key challenges for the sector in the European context within which we all operate. This book of essays is an excellent way to round off the formal sessions and provide food for thought for how we transition to a low-carbon, affordable and secure energy system in the future.

Lawrence Slade, *Chief Executive Energy UK*

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Energy Affordability 12th May 2015

The Uk Retail Energy Market: Affordability And Barriers To Engagement

The UK energy market has attracted a lot of attention and debate in recent years due to concerns about its ability to deliver a fair deal for consumers and businesses. Political and social commentators have highlighted the continuous increases in retail energy prices in the last decade and the fact that decreases in wholesale prices have not always been followed by reductions in retail prices. These phenomena, together with the financial difficulties resulting from the recession and austerity programme, have led to concerns about an affordability crisis in the energy markets. The state of competition in the energy market assessment undertaken by Ofgem in collaboration with the OFT and CMA in 2014 has led to the request of a full investigation, which was undertaken by the CMA in June, as a result of concerns about the lack of a well-functioning energy market in the UK.

The Competition and Market Authority (CMA) has recently reported[1] on the limits and barriers to competition in the market, following its year-long investigation. In this report they have confirmed the concerns expressed in the provisional findings published in February 2015 regarding the prevalence of inactive consumers and the existence of barriers to switching, which have caused some consumers to pay well in excess of what would be expected in a competitive market. These concerns are justified by considerations about the implications for effective market competition of a large number of consumers who do not exercise the right to choose their supplier and therefore do not put sufficient pressure on energy companies to charge cost-reflective prices, nor to deliver adequate levels of service quality.

While a lack of consumer engagement to some extent undermines the development of a well – functioning market, the fact that many energy customers pay more than others does not necessarily arise from a deliberate intention of energy suppliers to mislead customers.

Although rigorous evidence has been provided by the CMA about the extent of the problem and its monetary implications, it might be too idealistic to expect that a competitive outcome can be achieved in a market which is still, to a large extent, characterised by consumer inertia. It is also difficult to identify solutions to a problem which depends in part on consumers' behaviour and on their level of trust in the market, as regulation might prove ineffective or even counterproductive in these circumstances.

The results of the CMA's investigation seem to indicate that the extensive regulatory interventions implemented after the Energy Supply Probe (2008) and the State of Competition Review (2010) have led to major changes in the nature of retail competition and might also have led to anticompetitive outcomes. It has been suggested that setting a limit on the number of tariffs which companies can charge has constrained their ability to propose a range of tariffs which allows them to target consumers with different characteristics and needs and has limited the opportunities to offer more widespread discounts, therefore limiting the extent of competition.

In order to address the issue of a large number of consumers being on the relatively more expensive standard variable tariff the CMA has suggested imposing of a temporary price cap on such tariff, while other measures are devised in order to promote consumer engagement. It is realistic to expect that the significant advancements made in behavioural economics in the last decades will offer advice on effective policy tools to mitigate the effects of consumers' inertia however it might be optimistic to expect that the lack of engagement by many consumers can be resolved with minor interventions.

Until now the prospect of financial incentives, in the form of savings on bills, and attempts to simplify the tariffs structure or to reduce the number of tariffs on offer, has not led to significant increases in switching rates nor has it promoted more frequent switching. Furthermore despite the media attention to the missed opportunities to save on bills, some consumers consider the size of the expected savings insufficient to compensate them for the uncertainty associated with switching supplier, or the time and effort required to obtain the necessary information.

While a lack of consumer engagement to some extent undermines the development of a well- functioning market, the fact that many energy customers pay more than others does not necessarily arise from a deliberate intention of energy suppliers to mislead customers. The observed lack of exploitation of many opportunities to save on bills could instead be the result of a conscious choice of consumers who have high opportunity costs of time and/or are not interested in exercising the choice because they feel that the savings involved are not sufficient to persuade them to change supplier. Although attempts have been made to help consumers to make informed choices regarding their energy bills, switching rates have remained relatively stable and some categories of consumers continue to express a lack of trust in the process and the offers available.

It is also important to point out that the CMA report has highlighted that a large proportion of the retail price increases observed in the last ten years are associated with fuel and network costs associated with the transition to a low carbon economy. Indeed a large proportion of the increasing costs that consumers are facing cannot be ascribed to a lack of competition in the market but rather investment in the energy system required by the need to remove obsolete or carbon intensive plants from the system and replacing them with more expensive new technologies, which will allow in the near future for a more flexible, efficient and cost reflective use of energy resources.

While the CMA report has indicated the lack of engagement by consumers as a matter of policy concern, as it weakens the pressures on energy suppliers, not all consumers are affected to the same extent. The least able to pay and those using prepayment meters are likely to suffer more significantly by the lack of access to better deals even if they are not actively discriminated against. Indeed, substantial evidence is starting to emerge about the fact that many vulnerable consumers have consistently refused or have been unable to become engaged with the market and are therefore missing out on opportunities to save on their energy bills, and to achieve a more efficient use of energy in their properties by accessing tariffs which are better suited to their consumption patterns and financial capabilities.

To address this pressing social issue the suggestion has been made to prioritise the delivery of smart meters to prepayment meter users in order to reduce cost differentials. On the one hand, the introduction of a temporary price-cap on the most expensive tariffs will also help to address the issue of affordability for the most vulnerable in society but, on the other hand, it is important to recognise that many of the energy affordability problems for the least able to pay and the households who are in debt due to inability to pay their bills are often related to the quality of the premises they occupy, which might require unaffordable investment in order to improve their energy efficiency. This is an area that has witnessed significant policy failures, for instance in the case of the Green Deal, and will require substantial additional effort in order to eradicate many of the households' concerns about potential costs and disruptions, and about whether to trust the suppliers who have been tasked with the obligation to improve the energy efficiency of vulnerable consumers' dwellings.

In this context, one important area which might require prompt and decisive policy interventions is the agency problem. This arises for consumers who do not own their properties, who might be prevented from making the most profitable choices about their energy supplier or the adoption of energy efficiency measures for their dwellings, because they are (or think that they are) not allowed to make such decisions or because they would be unable to obtain the full economic benefits of their choices.

Indeed the possibility of taking advantage of discounts associated with fixed tariffs could be limited for tenants with short tenancy contracts and more importantly the long term benefits of installing energy efficiency measures to reduce energy consumption in the property would accrue to the landlord rather than the tenant, therefore reducing the incentive to adopt such measures. These agency problems are also likely to affect energy consumption of private tenants, whose number has substantially increased in recent years, with the percent of privately rented dwellings out of total dwelling in the UK having increased from 7.8% in 2001-2 to 17.9% in 2011-12.

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This problem is likely to be particularly prominent in the case of small and medium sized enterprises and above all microbusinesses, who do not usually own the premises from which they operate. This category also has been identified in the CMA's provisional findings report as not engaging and being vulnerable to poor outcomes in the energy market; a situation made worse by emerging concerns about malpractice by third party intermediaries, who can provide support in the negotiation of energy contracts with energy suppliers.

The issue of energy affordability remains at the forefront of the political debate and will continue to do so as the Government decides whether and to what extent to implement the remedies proposed by the CMA to address the failures of competition in the UK energy market. While these proposed interventions are likely to address the identified failures of market competition, the whole picture of the radical economic, technological and behavioural energy transformation currently taking place in the UK needs to be taken into account so that the critical issues of affordability and sustainability can be addressed in a fair and efficient way.

Monica Giulietti,

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Affordability For All

Following its creation in 2008 as a means of combining business and energy responsibility following the Energy Act, the Department for Energy & Climate Change (DECC) national objectives are often referred to as the 'trilemma'; a fine balance between securing decarbonisation, security of supply and energy affordability. Though these objectives can conflict, with policies contributing to, or impacting upon, more than one objective, consumer affordability has remained central to the objectives of multiple Secretaries of State. Under the leadership of Rt Hon Amber Rudd MP, the Department still widely accepts that improving the energy efficiency of the UK's housing stock is the most rational and sustainable way to decarbonise heat, ensure security of supply through demand reduction, and reduce costs for consumers.

Despite coordinated efforts to relieve the escalation of energy prices, it was always known and broadly accepted that UK households would have to support the cost of transition toward a decarbonised energy industry. We were assured the cost of doing so would not greatly impact low income households through the Levy Control Framework (LCF). Over the last decade however, UK households have witnessed a doubling of average domestic energy bills from £609 to £1327[2], leading to the false assumption by critics that 'green energy' has provided the largest contribution to bill rises. In spite of this belief, 7% of the average energy bill relates directly to the cost and upkeep of environmental and social policies and the current Government have very recently worked to reduce these costs, through the ending of the various subsidies and 'green energy support'. This is important work as it is right the Government regulate upon the burden of these costs for vulnerable households, but we know the true causes of high energy costs.

Unpredictable supply, regular reliance on energy imports, and rising cost of transmission has increased consumer bills. Investigations to date have revealed evidence that the competitive markets are currently failing many low income energy consumers, particularly those on pre-payment. Disappointingly, initial findings by the Competitions and Markets Authority (CMA) revealed that prices paid by domestic customers were £1.2 billion per annum above levels expected in a well-functioning market. There is therefore a clear risk that unless new safeguards and subsequent regulatory conditions are applied and enforced, energy prices will continue to have a disproportionate impact on poorer households, and low income consumers will continue to be least able to take advantage of effective competition.

The outcomes of this review could further erode trust without effective policy proposals and delivery mechanism to correct any adverse effects of competition (AEC). This, combined with low incomes and a woefully inefficient housing stock when compared to our European neighbours, has resulted in 4.5 million households across the United Kingdom living in fuel poverty[3]. Now is the time more than ever for Government to provide a retrofit for all low income households to defend against unpredictable energy costs.

Investigations to date have revealed evidence that the competitive markets are currently failing many low income energy consumers, particularly those on pre-payment.

These are not concerns that have gone ignored by successive governments. A recent cross-party poll by NEA of 100 Westminster MPs found that over 90% stated that unaffordable energy bills were a major concern for their constituents[4], whilst almost two thirds believed additional UK HM Treasury resources should be pledged to long term energy efficiency programmes to help those struggling with energy costs while on low incomes. As a result, the public are keen to see urgent and ambitious action and Government agree it is time to act. While the scale of this challenge may seem overwhelming, we must not doubt the strength that political and public sentiment on the need to adequately address these issues is at an all-time high.

Along with our campaign partners, we believe the most effective way to permanently ensure affordability for all households and the only way to end fuel poverty across the UK is to make all homes occupied by low-income households super energy-efficient. As will be demonstrated, this could also be one of the best ways to create jobs, generate significant economic growth and reduce costs from cold related hospital admissions and gas imports. However, despite there being strong and growing evidence that investing public funds would generate the UK more revenue than under business-as-usual, the main energy efficiency scheme, the Energy Companies Obligation (ECO), is insufficient in scale, yet increase energy prices for those that do not benefit. Currently these supplier-led schemes also fail to take account of the enhanced needs of vulnerable consumers. Meanwhile the bespoke programmes that exist in Scotland, Wales and Northern Ireland also need to be expanded if the Devolved Governments are to meet their existing commitments to end fuel poverty.

Despite coordinated efforts to relieve the escalation of energy prices, it was always known and broadly accepted that UK households would have to support the cost of transition toward a decarbonised energy industry.

It has become unmistakeably apparent that adequate funds for such a scheme are not only available, but they would also be cost effective in generating considerable macroeconomic returns. Other than the regressive burden on energy bills balancing the cost of decarbonisation, during this Parliament, HM Treasury will raise £28 billion from VAT and carbon taxes generated from domestic energy bills by 2030 – around £107 per consumer per annum[5]. Currently the UK invests none of these resources to reduce energy demand and make dwellings fit-for-purpose. Whereas thirteen other EU countries, however, have pledged to return all, or part of the proceeds from carbon taxes (the EU-ETS auctions) to climate and energy efficiency programmes. Analysis by the Committee on Climate Change (the government's advisory body on climate change) suggests that hitting the new targets would cost in total £18bn, or £1.2 billion –1.6 billion per annum to 2030, however current annual spending on energy efficiency improvements in fuel poor homes in England amounts to less than half that, circa £490m, a proportion of the GB wide ECO programme. Meanwhile, independent consultant Verco has also estimated it would cost £2.6 billion per annum to improve the homes of all 4.7 million low-income households to Band 'C' thereby bringing an end to fuel poverty by 2025[6]. Charging through green policy levies are key to bringing an end to the cost and suffering of fuel poverty for all low income households.

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Hypothecation and allocating these huge sums raised from consumer bills will be politically unpopular. At a time of high energy costs and fuel poverty showing no sign of a significant fall in the near future, the Energy Efficiency minister, Lord Bourne, accepts that the next government policy of energy efficiency urgently needs to "ensure people do not live in fuel poverty"[7].

Meanwhile, it has become undeniable that the benefits not only create a socially just energy sector where affordability is available to all households, but also an opportunity that benefits the stability of our national economy. The International Energy Agency (IEA) recently highlighted and quantified the potential for energy efficiency to deliver jobs and economic growth, reduce pressure on health services, improve energy security and reduce carbon emissions – at the same time as providing a long-term, sustainable solution to unaffordable energy bills for all consumers. In particular, their report – Capturing the multiple benefits of energy efficiency – demonstrated that large scale energy efficiency programmes can lead to increases in GDP of up to 1.1 per cent per year; can create significant employment (8-27 job years per €1 million invested); result in a 26% reduction in imports of natural gas in 2030, worth £2.7 billion in that year, and can have a benefit-to-cost ratio of 4:1[8] for every pound invested by Government. These benefits are by no means limited to national centralised government. The same research shows that others have also been recorded at a local community level. For domestic households on a low income reduction in energy bills increase spending within poorer local economies, while local businesses benefit from increased demand in low and medium skilled construction and manufacturing labour through an enthused energy efficiency industry.

In response to these tangible benefits felt at every level and in all pockets, previous Commercial Secretary to the Treasury, Lord Deighton, announced that he was "extremely attracted"[9] to the idea of reframing home energy efficiency as one of the UK's top 40 infrastructure priorities as it provided multiple financial, public health and environmental returns for Government. Energy efficiency can therefore, not only ensure affordability for domestic consumers who suffer in cold homes, it would also ensure multiple returns for any government in the provision of socially just, cost effective, macroeconomic, public health raising, and environmental benefits for the whole of society.

Ben Sayah,

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Security of Supply 11th June 2015

SECURITY OF SUPPLY

In winter 2014, a Utilitywise client saw a tabloid headline forecasting blackouts, rang up and asked "What can I do to help?". Unfortunately, there was limited opportunity for action beyond what they were already doing.

Despite using heat from a gas CHP in their manufacturing process, the spare electricity generation capacity was too small to bid into National Grid's Short Term Operating Reserve (STOR) and Demand Side Balancing Reserve (DSBR) schemes, and the opportunity to enter the Electricity Demand Reduction (EDR) pilot had come and gone.

They had already optimised their production schedules to reduce consumption during the Distribution Use of System (DUoS) red band – even to the point of delaying a tea-break. But while the DUoS tariff structure discourages consumption during the peaks of winter demand, it will equally reward the same actions on sunny and windy summer evenings. Lower and flatter peak demand over the winter has made it more difficult to forecast the three Triad periods. Triads are used for charging transmission costs based on consumption during times of national peak demand. However, these are increasingly considered to be blunt instruments, designed for a generation mix that is strained only at times of high demand.

Unclear Incentives for Demand Flexibility

While the wholesale market provides limited price signals, the growth of flexible contracts linked to baseload prices has resulted in Time of Use (ToU) tariffs falling out of favour, even for clients with Half-Hourly (HH) meters.

Even with balancing prices set by the average cost of the last 500MW of System Operator actions rather than the marginal price, ToU rates give the consumer limited benefit compared to that accruing to other market participants when the system is in greatest need of flexibility.

Consumers have also been insulated from market volatility by the structure of supply contracts where the risk is borne by their supplier in return for a fee. This approach clearly benefits consumers by aggregating and offsetting exposure to the balancing market.

While there has not been a clear market signal to incentivise demand response, in addition to the schemes already mentioned, the Capacity Market has been introduced. Some of the schemes could create conflict between regional and national needs, and others are ostensibly complementary to each other but the rules do not allow simultaneous participation. Furthermore, the impact of policies such as the Electricity Balancing Significant Code Review (EBSCR) and P272 will also have an impact on incentives for DSR.

Therefore, the consumer looking to contribute to security of supply must understand the advantages and disadvantages of each scheme. This would then allow the customer to identify the scheme which should provide the best return on their investment. However, rather than responding to short-term market signals, the customer would be required to bid to the appropriate auction well in advance of the time in which action may be required.

Despite this, across Europe the problem is less a lack of capacity, than a lack of flexibility within the system. A 2013 European Commission working document on Generation Adequacy assessed reliable available generation capacity at 113% of peak demand, and net generating capacity at 186% of normal load.

Conventional Approach to Security of Supply

The general approach to security of supply has been to forecast future, higher demand levels, and ensure that sufficient despatchable capacity is built that can meet a margin above expectations. Older plant, replaced by newer, more efficient generation, will either close, or run less frequently in response to peaks in demand.

Consumers have also been insulated from market volatility by the structure of supply contracts where the risk is borne by their supplier in return for a fee.

But this structure is being challenged by renewable generation pushing flexible plant up the generation stack. Falling demand is also increasing competition among peaking plant. Where predictable and inflexible demand has been satisfied by flexible generation with little need for storage, generation is losing flexibility, and demand becoming less predictable. This is putting the system under strain at different times, and from excess as well as insufficient generation.

Demand Side Contributions to Security of Supply

There are three main ways in which the demand side can contribute to security of supply: on-site generation, energy efficiency and demand response.

On-site generation can provide the generator with its own localised supply, reducing dependence on the transmission and distribution networks, while minimising exposure to market price fluctuations. However, onsite generation can also be used to increase the site's ability to respond to system stress. Increased energy efficiency can eliminate waste without affecting production, given the long term elasticity of demand to forward prices. In contrast, the use of demand response reflects the short term elasticity of demand to spot markets. Given the nature of consumption reduction, demand response is frequently mistaken for "shutting down". However, it can instead be the voluntary temporary reduction of either non-essential load or, if prices give sufficient incentive, production load.

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One of the best examples of effective demand response can be found in the PJM Independent System Operator. Representing 13 states across North East America, it represents the largest competitive wholesale electricity market in the world. Nearly 10% of peak demand within the market can be called on to reduce during times of stress, with the greatest capacity reduction coming from manufacturing demand. Heating, Ventilation and Air Conditioning (HVAC) can also provide 29% of total capacity, offering a greater contribution than on-site generation.

There are three main ways in which the demand side can contribute to security of supply: on-site generation, energy efficiency and demand response.

All three demand side approaches reduce the level of peak demand and lower the requirement for secure generation capacity. However, demand response also brings flexibility at any time, focusing not just on reducing demand at peak, but providing a viable solution to the problems of intermittent generation.

Another common misconception is the belief that if DSR is increased to a point greater than supply, the market will be left with nothing. However, DSR operates at the margins of the market, where generation is most expensive to hold in reserve and is infrequently run. This is also where storage and interconnectors are upending the status quo.

Heating is Often Overlooked

However, policy remains predominantly focused on electricity generation and the view that security of supply means meeting maximum demand. Yet increasing gas generation decreases security of supply for gas. If Europe experiences a cold snap, there is a dispute with Russia or LNG tankers are diverted to the Far East (all recent occurrences), the priority for gas is likely to be domestic heating, which is inexplicably relegated behind electricity when it comes to concerns over security of supply.

The contribution that can be made by domestic heating has gained a boost from the publicity surrounding a range of cutting-edge programmable Wi-Fi enabled thermostats. Technological automation means that DSR does not have to be intrusive. Automated controls could enable electric heating to benefit from ToU tariffs, but only with HH metering and settlement. Until then, the supplier would benefit more than the consumer.

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In essence, this would entail a return to the principles behind Economy 7 and Electric Storage Heating, but with updated technology – HH ToU rates and heat pumps. Familiarity with time of use pricing is being replaced by acceptance of dynamic pricing that reflects supply and demand, already prevalent in the travel industry for flights and hotels rooms.

Risk and Reward

Despite this, time of use tariffs are in decline among large consumers with HH meters. Insulated from short term price volatility by suppliers, this has been appropriate as vertical integration meant that suppliers were better placed to manage balancing risk and spreading the residual costs. However, renewable generation is contributing to increased volatility, and technology has evolved to enable new suppliers to challenge the vertically integrated incumbents by harnessing the flexibility of their customers.

Large consumers have shown willingness to engage with energy markets through flexible contracts providing them with control over longer term wholesale risk. Ironically, the structure of these baseload focused contracts has contributed to the reduced prevalence of ToU tariffs. However, with changes in the market reducing long term volatility at the expense of short term fluctuations, the rewards for managing demand are increasing.

The increased risk will come at a cost to consumers. They are increasingly faced with a choice between paying a rising premium for a provider to bear the risk, or to bear it themselves. Providing flexibility to the market will give consumers opportunities for reward, but will come with both capital costs – installation of equipment – and operational costs – the requirement to adjust working schedules and practices.

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Don't underestimate consumer willingness

Security of supply no longer means ensuring sufficient centralised generation can be transmitted and distributed to meet the level of peak demand that may be reached for a few half-hours in a decade. However, the changes leading to volatility in generation, and tight capacity margins, are increasing the value of flexibility. As consumers will pay a higher premium for a third party to ensure security of supply, they must also have the opportunity to be rewarded for their contribution to system flexibility.

The fear of unexpected blackouts is justified by business. This should not, however, be mistaken for a lack of willingness to participate in the market to help avoid them.

Jon Ferris,

Head of Energy Markets, Utilitywise
24th July 2015

Globalising the Uk's Gas Security[10]

During the 1990's the UK experienced a 'dash for gas' as bountiful supplies from the North Sea enabled the power sector to replace coal with cleaner natural gas. This process of decarbonisation played a major role in the UK meeting its Kyoto Protocol emission reduction target. At the same time, the Interconnector UK was built allowing gas to be exported, as well as imported. In 2000, production on the UK continental shelf peaked, and by 2004 the UK found itself a net importer of natural gas (though 2011 was a record year for exports). In 2014 the UK had to import 45 per cent of net natural gas consumption (more than 50 per cent if you factor in exports), meaning that in just a decade the UK has effectively 'globalised' its natural gas security, leaving consumers exposed to the volatility and geopolitics of global gas markets.

A recently completed project funded by the UK Energy Research Centre (UKERC) – and is supported by the ESRC – examined the consequences to the UK of increased global market exposure.[11] Because of events in Ukraine and the domestic debate over shale gas development, the issue of gas security of supply is seldom far from the headlines, but should we be concerned, and is shale gas the answer?

During the 1990's the UK experienced a 'dash for gas' as bountiful supplies from the North Sea enabled the power sector to replace coal with cleaner natural gas.

Today, natural gas continues to play a major role in the UK's energy system. According to figures from the Department of Energy and Climate Change (DECC),[12] in 2014, natural gas accounted for 32.4 per cent of the nation's primary energy consumption and it was responsible for 29 per cent of electricity generation – demand had been depressed until recently by high gas prices and cheap coal. Natural gas consumption in the UK is shared more or less equally between three sectors: power generation, industry and households. It is important to remember that more than 80 per cent of households use natural gas. Thus, the future of gas demand in the UK is as much about domestic heat as it is power generation.

Although the UK's import dependence has increased significantly, it benefits from diverse supply sources. In 2014, production from Norway accounted for 57 per cent of imports carried by pipeline directly to the UK and a further 16 per cent came from continental Europe via the interconnectors originating in Belgium and the Netherlands. These imports mean that UK gas security is increasingly exposed to pan-European developments and the policies of the European Commission to create a single European gas market and the recently launched Energy Union. The remaining 27 per cent arrived in the form of liquefied natural gas (LNG), 92 per cent of which came from Qatar. The share of LNG increased significantly over 2013 as a result of growing supply and weakening Asian demand.

The UKERC project paid particular attention to the development of the UK's LNG supply chain because it is relatively new. It is through LNG that the UK is connected to the global gas market. In anticipation of falling domestic production, the industry has built substantial LNG import capacity. Today there are three operating LNG terminals, the combined capacity of which is almost 50 billion cubic metres a year, equivalent to over 60 per cent of total UK consumption at the moment. Yet the scale of LNG deliveries has been variable over the decade that this capacity has been in place.

In 2014, natural gas accounted for 32.4 per cent of the nation's primary energy consumption and it was responsible for 29 per cent of electricity generation

Although the UK's import dependence has increased significantly, it benefits from diverse supply sources.

Early last decade there was a significant expansion of Qatari LNG production in anticipation of the US becoming a major LNG importer, but the rapid development of domestic shale gas production has meant that the US does not need these imports. In fact, many of the LNG import terminals that were built are now being re- developed to export LNG. With the loss of the US market, a lot of that new LNG production found its way to the UK. Thus we saw a significant increase in the role of LNG in UK imports. This peaked at nearly 47 per cent of imports in 2011.

In March 2011 the earthquake in Japan and the disaster at the Fukushima Diiachi nuclear power plant had a dramatic impact on the global LNG market. The closure of all of Japan's nuclear power plants post-Fukushima, combined with high oil prices, meant that Japanese utilities have been willing to pay a high price to attract additional LNG to Japan. The net result is that the 'surplus' LNG that was coming to the UK went to Japan instead. This was not a problem because UK gas demand was falling due to the economic situation. Additionally, the shale gas revolution in the US contributed to a surplus of cheap coal on the global market, which replaced a lot of gas in the UK's power generation mix. This set of events clearly demonstrates how the UK is intimately connected to events in the global gas market.

Natural gas has a part to play in the UK's low-carbon energy transition, but its role is changing from providing base load supply to backing up the intermittency of renewable power generation. At the same time, both industry and households will continue to demand significant amounts of gas throughout the 2020s; but just how much gas will depend on the progress made with energy efficiency and demand reduction as a result of the decarbonisation of domestic heat, as well as the arrival of a new generation of nuclear power stations, the expansion of renewable power generation and low-carbon alternatives for heating. Consequently, there is a good deal of uncertainty over the level of future gas demand. National Grid's latest Future Energy Scenarios show a range between 64.2 bcm and 77.7 bcm of gas demand in 2020 and 45.7 bcm and 75.6 bcm in 2035.[13] This presents a major challenge to the industry in relation to future security of demand and it is of little surprise that there is little interest in building new gas fired power generation at present.

Where our gas will come from in the 2020s is a different matter, and DECC is suggesting that without the development of shale gas, the UK will be 70 per cent import dependent by 2025. National Grid suggest that the future level of import dependence will depend on the level of overall gas demand, the rate of decline in production from the UK continental shelf (UKCS) and whether or not there is significant domestic shale gas production. National Grid's scenarios show a significant variation in import dependence from 92 per cent to 39 per cent in 2035. The lower end of the range sees commercial shale gas development at a level of 32 bcm a year, while the upper range sees no commercial shale gas development. Growing gas import dependence in itself is not a problem as there is sufficient infrastructure to handle this, particularly if total gas demand continues to fall, but there are obvious economic and geopolitical concerns that are raised. What are the chances that shale gas can make a difference?

Our project was not about shale gas in the UK, although we are now involved in research on the global implications of unconventional hydrocarbons, as well as the shale gas debate in the UK. The first thing to say is that shale gas in the UK is in the very early stages of development. We need a programme of exploratory drilling and appraisal to know the full extent of potential reserves. Although the Government is still going 'all out for shale,' recent protests and planning decisions make it clear that the industry does not yet have a social licence to operate.
To gain that it must demonstrate that it can minimise the impacts of its operation on human health and on the environment. At the same time, the Government must convince the public that the regulatory regime is fit for purpose. Only a carefully monitored drilling programme will provide the necessary evidence of the effects of shale gas on health and the environment, and test the regulatory regime.

Natural gas has a part to play in the UK's low-carbon energy transition, but its role is changing from providing base load supply to backing up the intermittency of renewable power generation. At the same time, both industry and households will continue to demand significant amounts of gas throughout the 2020's.

It is difficult to see how a moratorium on drilling can progress the debate. Equally, Cuadrilla's failure in getting planning permission to drill exploratory well in Lancashire is a setback at it would have provided the opportunity to gather evidence for a more informed debate. However, Cuadrilla is appealing against the decisions and there are other companies, such as iGas, Inenos and Third Energy, with plans for exploration drilling in the short-term. What is certain is that we are unlikely to see shale gas development of any scale until the mid-2020s, if at all. This means that slowing the rate of decline on the UKCS is the best way to reduce the UK's gas supply import dependence, while also preserving jobs and making a positive contribution to the UK's tax base and balance of payments. Thus, the new Oil and Gas Authority needs to address the challenging investment environment in the North Sea with a sense of urgency. At the same time, promoting energy efficiency is essential to reducing overall gas demand. This is not just a matter for power generation, but also for industry and households. Whatever happens, it is not a question of gas or no gas, as there will still be a need for significant amounts of gas in the UK energy mix into the 2020s and the chances are that the majority of that gas will need to be imported. Therefore, we need to continue to be vigilant of developments in the global gas market, which is currently fraught with uncertainty.

Professor Michael Bradshaw,

Professor of Global Energy, Warwick Business School, University of Warwick

Diversification and Innovation of Sources – 24th June 2015

Regulatory Risk in Power Generation

Policy Uncertainty

For most, 8th July 2015 was an unremarkable date. Very little of historical significance has happened on 8th July, unless perhaps you are a tennis fan and were looking forward to the Ladies' Wimbledon Final. However, for those in the power industry, it is yet another date to add to the growing list of announcements that have undermined investor confidence in new power generation assets.

The reason? It was the day of the new government's emergency budget, when the Chancellor unexpectedly announced the removal of the Levy Exemption Certificates (LECs) for renewable energy generation, currently worth about £5/MWh, from 31st July of this year. Very few, if any, saw this further blow to the industry coming. This seemingly innocuous announcement at the end of the Chancellor's speech left renewables generators, still reeling from the recent announcement regarding subsidies, astounded but its impact has been keenly felt across the industry because of the direct impact on investor confidence.

Whilst the value of LECs was expected to disappear by the end of the decade, as a result of the over-supply of LECs to the market, this still leaves exposure to four to five years' loss of LEC revenue. To put this into context, a small windfarm with a low load factor could be exposed to a revenue reduction of over £120k per annum. For a large plant with higher baseload (such as a biomass conversion), the impact would be much larger, and could be in excess of £30M.

Often, a significant policy change such as this, there will be winners and losers, but this particular change was widely seen as having no winners (except for the government who will collect greater tax revenues as a result) and only losers. It is a position that other areas of the industry can sympathise with, including us. Prior to 2013, Combined Heat and Power (CHP) stations, of which VPI Immingham is the largest in the country, received LECs for their good quality electricity output. However, that policy was changed in 2013, with a significant impact on earnings as a result.

Policy on LECs is not the only area of government intervention in the power industry that has caused concern. Another good example of huge policy uncertainty, where there are very definitely winners and losers, is Carbon Price Support (CPS). CPS was introduced in 2013 and is the tax that UK generators pay in additional to any European carbon tax, based on their annual carbon dioxide emissions. At the time of its introduction a carbon price out to 2030 was published showing a top up, in addition to the European carbon price, to a minimum carbon price that UK generators would pay. This showed a clear upwards trajectory and introduced an effective mechanism for replacing polluting coal stations which were running off cheap coal due to a global surplus with cleaner, more efficient gas plants and renewables.

Policy on LECs is not the only area of government intervention in the power industry that has caused concern.

The premise of a carbon tax is both a simple and sensible one. However, this policy was not set to last as factors beyond the government's control came into play. Because of an over-supply of EU Carbon Allowances, the European carbon price had collapsed and hence the UK CPS "top up" was becoming unsustainable as the cost was passed straight through to UK consumers, at a time when there was a lot of focus on the affordability of energy bills. As a result, in the March 2014 budget, the Chancellor announced that the carbon tax would be frozen to £18 per tonne with no further increases to the end of the decade.

This was not good news for many gas generators (or for those renewables supported by the Renewable Obligation), as they were already facing incredibly challenging conditions with low spark spreads and load factors. Replacing existing coal generation with existing gas generation is probably the most cost effective and straightforward route to decarbonisation, yet the revised trajectory undermined this switch. Further rumours regarding further changes to CPS continue to abound and continue to worry the industry.

Impact on the Power Sector

So what does this mean for the power sector? The power industry has undergone significant change in recent years as governments seek to address the much talked about trilemma – balancing security of supply with sustainability and affordability – and technologies and priorities have changed hugely with government intervention now de rigueur. Whilst it was to be expected that the Liberal Democrat run department of the previous administration would focus on the sustainability angle and very much push decarbonisation, the agenda has clearly recently changed with the new, Conservative Secretary of State telling the Energy and Climate Change Select Committee on 21st July that value for money will be the priority. This was further reinforced by the subsequent announcements regarding changes to renewable subsidies.

Further rumours regarding further changes to CPS continue to abound and continue to worry the industry.

However, this is not to criticise a specific government department or a particular party. Energy policy is not straightforward since competing priorities and stakeholders pull policy makers in different directions. The previous government went to considerable lengths to balance these objectives by introducing new market mechanisms. With government analysis and Ofgem's 2010 Project Discovery report identifying over £110 billion of required investment in new power generation assets and infrastructure by 2020, the requirement for the recent Electricity Market Reform (EMR), arguably the largest intervention in the electricity market since privatisation, was identified. The reform resulted in the first Contracts for Difference (CfD) auction, with spending controlled by the Levy Control Framework, capacity auctions taking place and an Emissions Performance Standard introduced.

Above all, intervention has resulted in a move away from a market-driven model, with which most industry players are comfortable, to one in which the government picks the winners and intervenes to achieve its desired objectives. Take the capacity mechanism as an example. It was designed to achieve security of supply at lowest cost but, with DECC's Permanent Secretary telling the Energy and Climate Change Select Committee that it may need to be adjusted to achieve secondary objectives, that clear objective may be compromised. Exactly what these adjustments will be remains to be seen, but further intervention can be expected resulting in further investor uncertainty.

What next for the industry?

With the design and implementation of EMR taking many years and causing significant and prolonged uncertainty, there have long been calls in the industry for a period of relative calm, to allow the new mechanisms to bed in as both industry players and investors to adjust to them. However, this does not look likely. With current confusion regarding budgets for renewable investment, the timing of the next CfD auction and consultations on further changes to the capacity mechanism, expected in Autumn 2015, change seems to be here to stay.

Above all, intervention has resulted in a move away from a market-driven model, with which most industry players are comfortable, to one in which the government picks the winners and intervenes to achieve its desired objectives.

Nor do government-led policy changes sit in isolation. Significant modifications to the wider regulatory environment also contribute to the mood of risk and uncertainty. For example, in the past year alone the CMA Energy Market investigation, Project Transmit, the Electricity Balancing Significant Code Review, the EU ETS Market Stability Reserve and the Supplemental Balancing Reserve, to name but a few, have all resulted (or will result) in significant investor uncertainty and potential impact on earnings.

Set against this regulatory background, what are the requirements of the industry? Although little has been reported recently on required levels of investment or the progress against the £100 billion target, there is no doubt that further investment is needed to replace ageing power stations with cleaner, more efficient alternatives. Going forward, diverse yet affordable supplies will be needed entailing investment and support for both new and existing technologies. Arguably, it is the new technologies which are the most exposed to investor uncertainty, but constant shifts in policy affect the whole sector, from the storage and demand side response to renewables and large scale gas generation, all of which are likely to play a part in the future energy mix.

With few utilities having the balance sheets needed to make the significant investments required, the UK must compete on a global scale for funds and investment. To do this successfully, policies which promote low levels of political and regulatory risk will be needed.

With current confusion regarding budgets for renewable investment, the timing of the next CfD auction and consultations on further changes to the capacity mechanism, expected in Autumn 2015, change seems to be here to stay.

To an industry that has long been comfortable with market risk, this is now a new world and one which is much harder to quantify. As always, it is those who can adapt the fastest and take advantage of the opportunities presented to them who will thrive in the new environment. However, it is unlikely that the required levels of investment will be achieved by constant (and potentially unnecessary) changes to policy and the regulatory environment. As an industry, most favour allowing the market to decide with light touch intervention on occasion. Given that we are now some way from this, incremental change, maintaining the principle of grandfathering, of which the UK has had an excellent track record, and not undermining or stranding existing investments would be an excellent starting point to take forward UK energy policy.

Mary Teuton,

Head of Policy and Regulatory Strategy, VPI Immingham

Waste Biomass and Catalysis: Biorefining to Secure Sustainable Uk Energy and Chemicals Production

Climate change, energy, and materials security represent key challenges facing humanity, arising principally from a historical reliance on increasingly inaccessible or un-burnable fossil fuels. Meeting these requires alternative feedstocks which are sustainable, defined as "have the ability to meet current needs without compromising those of future generations." In the context of energy, despite significant growth in proven and predicted fossil fuel reserves (such as heavy crude oil, tar sands, deep water wells, and shale oil and gas) over the next two decades, there are great uncertainties in the economics of their exploitation via current extraction methodologies, and of even greater importance, an increasing proportion of such carbon resources (estimates vary between 65-80%[14]) cannot be burned without breaching UNFCC targets for a maximum 2°C increase in mean global temperature relative to pre-industrial levels.[15]

There is clearly a fine balance between meeting rising energy demands, predicted to rise 50% globally by 2040,[16] and mitigating CO2 emissions, hence ongoing climate change. A recent report from senior fellows of the Royal Society including Browne, Layard, O'Donnell, Rees, Stern, Turner and King claim that "A Global Apollo Programme is required to tackle climate change". By 2020, 15% of UK energy is targeted to derive from renewable sources, in parallel with an 80% reduction in carbon emissions by 2050. A recent report from the UK Transport Energy Task Force highlights that the UK is missing its mandates for low carbon transportation fuels, for which 10% from renewable sources is required by 2020, alongside a 6% decrease in Greenhouse Gas (GHG) emissions. Currently, only 4% of transport fuel arises from renewable feedstocks, hence significant work and investment in new technology for sustainable advanced liquid transportation fuels is essential to recover from the present situation,[17] in conjunction with improved UK energy security and industrial growth, and the development of new skills and jobs.

There is clearly a fine balance between meeting rising energy demands, predicted to rise 50% globally by 2040,3 and mitigating CO2 emissions, hence ongoing climate change.

By 2020, 15% of UK energy is targeted to derive from renewable sources, in parallel with an 80% reduction in carbon emissions by 2050.

Unlike tidal energy or intermittent sources of solar and wind energy, biomass provides a flexible energy option since it can produce heat and electricity on demand, or even be converted to provide transport fuels and chemicals. In essence, biomass represents nature's own incredibly successful solar conversion and energy storage system. For intermittent renewable energy solutions, energy storage is a challenge and while pumped-water storage (hydroelectricity) is claimed as one possible option to overcome the supply instability and unpredictability, this is far from satisfactory due to the huge volumes of water that must be displaced. It is estimated to store a week's worth of energy from a typical 1000 MW site would require a reservoir of 66 km2 to be raised by 10m.[18] Biomass derived from agricultural and forestry waste residues, or non-edible oil sources, are a sustainable source of carbon that can provide low cost solutions for transportation fuels and organic chemicals. Biorefining such waste biomass affords integrated conversion processes whereby biofuels, chemicals and energy are co-produced, thereby maximising the economic viability of the process; this approach is analogous to existing petroleum refineries, which deliver high volume/low value fuels and commodity chemicals in tandem with low volume/high value fine and speciality chemical products, the latter underpinning the economic success of the industry. Indeed, the US Department of Energy has identified a range of sugar derived 'Platform Chemicals' produced via the chemical or biochemical transformation of lignocellulosic biomass as potential targets for production in biorefineries.[19] Exploitation of agricultural waste must only be undertaken in parallel with sustainable land management practices, to ensure that soil quality, biodiversity and water use is safeguarded, and land use changes carefully policed to ensure that biomass is sustainably sourced; deforestation and habitat loss practices that have sadly blighted 1st generation biofuels must, and can, be avoided at all costs.

Waste biomass has the potential to become a key resource and feedstock, with the implementation of technology for biomass production and conversion predicted to generate around 15 Billion Euro for rural economies across the EU, with 16% of transport fuel potentially supplied by waste-derived biofuels by 2030 and a concomitant 60% reduction in GHG emissions. (see 'Wasted: Europes untapped resource').[20] Furthermore, resource assessments show that the UK could generate almost half its energy needs from biomass sources, including household waste, agricultural residues and home-grown biofuels by 2050, without compromising land use. Coupled to this, the continued success of the UK chemicals sector, one of our highest-value manufacturing sectors (worth £60 billion per annum), will be defined by our ability to maintain a competitive edge through the development and implementation of new biomass technologies to buffer future oil price rises.

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Catalysis is a transformative technology that improves resource utilisation by making processes more efficient, while simultaneously reducing CO2 emissions by lowering the energy required to convert raw materials. Catalytic technologies have played a critical role in the economic development of the petrochemical industry and modern society, underpinning 90% of chemical manufacturing processes and contributing to more than 20% of all industrial products.[21] In a post-petroleum era, catalysis will underpin biorefinery technologies, and researchers will need to rise to the challenge of synthesising chemical intermediates and advanced functional materials and fuels from non-petroleum feedstocks. Conversion of bio-based feedstocks presents new challenges to the catalytic scientist, as the attendant reaction conditions are very different to those typical of petroleum processing (which occurs mainly through vapour phase processes >400°C).

The utilisation of biomass-derived chemicals, whether from fermentation broths or sugars themselves, represents an area with extensive R&D potential for a renewable feedstock based technology platform. Biomass processing will be characterised by liquid phase, low temperature pathways[22, 23], requiring the careful design of catalyst architectures to improve molecular diffusion and hydrothermal stability for operation under aqueous conditions, and tuneable hydrophobicity to aid product/reactant adsorption.[24] Platform molecules derived from enzymatic fermentation are often present at low concentrations (typically <10 %) in aqueous solutions, alongside other polar molecules. Purification of such fermentation broths is particularly difficult,[25,26] and energetically demanding, hence the ability to directly transform organic molecules contained within such aqueous solutions is highly desirable,[27,19,28] and necessitates new water-tolerant catalysts, resistant to impurities present in fermentation broths.[29]

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The UK Transport Energy Task Force has stated that the commercialisation of sustainable, advanced biofuels is a priority for meeting 2030 goals, and that mobilising investment through robust policy choices will be vital to achieving this. The UK should seek to secure economic benefits from developing this market in terms of skills, intellectual property, employment, and inward investment. In this respect, education and training to equip the next generation of scientists and allied workforce with the skills and expertise to operate at the chemistry-engineering-biochemistry interface is essential. There is a window of opportunity to develop low carbon, thermal technologies based around biorefining, and with appropriate investment the UK could take a global leadership position in the new, high growth strategic market in low carbon energy and renewable chemicals: We need to act now to avoid falling behind in this global race.

Professor Karen Wilson,

European Bioenergy Research Institute, Aston University

Carbon Reduction – 15 July 2015

Resilient Futures: The Appropriate Reaction to Climate Change

The Objective

The Climate Change Act 2008 sets out an obligation to reduce greenhouse gas emissions by at least 80% by 2050. The Act was passed with broad-cross party support, which has continued through the last election and under the current government.[30]

The 2050 target, with its associated carbon budgets (the 5-year 'stepping stones' on the way to that target), has been held up as a model of how to tackle an inherently difficult and long-term issue sensibly. It allows for a range of competing objectives on government, businesses and households to be balanced in a clear, predictable way.

Prior to government action here and around the world, the costs of greenhouse gas emissions were not reflected in the decisions of firms, households or governments anywhere. This is perhaps the most widely recognised and acknowledged of any market failure in modern economies. Enshrining the target, and the associated carbon budgets, in law makes clear that the UK proposes to address this failure. Over 60 countries have followed suit and at the end of the year, at an international meeting in Paris – COP21 – the world will try to create an outcome akin to the first global budget to 2030.

None of this is without real and important debate: how far and how fast to act at a global and UK level requires many questions to be answered. The Committee on Climate Change provides the expertise and independent analysis to help answer those questions.

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In the UK, the Committee will present to the Government and Parliament its advice on the fifth carbon budget by the end of this year. The fifth carbon budget will set the limits on greenhouse gas emissions for the years 2028 to 2032 – another stepping stone on the cost-effective path to the 2050 target. The Committee's recently published progress update to the new Government and Parliament set out where things currently stand.[31] That provides an important input into what can be achieved in the fifth carbon budget period.

Ahead of that advice – and as part of our ongoing efforts to collect and assess the evidence – it is worth setting out:

- What has been achieved so far
- The barriers to future success
- The benefits of future success
- The next steps

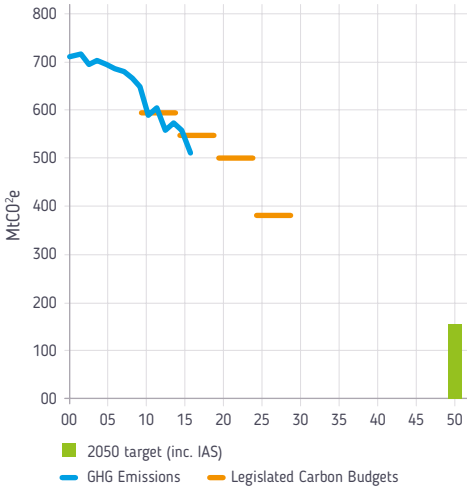
The next sections briefly address each of these points.

This paper focuses on the UK. It is clear that tackling climate change is a global problem and the biggest barriers are getting global agreement and the biggest benefits follow from a global agreement. However, UK action is one factor helping to achieve that agreement and will help to underpin future UK economic benefits in the context of global action.

What have we achieved so far?

UK emissions have fallen by 36% since 1990 – the baseline against which emission reductions are measured (see figure below). At the same time, GDP has grown by 61%. 2014 saw an 8% decrease in emissions while GDP grew by about 2.8% and manufacturing by about 3%. Global action suggests these trends can also emerge elsewhere. 2014 was the first year where the global economy grew but greenhouse gas emissions did not.[32] These types of positive trends (de-coupling economic growth with all its benefits from emissions) are issues the Committee considers in providing its advice.

The Committee on Climate Change's advice must balance the rate of reduction in emissions with the impact on households, businesses and government. It also takes into account the impact on households from future increases in bills, businesses from impacts on their competitiveness, and government from impacts on its fiscal position.



Source: CCC Progress Report (see that report for full details). The 2050 target is not fixed but varies as better data and methods become available as such there is a range of uncertainty around the central estimate in this figure.

The barriers to future success

The success achieved so far can only be maintained with action. The trend evident in the figure overleaf will not be sustained into future years without businesses, household and governments actively striving to reduce emissions. What prevents them from doing so?

A significant barrier to coordinating that future ambition is the lack of a price on greenhouse gas emissions that reflects their cost. Finding effective, innovative, productive solutions to such a complex issue is something that markets (using accurately priced inputs and outputs) excel at. To date, achieving a stable price now and into the future against which market-based decisions can be made has not proved possible. We should continue to try but the risks from climate change mean that we cannot suspend all other action while we continue with that effort.

Regardless of the outcome of efforts to establish a stable, cost-reflective carbon price there are other well-known market failures associated with specific issues. Two important issues are around innovation and individual behaviour. For a long time governments around the world, and here in the UK, have supported innovation (e.g. fundamental research, helping SMEs and bringing new products to market) because there is insufficient innovation without that support. A more recent development is recognition that people (and firms) can be reluctant to change existing behaviours (e.g. in relation to smoking, obesity, pensions, warmer homes) even when it is in their interest because of a range of factors that lock-in the status quo.

The package of actions recommended by the Committee seeks to address the lack of a cost-reflective price for greenhouse gases and these associated failures. It includes actions to:

- inform household and businesses about future risks and sensible changes,
- support new and emerging technologies,
- regulate common standards compatible with future needs,
- develop carbon pricing where it has proved possible (e.g. in electricity markets); and
- adjust taxation in-line with changing behaviours and technologies.

The current fiscal and economic situation presents a potential barrier to implementing some of the measures. Government budget constraints and the importance of the economic recovery after the recession places greater focus on spending and regulatory measures.[33] Therefore, it is even more important, to understand the evidence about whether, when and how benefits from action exist.

The benefits of future success

A wide range of benefits have been identified but quantifying and comparing their relative importance is difficult and raises new uncertainties. There are probably two immediate benefits, alongside a wide range of others.

The first significant benefit is that domestic actions are the UK's contribution to avoid the costs of climate change. This is often thought of as an "insurance policy": our actions directly reduce emissions,

increase the likelihood that others will reduce emissions and help to prepare us for some inevitable changes.[34] All of this reduces future costs that would ultimately be faced by UK households and consumers were the climate to change in-line with projections associated with an ongoing growth in emissions (e.g. increased risks of flooding, impacts on health, supply chains etc). Furthermore, appropriate earlier action in some areas is likely to be lower cost than later action in those areas (e.g. early decarbonisation of the power sector reduces costs when compared to waitinguntil later).

The current fiscal and economic situation presents a potential barrier to implementing some of the measures. Government budget constraints and the importance of the economic recovery after the recession places greater focus on spending and regulatory measures.

The second significant benefit is that our earlier action better positions UK businesses and individuals (e.g. through skills they acquire) to compete in a future carbon-constrained world. Innovation, business models, new skills and supply chains all take time to create. Since the economy in 2050 will look different to that in 1950, the UK is best placed by developing its comparative advantage in line with the demand that will exist in 2050. That is not something that can be done quickly in 2045 but something better done over the coming decades.

There are serious concerns about the impact on fuel poor households and the competitiveness of some existing industry amidst these larger and wider benefits. It is important that some of the economic gains from these wider benefits are used to adequately protect vulnerable households. Indeed, some of the measures (such as insulation) help to reduce emissions and reduce energy costs. It is also important that where industry is vulnerable from cost pressures caused by UK action to tackle climate change (that is not mirrored in other countries) it is suitably compensated. Measures have been put in place to do that and are continuously reviewed.

The range of important and wider benefits includes:

- improved air quality and wider health benefits[35]
- sensible actions help to improve energy security and ensure the UK's energy supply is suitable over the coming decades
- emerging evidence about the links between climate change and increased pressures on migration, food supply and other factors that UK action directly and indirectly helps to reduce.

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Next steps

The objective and progress to-date is clear. The current and future barriers and benefits are inevitably subject to more uncertainty. The UK has a good, proportionate and transparent framework for dealing with that uncertainty: a process of setting carbon budgets and objectives sufficiently far in advance to allow the required changes to take place at least cost. It is a process that also includes an appropriate division of roles between government policy decisions and an expert, independent scrutiny of those decisions.

The most immediate next steps are the government's response to the Committee on Climate Change's 2015 Progress Report (and actions it takes) and then the Committee's advice on the fifth carbon budget. The government will have until June 2016 to decide how it will legislate for the fifth carbon budget.

Decisions made on the actions that have been recommended, UK carbon budgets, international negotiations and progress in other areas will indicate which barriers have proved insurmountable and which benefits are likely to emerge.

Matthew Bell,

Chief Executive, Committee on Climate Change

The most immediate next steps are the government's response to the Committee on Climate Change's 2015 Progress Report (and actions it takes) and then the Committee's advice on the fifth carbon budget. The government will have until June 2016 to decide how it will legislate for the fifth carbon budget.

Resilient Futures: Carbon Reduction

The energy system is the biggest contributor to greenhouse gas emissions, and hence is a critical component when we are looking for carbon reductions to meet climate change targets. But changing how we supply, use and distribute energy in the transition to a low carbon economy could have a serious impact on the resilience of the system. And referring to an 'energy system' risks simplifying a very complex set of interacting systems, whether it's heat, electricity, gas, or liquid fuels. This complexity also has implications for resilience.

We can consider building a resilient and low carbon energy system from perspectives of scale: large centralised power generation with long-distance transmission infrastructure taking electricity to the population at large; or decentralised city-scale (or smaller) supplies operating through distribution networks to buildings and centres of industrial demand.

Centralised energy

For the last seventy years, the emphasis has been on deploying large-scale solutions, and this has tended to dominate the approach for the future development of the energy system. However, a 'conventional' 2030 scenario for the UK which has large amounts of renewables (mostly wind and solar) and nuclear power, combined with rapidly increasing electrification of heat and transport, presents a massive change to the dispatchable supply and predictable demand that we had just 10 years ago.

In particular we face:

- The challenge of ensuring adequate security of supply when more than half of instantaneous generation could be from variable sources.
- Networks coming under great pressure, especially for the provision of heat, to meet seasonal and daily peaks.
- The prospect of investing in and building new infrastructure that could be significantly under-utilised.

The fundamental issue is that to balance supply and demand in the future, the energy system will need tools for providing greater flexibility. There are a number of ways to do this, and energy storage is emerging as an attractive option. The range of energy storage technologies covers orders of magnitudes in both time and energy scales with applications across the energy system. In practice though, the costs are too high for wide commercial deployment at the moment, given some limitations of the technologies and the value that can be accessed in the market.

With recent increases in public funding for energy storage and other flexibility options, the prospect is that technology costs will come down and performance will improve. In tandem with this, the deployment of wind and solar generation at the level needed to meet renewables targets will increase the value of providing such flexibility.

The risk is that short term costs are prioritised, with incentives for building conventional fossil fuel plants to meet the need for capacity and flexibility. These could then crowd the market for alternatives, which may be more suitable for a longer term energy system.

Decentralised powers

At the local scale, cities and regions are increasingly considering how they can meet their own climate and social policy targets through decentralised energy systems. Domestic and business consumers are also seeing the potential of deploying new technologies for both resilience and cost savings.

This approach is especially favourable when considering the development of heat networks: piping hot water into buildings, rather than relying on electrical heat. This takes some of the strain away from the power system and electricity networks. Combined Heat and Power (CHP) plants, or boilers, are very efficient, and despite using fossil fuel in general, they may be converted to renewable sources. Heat networks can also run off surplus heat from industrial processes.

But some technical and non-technical challenges will need to be tackled, including:

- The economic and carbon costs and benefits of heat networks are not clear.
- Generation from distribution network-connected solar PV, the capacity of which is growing, is not well correlated with demand.
- Optimising at a local scale may not be consistent with meeting national targets or policy aims.
- Local authorities may not have the necessary expertise and powers to implement radical plans effectively.
- A national infrastructure, with lower utilisation, will still need to be paid for.

Again, energy storage, in the form of thermal energy, or demand-side response could be important enabling technologies if commercialisation can be encouraged.

At the local scale, cities and regions are increasingly considering how they can meet their own climate and social policy targets through decentralised energy systems.

Where next?

A solution could be a hybrid, where small consumers and suppliers are aggregated using 'smart' technology, including meters, appliances and storage units. This would see the emergence of innovative business models, but there needs to be a policy and regulatory framework in place which recognises the longer term benefits of new technologies.

This is a focus for us at the University of Birmingham. We are developing electrical and thermal energy technologies based around cryogenic, or 'liquid air', energy storage; and analysing how they can be integrated into systems, technically and through policy. The liquid air technology also brings in the 'cold chain' which is responsible for about 15% of fuel use in the UK, and a lack of cold chain is responsible for a quarter of food loss and waste in developing countries. In this sector also, an emphasis on increasing access, reliability and resilience could mean higher carbon emissions unless we look more broadly at the system.

How things turn out will depend on the pace of technology developments coupled to market or regulatory innovation, driven by strategic energy policy decisions. Inappropriate policy could stifle the roll-out of the sorts of disruptive technologies which enable the rapid transition to low carbon. The Government has to balance its de facto number one energy policy priority – keeping the lights on and voters warm – with climate and cost objectives. Protecting incumbent utilities to encourage the scale of investment needed in the energy system may seem attractive. But such investment may eventually come from non-traditional quarters, introducing new business models and services that more explicitly recognise the needs of consumers.

How things turn out will depend on the pace of technology developments coupled to market or regulatory innovation, driven by strategic energy policy decisions. Inappropriate policy could stifle the roll-out of the sorts of disruptive technologies which enable the rapid transition to low carbon.

So whilst consideration of the geographic scales can help us understand the available options for developing a resilient energy system, it is appreciation by policy makers of the time-scales over which the system changes that will determine its evolutionary, or revolutionary, course.

Jonathan Radcliffe,

Senior Research Fellow and Policy Director, Birmingham Energy institute, University of Birmingham

Footnotes

1. https://assets.digital.cabinet-office.gov.uk/media/559ad883e5274a155c00001b/EMI_PFs_Summary.pdf
2. https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics
3. https://www.gov.uk/government/collections/fuel-poverty-statistics
4. For further information regarding NEA's poll, please contact ben.sayah@nea.org.uk
5. http://www.nea.org.uk/Resources/NEA/Publications/2013/MANIFESTO%20FOR%20WARMTH%20(LO%20RES)%20CS6.pdf
6. See full Cambridge Econometrics & Verco report on action required and the economic and fiscal benefits of energy efficiency here: http://www.energybillrevolution.org/wp-content/uploads/2014/10/Building-the-Future-The-Economic-and-Fiscal-impacts-of-making-homes-energy-efficient.pdf
7. Read full interview of Lord Bourne here: http://www.edie.net/news/6/Lord-Bourne--Green-policy-shake-up-vital-to-curb-energy-bills/
8. http://www.iea.org/bookshop/475-Capturing_the_Multiple_Benefits_of_Energy_Efficiency
9. Full statement here: www.ukgbc.org/news/lord-deightonpercentE2 percent80percent98extremelyattractedpercentE2 per cent80per cent99-energy-efficiency-infrastructure-priority
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32. http://www.iea.org/newsroomandevents/pressreleases/2015/june/iea-sets-out-pillars-for-success-at-cop21.html

33. See section 5 of Volume 1, Chapter 1 of the Progress Report. In particular, public expenditure on R&D related to emissions reduction is about 0.05% of all government spending in the most recent years; public expenditure on particular policies (e.g. support for low carbon technologies) is about 0.2% of government spending in the most recent years. https://www.theccc.org.uk/wp-content/uploads/2015/06/6.737_CCC-BOOK_WEB_030715_RFS.pdf

34. Historic and ongoing emissions mean that some of the risks from higher sea levels, higher temperatures and other impacts of climate change will materialise even if future emissions are reduced or stopped. See: https://www.theccc.org.uk/wp-content/uploads/2015/06/6.738_CCC_ExecSummary_2015_FINAL_WEB_250615.pdf

35. For example, The Lancet recently published a wide-ranging, academic study of the links between health and climate change. See: http://www.thelancet.com/commissions/climate-change

Notes

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