P2.1-2 The Long-Term Challenge of Secure, Low Carbon Energy: A Perspective from the UK

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Introduction

Energy systems consist of a complex web of interconnected technical and social components. Changing any single part of the system is likely to have consequences elsewhere. Energy policy in the UK and other countries implies a fundamental remaking of this system, but its complexity and heterogeneity mean that no single pathway can be defined which optimally responds to policy imperatives. Rather, there are multiple possible responses, and scenarios of system change can identify many pathways and trade-offs consistent with policy goals. For example, a key trade-off is reduction in energy demand, versus de-carbonisation of energy supply. In the face of such complexity, uncertainty and indeterminacy, policy becomes a matter of prioritisation though processes of social, political and organisational deliberation and choice. The role of energy systems research is to support and inform this process by providing best available evidence.

This paper presents research-based findings on the long-term challenge of UK energy system change, on a set of key themes:

(i) supply side change and the role of technological innovation;

(ii) energy demand and lifestyle change;

(iii) public attitudes and acceptability considerations;

(iv) energy security and system resilience; and

(v) the wider international context. The paper ends with some overall observations for research and policy.

(i) Supply side change and the role of technological innovation

Many scenarios emphasise the importance of supply side change, particularly for electricity supply. Three important low carbon electricity supply options for the UK are (a) large-scale renewables (mainly wind, but also biomass and in the longer term, marine and solar PV), (b) new nuclear power, and (c) fossil fuels with carbon capture and storage (CCS). Provided good levels of technological development are achieved over time, the costs entailed in the large-scale deployment of these technologies, while still uncertain, are likely to be affordable.

Technological innovation has the potential to reduce the overall cost of decarbonisation between now and 2050, through a long-term commitment to RD&D. There is a need for a close alignment between innovation policy and energy policy, with an emphasis on maintaining diversity and option creation in early-stage innovation. Low-carbon technology acceleration is essentially a global challenge and opportunity, but the UK has an important role to play where it has particular technological strengths.

(ii) Energy demand and lifestyle change

Lifestyle changes that reduce energy demand could enhance energy system resilience and reduce the costs of decarbonisation. Low carbon lifestyle scenarios suggest that very substantial reductions in energy demand and emissions are possible from lifestyle changes, and that these can have an earlier impact than many supply-side changes, with much less fundamental changes to supply portfolios and infrastructures required between now and 2050. This implies that a policy approach with a successful early emphasis on behaviour change could apply less pressure for disruptive supply technology changes.

(iii) Public attitudes and acceptability

Public attitudes are potentially very significant influence on decarbonisation pathways, with the potential to impose major restrictions on the availability or affordability of energy supply resources, technologies and infrastructures. In scenarios where supply side constraints on technologies and fuels are acute, there is a greater emphasis on demand reduction and microgeneration, but also, these scenarios are characterised by higher cost decarbonisation pathways.

For policy, this suggests the need to take public attitudes and opinion into account in the overall policy process, with more thorough and early processes of deliberation and engagement. It also suggests that policy options need to be maintained for other options, such as demand reduction and microgeneration, in case supply side expansion is restricted by public concerns.

(iv) Energy security and system resilience

Energy system resilience can be secured by (a) promoting reductions in energy demand and import dependence through improved energy efficiency; (b) encouraging diversity of supply; and (c) ensuring adequate investment in capacity and infrastructure. Reducing energy demand is a particularly important enabler of a resilient energy system, reducing the UK's exposure to energy price shocks and disruptions to infrastructure. Scenarios of UK energy system change that emphasise resilience also feature significantly lower overall energy demand and carbon emissions, suggesting a partial overlap between decarbonisation and energy security drivers.

Ensuring adequate capacity and infrastructure is largely down to market design and regulation. Changes will be needed to the design and regulation of energy markets, with stronger incentives for investments in supply and transmission infrastructures. Having large volumes of intermittent renewable energy on the system suggests the need to consider policy options such as capacity payments, or allowing grid operators to earn a regulated return on back-up capacity.

(v) The international context

Many international uncertainties will affect the evolution of the UK energy system, including, fossil fuel prices, biomass imports and the use of international CO2 emission credits. The first two are in large part outside the control of UK policy, have potentially important consequences for the cost and feasibility of achieving a low-carbon resilient energy system. For example, with high fossil fuel prices, coal-fired generation (using CCS) has a significantly diminished role in achieving decarbonisation, especially when combined with the pursuit of energy system resilience. In such scenarios, renewables and nuclear power have more significant roles. There are also likely consequences here for overall energy system costs and levels of demand.

The policy message here is that the path towards UK decarbonisation will be heavily influenced by international drivers. There is a consequent need to mitigate the associated vulnerabilities where possible. Scenarios also suggest that emission credits offer a useful source of long-term flexibility, as credit prices are anticipated to be lower than the cost of domestic action in the longer term.

Conclusions

Messages for Research

A key role of research on energy systems is to help inform political and societal decision-making, so that the setting of priorities, targets and measures can be made with improved awareness of the range of options and contingencies. In this spirit, the scenarios discussed here explore possible pathways for UK energy system change from now to 2050. Each scenario prioritises one or more aspect of system change - economic, technological, social or security - and each places a different emphasis on enablers of system change, such as supply decarbonisation or demand reduction.

Energy systems are assemblies of connected parts operating at different social and technological scales, from individual behaviours and lifestyles, through to households, communities, organisations, cities and regions, nations and international groups. These interconnected and multi-layered aspects need to be understood, or research (and policy) may lead to perverse messages or unintended consequences. Increasingly, research also needs to respond to the prospect of more radical system change, such as highly distributed systems of energy production and use.

System level research and research tools allow structured exploration of the complex interdependencies involved, but no single research discipline can fully address the problem. Rather, there is a need for different research perspectives and tools to be brought together to properly respond to the challenges involved, iterating between a system-level view and the detailed but inevitably partial insights deriving from more specialised disciplines.

The basic message that emerges from scenarios is optimistic, in that multiple possible pathways can be identified for an affordable transition to a resilient and low-carbon energy system by 2050. However,

the practical task of translating this potential into real change faces a number of challenges that are not easily represented in scenario exercises. Political, technological, economic and societal responses are needed that reflect the scale and extent of policy ambition.

Messages for Policy

Private capital plays a key role in the energy system. This creates an imperative to establish stable and predictable conditions for large and small scale project investment. At the same time, there is a need for flexibility of policy responses to changing conditions and priorities, and technological and social innovations. There is an inescapable trade-off between policy stability and flexibility. Energy policy history demonstrates the danger of inflexibly pursuing long-term programmes. On the other hand, there is that danger that 'keeping options open' will be interpreted as an excuse for incrementalism, prevarication and a retreat away from necessary bold decisions. A blend of stability and flexibility is required. Policy will also need to promote the right mix of market dynamism and competition and state guidance and regulation, if the required investment for a low-carbon and secure energy system is to be unlocked. This is a major ongoing concern for the UK, in a wider con of public and private financial stringency.

While scenarios can outline many possible pathways towards a low-carbon and more resilient energy system for the UK, none of these will come about without strong and sustained policy interventions. Just as there no single pathway to be predicted and preferred, so there is no unique policy package that will achieve it. All the packages will need some combination of the three core policy elements – carbon and energy pricing, technology support, and lifestyle and behaviour change. Different scenarios show that different mixes of these elements are possible, and can achieve climate and energy security objectives at affordable cost, provided that the conditions for their successful implementation exist. The political challenge is to help create those conditions, articulate an approach that is sufficiently ambitious while commanding adequate public support.