The Key Energy Policy Issues for Energy Security in the UK

Summary Report

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The field of energy policy is full of uncertainties. Government policy is to reduce GHG emissions by 80% by 2050 from 1990 levels. The only legally required milestones are that 15% of our energy is derived from renewable energy sources by 2020 and that the carbon budgets set by the Committee on Climate Change is met. Given that there are many technological pathways able to achieve the low carbon objective; the choice of pathway to follow is really one about the sort of society that is preferred. Energy policy becomes a reflection of the sort of society that is wanted, including whether it is acceptable that the UK has large numbers of fuel poor; whether the UK should act as a responsible global nation/friend; if there is concern about the environment; and what the balance is between the environment and security.

This report has set out in detail the many issues that impact upon energy security and how these directly link to energy policy and the decisions that shape our energy system. Given the central role that energy plays in modern society, a failure to effectively act on energy security will have serious social, environment and economic implications for the UK. With this background, it is possible to set out what we argue are the key issues regarding the future of energy policy for the UK.

In order to understand the issues that affect energy security and their implications for our energy systems it is necessary to consider the whole energy supply chain, from how we get our energy, to the way it then flows through our energy system and ultimately how it is then finally used. Given the complexity at every stage in this process, we have split this research into two sections:

1. This first section summarises the full research and the key issues we have drawn from it them (pages ii to xvii).
2. The second section comprises the full research report which discusses in detail the different elements to energy security.

Key Findings from Background Research

Energy Security

In section 3, we set out what we mean by energy security, showing that it is not just about security of supply, which tends to dominate much of the discussion on the subject. Instead, it is about the properties of, and the interactions between, all of the components of the whole energy system, both technical and non-technical, such as people, institutions, technologies, energy resources, etc. It is also a reflection of the risks and threats to that system, which change with time and location; and how Government and other actors within the energy system respond to those risks and threats – proactively and reactively. Energy security also has to be considered alongside climate security, with the aim of trying to ensure that both of these issues are collectively addressed. Given the global nature of both climate change and our energy systems, international relationships are also a central part of energy security. To improve the UK's energy security, our energy system needs to be robust, durable, resilient and stable in order to withstand the uncertainties that shocks and stresses cause.

UK Energy System

The overview provided in section 4 describes how energy flows through the UK from the extraction of resources to final end use. It shows that UK production of primary fuels have been in decline since around 2000, whilst overall demand has slowly risen, with particularly strong growth in the domestic and transport sectors, issues which energy policy will need to address. Since 2004, the UK has been a net importer of energy and this import dependency is expected to grow as our own resources continue to decline.

The Demand-Supply Balance and its Implications for Energy Security

Whilst energy security is a broad and complex issue, a key component does relate to the ability to match current and future demand with adequate supplies. In order to understand some of these underlying issues, section 5 and 6 look at the demand-supply balance for gas, coal, oil and electricity. Section 5 considers the UK energy balance in respect of current and predicted demand and supply, reserves, rates of production and imports and exports. Section 6 then considers the same underlying issues from a global perspective, to set out the current and projected levels of global demand, supply, reserves, production, trade and future energy prices. From these it is possible to discuss some of the implications for energy security – Section 7.

The options for balancing any energy system depend on a wide range of variables for each energy resource, such as the rate of economic growth, fuel prices, household numbers, imports, exports, temperatures, efforts to reduce demand, etc; and the degree to which the different energy resources are used to meet the demand in the power, heat and transport sectors. As energy systems have become increasingly globalised, what happens in one country impacts on others and therefore changing patterns of supply and demand are key elements of energy security. With all this analysis, it needs to be borne in mind that there are a great number of uncertainties in future projections and a wide range of different assumptions are made in estimating future levels of demand and supply.

Gas

To ensure energy security, the UK needs to meet both its average annual demand for gas and be able to meet peak demand on any one day. Annually the UK uses around 100 bcm/yr of gas and projections to 2020 suggest this may decrease to 80 to 95 bcm/yr, depending on how our energy system develops. The current peak demand is approximately 500 mcm/day and this is expected to remain stable over the same period.

To meet demand, the UK has a range of different supply options. This includes indigenous production from the UKCS, although this is in decline and we have a current reserves-to-production-ratio (RPR) of around 10 to 15 years. To balance supplies, the UK therefore imports gas from a number of different markets, including interconnections with Belgium and the Netherlands, although most currently comes via pipelines from Norway and increasingly international Liquified Natural Gas (LNG). The total import capacity of the UK is currently 151 bcm/yr (ie well above demand). In addition, the UK also has the capacity to store around 4.6 bcm of gas and there are proposals to increase storage, nine of which have planning, which would add a further 5 bcm of capacity. Overall, demand does not pose a problem in the short term, and depending on choice of future energy pathways, also seems acceptable in the future if gas is used as a transition fuel to a sustainable future. Collectively these different supply options are all used by the market to meet the level of demand at any one time and further storage and import capacity may well be developed in the future to help balance our energy needs.

Global demand is expected to rise from 3,000 bcm/yr to around 4,500 bcm/yr by 2035, but the rate of growth varies significantly between different regions. Looking at average rates of growth, most is expected to occur in non-OECD countries, where it increases by 2% per year to 2035, compared to around 0.5% per year increase within OECD countries.

In 2009 global proven gas reserves stood at 187 tcm, giving a current RPR of 60 years, however, recoverable reserves could be as high as 800 tcm (including non-conventional gas). Most of these reserves are within the Middle East and Europe/Eurasia regions, with around 54% of all reserves found in just Russia, Iran and Qatar. Most of the growth in production is expected to occur in the Middle East and over half of it is in just four countries – Qatar, Saudi Arabia, Iran and Iraq, although LNG trade is also expected to grow, accounting for around 42% of all gas trade by 2035 and this will mainly come from Qatar, Algeria, Angola, Australia and Papua New Guinea. However, a key issue for increasing production will be the rate of investment that takes place in producing countries and this will be influenced by a range of issues, such as global demand, price, energy and carbon policy, etc.

Unconventional gas

There are also a range of unconventional gas resources which are more widely distributed around the globe. In 2009 around 4% of proven reserves were in unconventional resources, although they accounted for 12% of total gas production. Their share of production is expected to rise to around 19% of total gas production by 2035, mainly from coalbed methane, shale gas and tight gas. However, there are a number of environmental and other issues associated with their production, particularly for shale gas and tight gas, which use highly intrusive production techniques, and require considerable amounts of water and land area. There are concerns regarding the amount of water needed, its subsequent treatment and disposal, and risks of groundwater contamination during the extraction process. There are also physical constraints in respect to the infrastructure needed to get the gas to the market in some regions. All of these issues mean the actual level of growth for unconventional resources is difficult to predict and its use and acceptability is likely to vary from country to country.

Gas imports and the implications for gas security

The level of demand can be reduced through policy and action to improve the efficiency of its conversion to electricity, action to reduce leakage in its distribution, as well as action to improve the energy efficiency of buildings and the behaviour of end users. Currently, UK gas import dependency is expected to rise from around 33% in 2009 to 68% by 2025, although this depends on a number of variables that are difficult to predict with any accuracy. Looking at global availability and the predicted level of demand suggests that security of supply issues are broadly benign in the near term and the UK has a wide range of energy supply options open to it, including UK production, imports and storage. These will all play an important role in balancing annual and peak demand. The scenarios presented suggest that generally supplies should be in excess of demand, although this may require network improvements to increase the range of options from which supplies can be drawn. As well as energy supply options, there are a range of measures that can be taken on the energy demand side, particularly at times of peak demand, to ensure security of supply. These include market based incentives such as financial penalties on suppliers that do not balance their needs, interruptible supply contracts, fuel switching and wholesale market price signals that generally ensure that more gas comes to market at times of high demand.

However, changes in the global market place will affect the UK, particularly as our import dependency increases, meaning the UK will have to compete with other markets to secure supplies, at the price set by the market. One area of concern that is highlighted is the growing market dominance of a few producer countries and the possible role the GECF may have as supplies become concentrated. These issues could lead to price rises, as well as increasing the risk of supply disruptions from the choke points in the supply chain, although the evidence suggests that most disruptions to supply have tended to be around local or domestic problems. As resources decrease and global demand increases, prices will inevitably rise and they are expected to triple by 2035, although it is clearly difficult to predict these with any accuracy.

Coal

The total UK coal demand in 2009 was 50 million tonnes, 86% of which is for Steam Coal nearly all of which is used within the generation sector. Demand is therefore essentially driven by the decisions that take place within this sector and the relative cost of coal to gas has been a key determinant in the level of its use. Increasingly, the future demand in generation will be more strongly influenced by environmental and carbon legislation and it seems likely that it will play a declining role within the UK energy mix, unless CCS is proven to be effective. Current projections suggest that its use will fall to around 10 to 20 million tonnes by 2034.

The UK has large reserves of coal, estimated at around 3,405 million tonnes and based on sites with current licenses it is suggested that around 20 million tonnes a year could be produced to 2025. Despite the level of reserves, the UK has been a net importer of coal since the Miners' Strike in the 1980's and imports continue to exceed UK production, mainly coming from Russia, although a wide range of alternative sources are also available.

Global coal demand has remained fairly steady at around 5,000 million tonnes (Mtce) a year with a decline in its use within OECD countries being offset by increasing growth in the non-OECD (they are expected to account for around 82% of demand by 2035). The central projection for growth suggests coal use will increase by around 1.7% per year, reaching 5,621 Mtce by 2035.

Proven reserves of coal are estimated at 826,000 million tonnes, giving a RPR of up to 150 years. Production is expected to increase, mainly with the non-OECD. As coal is widely distributed across the globe, it is an attractive choice of fuel for many countries from an energy security and cost point of view. However, given its high carbon content, in comparison to other fossil fuels, it is not a good choice for climate security. Future supply and demand will ultimately be driven by the way that global policy develops to tackle climate change, as well as the success of CCS.

The implications for coal security

Given the reserve base within the UK and globally, the use of coal could reduce the demand for other fuels, particularly gas, but this would clearly have implications for climate security. Nevertheless, in terms of energy security, coal will be available. Coal'sfuture use is therefore dependent on how policy develops to reduce emissions, or charge for emissions, and the outcome of the demonstrations to develop CCS, at least within the OECD. Its use outside of the OECD is expected to rise, which will have an impact on international efforts to tackle climate change and so the security of coal has much more to do with this issue than energy security.

Oil

Total UK oil demand was around 86 million tonnes of oil equivalent (Mtoe) in 2008 and three quarters of this demand is from the transport sector. The level of demand is expected to remain flat to 2025, although the mix of fuels has increasingly been dominated by demand for aviation and diesel fuels, which UK refineries cannot produce enough of.

UKCS production has been in decline since 1999 and is falling at around 7% per year and the current Reserve to Production Ratio (RPR) is estimated at 16 years. Currently the UK meets around 91% of its demand indigenously, but we have been a net importer of crude oil since 2005, and around two thirds of this is from Norway, with the rest coming from a variety of countries, including Russia, Algeria, Libya and Nigeria.

Global demand stood at around 84 mb/d in 2009 and is expected to rise to 99 mb/s by 2035 (excluding biofuels). All of the expected growth in future demand is within the non-OECD, increasingly by around 1.6% per year to 2035, against a 0.6% decrease in the OECD over the same time. The strongest growth is within Asia and the Middle East.

Proven global oil reserves were estimated at 1,333 billion barrels in 2009, giving a RPR of around 45 years. Most are within the Middle East and 70% of the total is held by members of OPEC. Reserves are mainly in conventional forms and it is estimated that the total recoverable resource may be as high as 2.5 trillion barrels, with the possibility of a further 2-3 trillion in unconventional sources, although there is uncertainty surrounding all these figures. As with gas, getting the oil to market in a timely way will require sufficient investment within production and this will be influenced by global demand and oil prices. It is expected that OPEC members will account for over half of all production by 2035.

Unconventional oils and biofuels

Unconventional oil is expected to meet around 10% of total demand by 2035. Most of this is expected to come from Canadian oil sands and extra-heavy oil in Venezuela, although there are further options to develop oils from coal-to-liquids and gas-to-liquids, as well as shale oil, all three of which are widely distributed around the globe. There are also options to develop resources that have been too difficult or expensive to exploit, including deepwater drilling. The production of all depend, in some part, on the price of conventional oil, but generally the higher it is, the more economical it becomes to develop unconventional resources and, based on future prices, it is likely many will be developed, particularly in non-OPEC countries where indigenous resources are in decline.

There are a number of issues relating to the extraction process for unconventional resources, which because of their location such as deepwater, or because of the extraction and refining process, can have significant environmental implications associated with them. This can include the level of energy needed in the extraction process, which gives them a higher well-to-wheels level of emission compared to conventional oil. It is clear that Oil from Tar Sands is not to be supported at all.

There is also likely to be a growth in the use of biofuels, mainly from bioethanol and biodiesel. In 2009, 1.1 mb/d (52 Mtoe) was produced, three quarters of which was within the US and Brazil. This is expected to increase to around 4.4 mb/d by 2035, most of which will be within the OECD. This is currently minor though compared to global oil demand. There are some ongoing issues around the sustainability of biofuels that are starting to be addressed, particularly in relation to the carbon emissions that are associated with them, through the whole production chain and their environmental impact. Future growth will require these issues to be comprehensively dealt with, along with determining the suitable rate of integration in fuel mixes to suit the majority of engines.

The implications for oil security

A principle issue for oil security is that there are currently few alternative options available for transport fuels, the dominant sector in demand. This demand has always been inelastic, regardless of price, but efforts to reduce demand through technology improvements and changing behaviour is key in reducing import dependency. In addition, other policy options including the electrification of transport and the increased use of biofuels could also help reduce demand for oil. However, the increased use of biofuels faces sustainability and technical limits to blending fuels and whilst electrification of transport would reduce oil dependency it will have bigger implications for the cost and design of the electricity system, so neither answer is straightforward.

The level of demand is not expected to decrease in the short to medium term and as North Sea production is falling within the UKCS and with Norway, our main supplier, import dependency is growing; projections suggest that it will rise from 31% in 2008 to around 61% by 2025. To help maintain security of supplies within the UK will require ongoing investment in downstream infrastructure, to both account for the rising import dependency and the ongoing changes in the UK demand profile for transport fuels.

The global picture is also one of rising demand, with import dependency increasing in almost all regions. The main exception is the Middle East and reserves are increasingly becoming concentrated in this region. This increasing market dominance is further complicated by a growing concentration of production in NOCs, who are expected to account for 66% of the share of production of 2035. Meeting future demand therefore becomes increasingly reliant on these countries and companies making sufficient investment in production capacity. There are some doubts that this will happen in a timely manner. If it does not, prices will rise quickly and there could be considerable volatility in the market, although these higher prices will eventually lead to increased investment. The increasing concentration also means that there are risks of supply disruptions from a number of strategic choke points. To some degree, these possible supply shocks can be limited through the strategic storage of oil, which the UK and other EU and IEA members are required to hold.

Oil prices show considerable volatility compared to other fuels, but all modelling suggests that they will significantly increase in the future, possibly rising to around $243 per barrel by 2035, but this is incredibly hard to predict with any accuracy. Ultimately, it will depend on how global demand develops and how investment in production follows this demand. The concentration of resources will also put pressure on prices and the role of OPEC will be a key component of this.

A further complication in assessing oil security and price relates to global oil depletion. Whilst there is considerable uncertainty about when a peak in oil may occur and differing views about whether this is a physical peak or more to do with policy decisions; it is suggested that a physical global peak will probably before 2030, almost definitely before 2040 and possibly before 2020 . This could have significant implications if policy does not take account of the impact that this could have on price and supply. Both the timing of the peak and the rate of decline are key issues and more attention is needed to in order to reduce demand and look at alternative options.

Electricity

Over the last five years, average annual demand has been around 398 TWh and, depending on the effectiveness of policy to try and increase the share of electricity in the heat and transport sectors, demand could double to around 800 TWh by 2050. Peak demand in the UK is currently around 60 GW and is expected to stay close to this until 2025, although a range of sensitivities will impact this.

Most of the demand for electricity is met through generation within the UK using gas, coal, nuclear and renewables. The actual energy mix changes from year to year, reflecting a range of variables within the market. The UK also has four interconnectors, connecting GB to France, the Netherlands and Ireland, which can be used for both imports and exports. Future changes to the energy mix will in part be driven by the closure of old nuclear power stations (7.4GW expected to be decommissioned towards the end of the decade), and through possible closures of coal, oil and gas generation from the EU LCPD and IED directives (40 GW may close). However, the lifetime of some nuclear may be extended and some plants impacted by the EU directives will retro-fit equipment to avoid closure or accept lower running hours, so there is uncertainty about some of these figures. Future changes will also be determined by what the market decides to build, projections for new capacity suggest that in the short term much will come from gas CCGT and on and offshore wind; in total around 40 GW is expected by 2016, and around half of this has currently got consent to build. To 2025 new capacity is expected to reach 77 GW, although what will actually be built becomes less certain. These changes will see the UK’s total generation capacity increase from around 83 GW today to 109 GW by 2017, allowing for closures and for necessary back-up. It is also expected that there will be a growth within embedded generation within the distribution networks. The extent this increase will occur is very much to do with the extent that heating will move from gas to electricity; and whether transport will move from oil to electricity; and if there is demand reduction. To support these changes and to reflect the ongoing need to update infrastructure, considerable investment and work will be required within the UK’s transmission and distribution networks.

Global demand is expected to increase by around 2.2% per year to 2035 to reach over 35,000 TWh and most of this growth is expected to occur in the non-OECD. How this demand is met will increasingly be shaped by policy and efforts to tackle climate change as this will determine the fuels and technologies that are used. Growth is expected in almost all generation technologies, although coal is expected to continue dominating supply, with its declining use within the OECD being offset by an increase in use in the non-OECD. Gas fired generation is the next highest generation method, again mainly in the non-OECD. Further technologies in their order of expected use include hydro, nuclear and then renewables.

The implications for electricity security

As supply has to match demand continually, a central aim should be to reduce demand as far as possible as this will reduce the cost of new capacity and infrastructure. As with other sectors, this can include action to improve buildings, change behaviour and increase the efficiency of all the technologies that produce it and use it, along the whole supply chain. The UK has a range of options for meeting supply, including the use of primary fuels within generation, renewables, nuclear power and interconnectors to other markets. What the future energy mix will look like depends on how the UK meets its renewable energy and carbon reduction targets, but it is widely suggested that the whole generation sector will need to be virtually carbon free by 2050; future electricity security is about which route is taken to achieve this. There are a wide range of different assumptions and sensitivities that underlie these choices, including what happens in regard to the electrification of heat and transport.

It is suggested that a large amount of the UK's generation will close over the next decade or so, including gas, oil, coal and nuclear generation, and new capacity will need to be developed to replace this, with gas and on/offshore wind looking like major contributors in the short term. In the longer term, Government is trying to encourage new nuclear capacity, but there are many uncertainties around how much will come forward and at what cost, there are also implications for how well new nuclear will encourage action to reduce demand and use more renewables. The effective demonstration of CCS could also see coal making a revival in the generation mix, although this would not be likely to occur after 2020. Increasing renewables, particularly from variable sources, will require the system to become much more flexible than it currently is to maintain system security most cost-effectively.

The future of electricity security therefore depends on a wide range of factors around future policy choices and the way that the market responds to these, through the legislation and regulations that govern it. This makes it very difficult to say with any certainty how prices may change, although they will clearly rise, whichever route is taken, because both new generation capacity is needed and infrastructure improvements and upgrades are also required. However, we would argue that it is important to keep options open to avoided potential lock-in to one technology, like nuclear. This would reinforce the centralised energy system and discourage more decentralised generation, which could bring wider benefits to individuals and communities. Decisions have to be based on a whole systems approach.

Key Points

Based on the analysis of demand and supply and its implications for energy security, several key points arise. Firstly, there are almost endless variables in all the assumptions that impact on demand and supply in the UK, we have used projections from DECC, Ofgem and National Grid to set out how different organisations think things may develop, but all are open to interpretation and really only act as a guide. We cannot really know what may be built in respect to new import or storage capacity, what new generation will come forward or how infrastructure will change in response. Given all these uncertainties, a key issue for us is the importance of keeping options open.

In respect to global issues, we have drawn on the projections of the IEA to consider how demand and supply may change. There are also uncertainties within their projections, which tend to be quite conservative, but several key facts do emerge; we know that:

- demand for all fossil fuels is increasing in non-OECD countries;
- reserves of oil and gas will become increasingly concentrated in fewer countries, such as the Middle East;
- as this happens, the role and importance of OPEC, the GECF and NOCs will increase;

- it will also increase threats and risks on energy systems, from supply shocks that result from political unrest, changing demand-supply patterns, geopolitics, and choke points;

The implications of all these issues are that to improve energy security we have to start by reducing demand as this will cushion the UK against price volatility and reduce risk by reducing the total amount of energy that we will need to secure from international markets. It also reinforces the energy security argument and the need to develop an energy system that is robust, durable, resilient and stable, etc. This can be further supported through the creation of a diverse energy system, that can use different fuels, infrastructure, interconnections and storage to balance the demand that remains. If CCS can be demonstrated this would allow the use of coal within the system, which would reduce import dependency. All of this links back to the need to keep options open.

Geopolitics

Section 8 discusses the relationships between energy security and the role that geopolitics can play in securing supplies. At its most basic, these concerns reflect the relationship between global politics and the distribution of resources. This is often considered in respect to the historic role that energy has played in enabling societies to develop, including their political and economic power; as well as the way that different countries view energy resources. Many in the OECD moved towards a view of energy as a commodity, but this view was not adopted globally and the debate has therefore increasingly focussed on the tensions between consumer states and producer states, with energy policy increasingly becoming linked to international relations and foreign policy.

The changing view has also been influenced by the changing patterns of global supply and demand, as new centres of each have emerged in recent years, particularly within the non-OECD. This has happened whilst reserves have declined in many OECD countries, creating a new market environment and increased competition for resources. This is further compounded by the concentration of resources, particularly oil and gas and the role that OPEC, the GECF and NOCs can and could play in future supply and pricing. The upshot of much of this is that supplies are increasingly out of the 'control' of consuming countries, something that is new to many and something that is often interpreted as a possible threat to energy security. Not only in respect to the relationship between different countries or regions, but also reflecting concerns over the transit of fuels between producer states, transit states and the end markets – both via shipping and pipelines. These concerns can include physical disruptions at choke points in the supply chain, as well as the policy and economic relations between the different countries involved.

A further complication is the geopolitics of climate change. This in part relates to historic responsibility for emissions, but also given its global nature, there is a need for a global consensus on how best to deal with the problem. There are concerns over how the impact of climate could lead to new resource conflicts, not just for energy. A key issue is how to reduce global emissions and enable economic growth, particularly in developing economies, in a way that does not compromise the stability of the global climate or the relations between different regions and countries. This has to be done equitably, be linked with efforts to reduce poverty, and be carried out through international cooperation that includes the transfer of funds and technology to developing nations.

What becomes clear when considering geopolitical dimensions is that international relations will become increasingly important in our energy future. It would be preferable if this is based upon a cooperative approach, rather than a securitisation approach and in some respects regional cooperation may be a sensible way forward to help balance the differing needs of energy security, climate security and the need for equity between nations.

Policy and Legislation

Section 9 sets out a detailed overview of key policy and legislation within the EU and UK, discussing how they have developed, what they mean for energy policy, climate policy and energy security. Ultimately these all interact to shape and inform the way that our energy systems develop, including the way that energy is supplied and used, what technology choices are made, what system choices are made, what impact these have on cost and affordability and what requirements are made on the market and those operating within it.

Section 9.1 provides an overview of EU policy in respect to energy, climate, energy efficiency, renewable energy, nuclear power, CCS, the internal energy market, infrastructure, energy security, and research and innovation. It is hard to summarise this information succinctly, but there are broad implications that decisions at an EU level has on UK energy policy as well as specific legally binding targets that the UK is required to meet. The overall framework for EU energy policy has changed over time against the wider backdrop of what has been happening globally in respect of energy resources, supply, demand and prices. It has taken a long time for a coherent EU-wide energy policy to emerge, often because of the tensions between individual member states and this is an evolving process. Key policy action has been developed around concerns over climate change and more recently energy security, with policy goals focussing on these and the options for improving the internal energy market, ensuring sustainability, and reducing import dependency. This has lead to a range of support and other policies around technologies, demand reduction, market operation and interconnections. Specific targets have been set for reducing GHG emissions by 20% by 2020, increasing the share of renewables by 20% by 2020, using 10% biofuels in transport fuels by 2020 and a currently non-binding 20% improvement in energy efficiency by 2020.

Section 9.2 set out the UK policy framework and what this means in respect to the differing aspects of energy policy. This includes a discussion on how views have changed towards energy in a market based system, before discussing policy details on energy, climate, energy efficiency, fuel poverty, renewables, nuclear power, CCS, energy markets, energy security, planning, research and innovation, and infrastructure. Again this is a complex area of the report setting out key issues for individual policy areas, but recognising that these all interlink and shape the energy system, the at the UK has and will have. The EU drives some of these policies, but many are UK specific. Given that the UK energy market is privatised, much of the policy focus is around how the market should develop to deliver the UK energy policy goals of tackling climate change, ensuring energy security, affordably, and in a competitive way. Much of this is currently the subject of fundamental change which has far reaching implications for the UK energy system, many of the key findings build on the background information provided within this section. The UK has a legally binding target of delivering 15% of all energy from renewable sources by 2020, a legally binding target to reduce GHG emission by 80% by 2050, with a reduction of at least 34% by 2020 and target to achieve 9% energy savings by 2016. There is also a target to eradicate fuel poverty ‘as far as reasonably practicable’ in England and Wales by 2016 and a target to increase the share of biofuels in transport by 5% by 2014.

What emerges from the analysis of this policy is the shear amount of it and its almost constant evolution. This can make it difficult to join up coherently as there are lots of differing policies all interacting in different ways. Some key issue that we would highlight are:

- the importance of understanding the underlying assumptions that Government base their decisions upon;
- the need for more clarity of what is the most important aspect of energy policy, is it about climate security, energy security or affordability, or all three and if so how do these differing goals complement or compete with each other?
- of all the policy goals, demand reduction ticks all of these boxes, which is why we argue it is a key priority.

All of these points reinforce the need for keeping options open and show that energy policy and the development of approaches to reach specific outcomes is essentially a question of choice. This choice should be driven by consideration of the sort of energy system that we want.

Other Important Considerations

The final section of the background research looks at a broader range of issues that we believe are important in developing energy policy to improve energy security.

This includes the role of people within the energy system, which is currently characterised as passive, but there would be much to gain in enabling individuals, communities and those within rural areas to play a much more active role within the energy system, to support the uptake of low carbon technologies, reduce demand and change behaviour. Without this the transition to an energy secure, low carbon, economy will be harder and more costly to achieve. Ultimately the energy system is there to meet the needs of people, so people have to be at the heart of the system. Policy needs to become an enabler for action and responsibility within society.

Making the energy system more intelligent, in respect to the nature of, and possible future role that smart grids could play. The rationale for these are clear, not only in respect to the fact that much of the existing energy infrastructure needs replacing, but because of the possibilities that a smart energy grid could play for reducing carbon, improving energy security, making the system more resilient, enabling effective interconnections between markets and new technologies and supporting more action to reduce demand. Essentially smart grids contain a range of different components that work intelligently to help balance supply and demand across a system; they would also be much more effective at enabling the uptake of low carbon generation and balancing intermittent supplies with other generation capacity. If we have to upgrade our energy infrastructure, let's make it a smart upgrade before too much investment takes place that would lock-us into an old top-down, centralised approach.

The background research has not strongly focussed on the future costs of energy, partly because of the uncertainties surrounding them, but also because the focus of this report is more about the role of the energy system, the policies that shape it, and what these mean for energy security. However, Section 10.3 provides a very simple overview of some of the future cost projections globally, and for the UK, in respect to both the price of primary fuels and infrastructure requirements. Future cost will have a lot to do with what policy decisions are taken regarding the transition to a low carbon energy system. This will include direct costs within fuel bills that relate to the wholesale price of gas and electricity and the indirect costs for infrastructure and other legislative requirements. The long term trends for household bills and fuel costs is shown, all of which have been increasing in recent years, a trend that is likely to continue. A range of possible future costs suggests that bills could rise by up to 52% by 2020. Energy price rises are inevitable, reinforcing the need to reduce demand first.

One of the key implications for future energy costs is the impact that they will have on the affordability of energy and the levels of fuel poverty within the UK. There are real difficulties in defining this problem, but the relationship between energy prices and the energy efficiency of homes is a central issue. The evidence shows that the number of fuel poor has significantly been increasing over the last decade as fuel prices have risen. The most logical way to turn this problem around is by both improving the energy efficiency of homes and by maximising incomes for those that are poor. Policy recommendations are put forward to deal with the worst housing first and to take this to an energy efficiency level that would future-proof the property against fuel poverty. This will requires a zone-based approach, that uses whole house measures to both improve thermal efficiency and low carbon generation, such as PV and solar hot water. Better policy alignment would ensure that money is properly targeted, whilst helping reduce the carbon emissions and energy demand within the domestic sector – additional policy wins.

Section 10.5 discusses the operational tensions that could occur under a policy to develop new nuclear, alongside intermittent renewables, such as wind power. The issue relates to the high cost of nuclear and its relative inflexibility, meaning that once constructed it needs to operate whenever possible. However, intermittent renewables need to operate whenever their primary resource is available – e.g. the wind, sun, etc. Both technologies are therefore 'must run' types of generation. At times of high demand, this is not a problem, but issues will arise when the level of supply from both these sources is in excess of demand. At such times, the system operator will need to constrain off generation to balance supply and demand and the issue is what will be constrained off and how will they be compensated, as well as what impact this will have on electricity prices and the economics of different types of generation and decisions to invest within them. It is not clear at what point these issues may occur, and in some respect it will depend on the overall flexibility of the system, but strategies such as storage and interconnections could help smooth supply. These sorts of issues need to be considered in the whole design of the system and the choices that are made around the future energy mix.

Section 10.6 looks at the need for policy to focus on demand reduction, rather than on how supply can meet demand, whatever its level. Such an approach would deliver multiple energy policy objectives including reducing emissions, increasing energy security and making energy more affordable for energy users. In respect to energy security, a system that needs less energy to drive it will be more secure, both in terms of resilience to price shocks and the availability of fuels from the global market. The approach being taken in Germany, which shares many similarities with the UK shows how policy can shape the sort of energy system that we end up having. The section also discusses the importance of the rebound effect, and how to limit its impact. We argue that the primary effort within energy policy should be to manage energy demand, as this would reduce total energy use – both direct and indirect. Although there are a range of complex downsides to this that may hit some sectors who businesses model is currently based on the sale of energy.

Section 10.7 expands on some of the issues raised on geopolitics to discuss the importance of the UK as a global citizen. This is a reflection of the need to change our current view towards energy and accept that we are working within a global energy and climate system. We should also accept our historic contribution towards climate change and facilitate global solutions that include technology transfer.

The final two sections discuss the importance of keeping our options open and taking a whole system approach to decarbonisation. We also discuss what the future role of gas could be. This in part links to the discussion on the relationship between nuclear and renewables, but also talks about the most effective way to enable a transition to low carbon. We argue that if gas is available and environmentally acceptable it is a better fuel for enabling a flexible energy system to develop.

Key Energy Policy Choices

Energy is central to the way we live our lives, it has historically shaped the way our society has developed and will continue to do so in the future. Governments should recognise energy policy's powerful influence in the development of a society's character and use energy policy as a tool to support the development of the sort of society needed for a secure, equitable and sustainable globe. We argue within this paper that energy policy is not sufficiently recognised as an influence in societal change and that this should alter so that energy policy directly and indirectly interacts with wider social goals. We suggest that there are four key issues to be decided on, and then depending on the outcome of those choices, a number of further energy policy issues and choices flow from them.

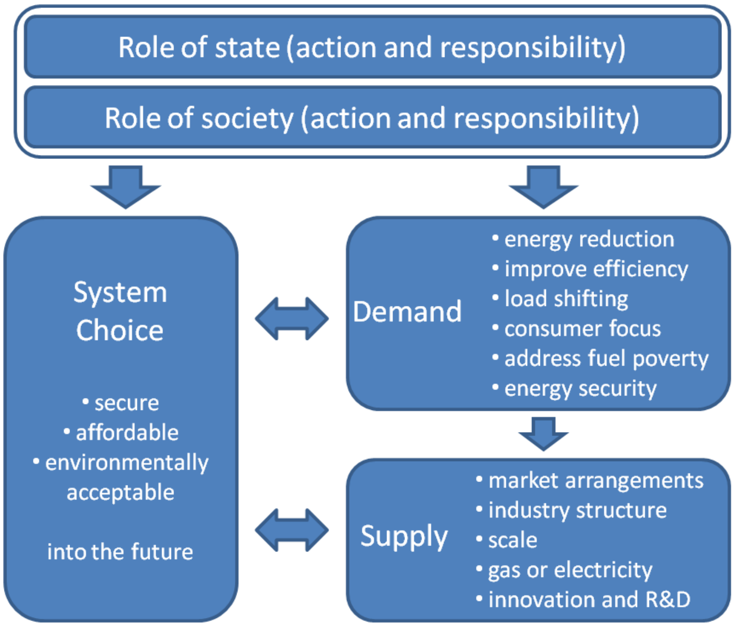

Figure i: A decision-flow view of energy policy

The first issue concerns the role of the state in this energy future. This report argues that Government has to take responsibility for its energy policy. While it can have executives of its policies, for example Regulators, it has to be clear that it is Government which is responsible for, and which takes, key energy policy decisions in a timely manner. Moreover, Government has to be more transparent about how it comes to the decisions it makes.

The second issue is the role of people and customers within the energy system:

- If it is felt that customers should be able to choose what energy service relationship they have to their energy service company, then there will be support for an energy policy which creates an energy industry structure which enables that. In addition;
- If it is felt that individuals have to connect to their energy use more than they currently do in order for them to think more about the way they use energy (and from there live a more energy efficient life, thereby leading to reduced energy demand and emissions), then an energy policy which is 'visible' and endorses mechanisms which increase visibility, connection and inclusivity should be supported. This suits an energy policy which supports energy efficiency, small scale renewables and so on.

The third issue is whether there is support for a 'smart system'. This is a system which sets energy reduction and efficient use of energy at the heart of energy policy:

- energy demand is reduced as far as is possible across all sectors (reducing energy demand is the most energy secure measure that can be undertaken and this report argues that energy demand reduction and efficient management should be placed at the centre of energy policy;
- the resource productivity, including energy efficiency, of energy using devices across all sectors is improved;
- the most efficient time management of energy demand is achieved through 'smart' management (this could include a demand response within the electricity market; establish protocols for charging electric vehicles and so on);
- then it includes the design and operation of the most efficient means of energy supply between electricity, heat and transport.

If, as argued within the report, energy policy choices should be made by Government, that people are placed at the centre and the system becomes smart, then there are a number of other energy policy decisions are supported:

- Managing energy demand and creating an efficient energy system is placed at the centre of energy policy.
- An industry structure is required which enables customers to have choice; for Energy Service Companies to develop; for energy demand management to take primary place; for new entrants and new practices to develop and so on.
- Interconnectors, storage etc are supported as part of that resilient, flexible, energy efficient system.
- Attitudes to innovation, R&D and so forth are then supportive to enable this smart system to develop.
- In this future, individuals and communities need to be prepared to accept that their homes are made energy efficient and that renewable energy power plants are widely distributed, including on their homes. An important aspect of energy policy is to 'connect' energy use and its societal and policy implications to individuals. Early steps towards this can be to make energy 'visible', as discussed below, but also to involve individuals and communities into energy decisions. Given a choice on a specific energy policy decision, the one which better involves individuals should be taken.

- This affects all communities – both urban and rural, with agricultural integration into energy policy a very important, but hitherto, neglected area.
- The security, sustainability and social agendas of energy policy should work together so that energy demand reduction becomes central to energy policy; so that energy security is complementary to an environmental future.

The implication of this is that when an energy policy idea is put forward, its effect on these issues should be ascertained. For example, if it enables new entrants then it may be worthwhile supporting, but if an energy policy is bad for new entrants then it should be treated with caution. At all times, the overall value to the whole system should be kept in mind.

If the first three key decisions about energy policy are supported, then there is also a fourth key issue which has to be decided on -the role of natural gas. This issue broadly relates to whether, amongst all the various pathways to reduced energy emissions, natural gas should be the transition fuel to a sustainable future. As more renewable energy is deployed, the energy system will have a greater proportion of variable power. This variable power has to be used when it is generated and a flexible reserve provider of energy is needed for when the renewable energy is not available. From a system perspective, natural gas would be the natural provider of flexible power because it can respond to demand quickly, the plant sizes can vary and they are quick and cheap to construct.

If gas is available and environmentally acceptable, it seems sensible that gas becomes the transition fuel. A central question about natural gas therefore, is its availability (and for how long) and also whether its production is sustainable. This can be divided between the short term (i.e. winter balancing) concerns which need to be addressed now; and the broader gas as a transition fuel issues. Of the latter, we argue in this report, that given the availability of the gas network, and the global availability of the resource, that natural gas combined cycle power plants should move from providing mid merit generation to ensure energy security to using that (or new) generation as balancing reserves in a sustainable future.

The future energy system which emerges if gas is not the transition fuel is very different in that it becomes electric-centric. Instead of gas being a transition fuel to a diverse set of renewable energy and energy efficient technologies across electricity, heat and transport; fossil fuels (i.e. natural gas, coal and oil with CCS where possible) become the transitions to an electric-centric future. Transport is seen as becoming dominated by electric vehicles and trains; heating also moves from natural gas to electricity. There are serious implications for customers in this future as well as for renewable energy as the latter develops alongside nuclear power. This is because in a time of constraint, when both renewable energy and nuclear power want access to the grid, nuclear power is always taken first. Because of nuclear power's size, it costs far more to the system operator to constrain off 1 GW of nuclear power than it does several MW of wind power and so it is the smaller generator (i.e. renewable) which is constrained off at detrimental economic effect and causing the perception of risk for investment in renewables to rise. Moreover, in the future, as more variable power comes online there are concerns that constraint compensation will cease, thereby having a further fundamentally detrimental economic effect on renewable energy.

Overall, the central key issues and choices we have set out means that the details of energy policy has to change. Examples of this could be:

- energy tariffs should get more expensive as more are used;
- industrial and whole house refurbishments and new build should take precedence;
- measures which reduce energy bills and increase comfort, such as solar water heaters or triple glazed windows, should be rolled out, with priority for the vulnerable and fuel poor;
- public sector procurement becomes the driver for this future;
- promotion for renewable energy should be risk free but include payment degressions;
- costs should be socialised but the vulnerable or fuel poor should be exempted.