Energy Security in a Multi-polar World

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Introduction

All Governments express the need for a secure energy sector and for the 'lights not to go out'. They know that the electoral and economic cost of prolonged interruption in energy supply is enormous and therefore strive, often above all other policy measures, for a security of energy supply, but what is secure and secure for whom?

In recent years the rapid growth in the demand for coal, oil and gas in Asia and other developing regions, coupled with the depletion of conventional reserves, such as in the North Sea, have resulted in fluctuating and often significantly higher energy prices. This has increased concern on the need for a secure energy sector.

Britain's energy security has become the focus of increasing attention for a number of reasons including the UK becoming a net importer of energy, blackouts in power systems around the world – particularly in countries with rapidly growing demand-, geopolitical concerns such as the dispute between Russia and Ukraine, industrial action and the blockade of refineries and fuel depots and concerns over global oil depletion. At the same time, the world has been moving away from the bipolar axis of the Cold War towards a multi-polar world driven by the rise of Asia and the relative decline of the Europe and the United States of America. In addition an increasing number of major economic powers are demanding more energy to fuel economic growth and satisfy the needs of their populations. Finally, climate change and the need for low carbon energy add further constraining dimensions. This will be tested by the use of coal in an abated or unabated form, which is widely available in those countries with rapidly growing energy demand, such as China and India, and whose use is seen as essential for economic development. Against this background, the purpose of this paper is six fold:

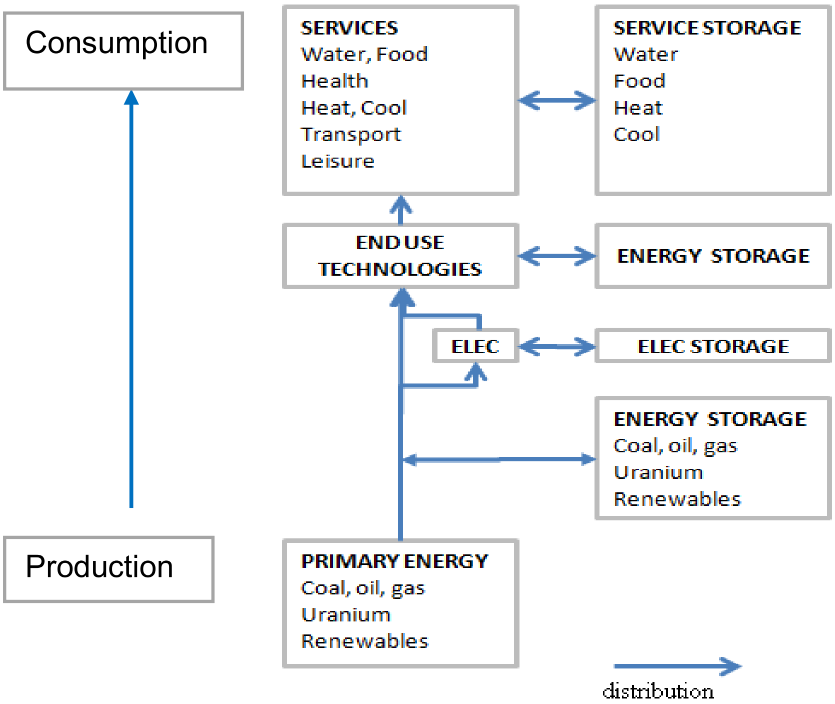
- To highlight the increasing complex nature of 'energy security' as a concept
- To consider the dynamics of energy security
- To present the range of energy security threats currently facing the global energy system;
- To explore the key dimensions of those threats
- To identify the specific energy security threats that confront the UK
- To present the research and policy challenges posed by those threats.

Throughout the paper we favour the term ‘energy security’ over ‘security of energy supply.’ Energy resources, be they conventional fossil fuels or renewable energy sources, are exploited, transformed, distributed and delivered to consumers, be they individuals or businesses, to provide energy services, such as heating, lighting, cooking, manufacturing and transport (see Figure 1). The level of security is not determined by supplies alone, but by the immediate balance between supply and demand and the longer term trade-off between more energy security and environmental considerations (e.g. more wind farms vs. open spaces or more nuclear power vs. global security and nuclear proliferation). The term energy security is therefore less misleading because it avoids the narrow focus on the supply side.

Box 1: Energy Services

Energy per se is not useful; energy is required to construct and operate systems to deliver services. Some energy services are more critical than others. There are core services which it may be dangerous to interrupt even for a day or even hours, ,these include refrigeration of food supply, domestic space heating and lighting, and emergency services such as health, fire and police. Then there are services of intermediate importance such as hot water heating which may be interrupted for short periods without significant social or economic impact. Finally, there are lower importance services such as television and holidays which are not urgently critical to wellbeing. Part of security planning is for these services to degrade gracefully to the core should there be a problem in the energy service system.

Figure 1 : Energy service chain



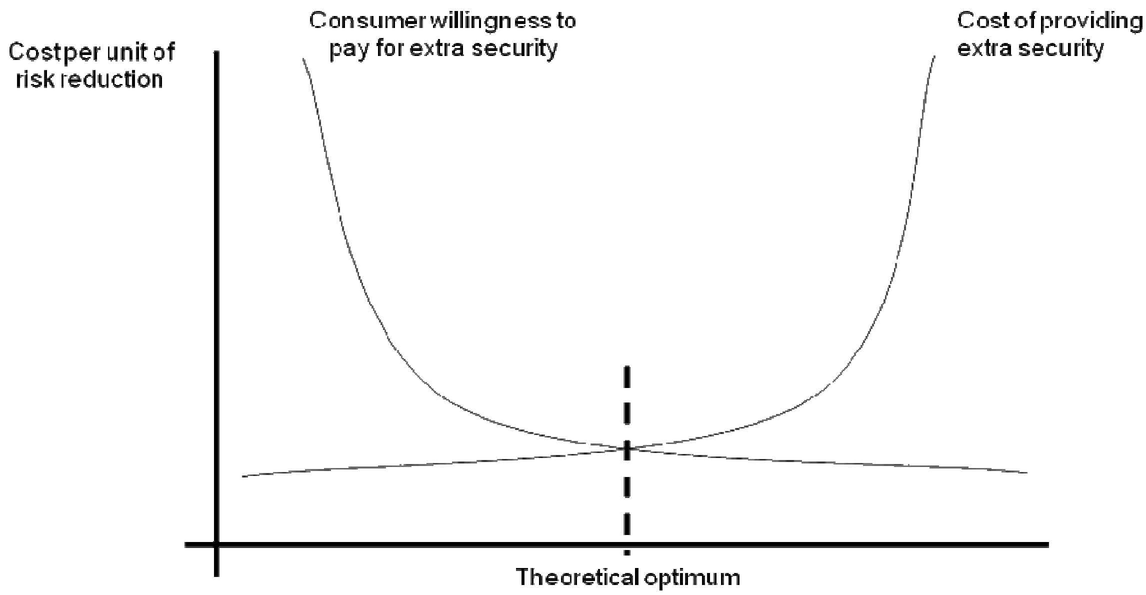
Definitions of Energy Security

There are several possible ways of measuring energy security: continuity of individual fuel supplies; continuity of total energy supply; continuity of service supplies; and continuity of the economy. However, energy security has traditionally been concerned with securing the supply of fossil fuels. Similarly, the definition of energy security has related to both the supply side and fossil fuels. For example, the International Energy Agency[i] argue that 'energy security is defined in terms of the physical availability of supplies to satisfy demand at a given price' while Grubb defines it as[ii] 'security of supply for the purposes of this paper can be defined as a system's ability to provide a flow of energy to meet demand in an economy in a manner and price that does not disrupt the course of the economy '.

Box 2: Cost of Energy Security

We know that there is no way that that security can be 100% and even if there was how much are we prepared to pay? While there may be a theoretical optimum cost the political consequences of interrupted supply may force utilities and governments to 'gold plate' the system.

Figure 2: Secure Supply at What Cost?



Source: Jim Watson, SPRU, 2010[iii]

Cost is just one measurable point – there are other important dimensions of energy security, such as the resource efficiency, volume of imported energy and the stability of its origin, the fuel quality and the environmental sustainability. Therefore energy security is seen as both variable and complex and it is difficult to have one combining measurement – the net economic cost or probability of unserved energy service does create a single definition, but quantifying this creates issues. However, simplifying the measurement and taking only a single or few criteria must be treated carefully as there may be significant distortionary effects.

However, as Britain's energy security has to be satisfied within a multi-polar world, with new governance systems and actors at all levels and as the energy system is increasingly moving towards a lower carbon system. The 'old' definitions related to the primary impacts of physical supply and fossil fuels, such as the percentage of energy that is imported, are not sufficient. Thereofore, energy security is increasingly a multidimensional, dynamic requirement that will differ by country and will also consider the increasing competition over energy with emerging economics, and with greater and more complex patterns of interdependencies . In this way, one encompassing definition is unlikely to encompass all primary and secondary (for example the impacts of the share prices of energy companies on pension funds) risks and dimensions and so should be expressed in a more fluid manner.

Without wanting to pre-date the discussion a starting point for our expression of energy security could be "the extent to which the population in a defined area (country or region) can have access to affordably and competitively priced, environmentally-acceptable energy services of adequate quality". (Jensen, 2009)[iv]

Shocks/Stresses

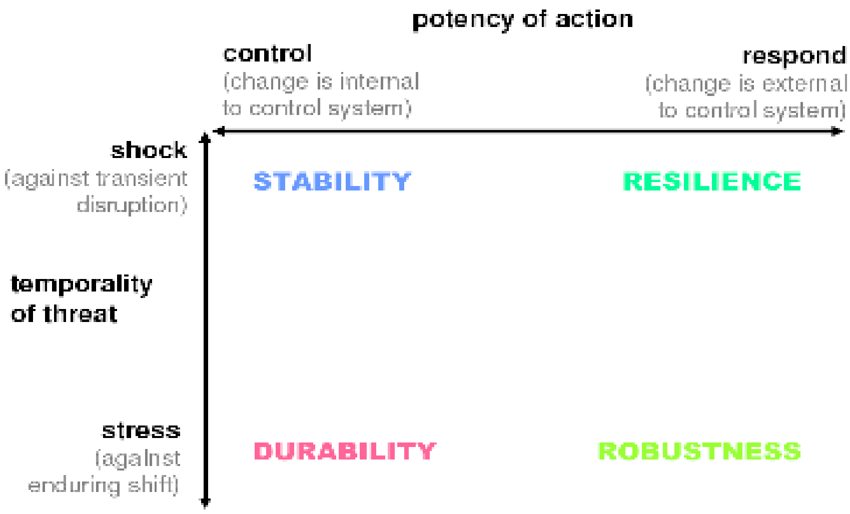
Three aspects of energy security are particularly important for our analysis.

- Energy security is a property of energy systems, where we take the energy system to include people and their institutions as well as technologies and energy sources. It is not meaningful to assess the security of particular components of these systems (e.g. infrastructures for the supply, transmission or use of energy) in isolation. The overall security of energy services depends on the interaction of these different components whether they are technical or non-technical. Furthermore, energy systems are dynamic and are changing rapidly due to the imperative of transitioning to more low carbon forms of energy provision and the growth in resource demands from developing countries and regions.
- Energy systems are subject to a range of different risks or threats to energy security – and these vary with geography (e.g. conflicts abroad vs. infrastructure failures at home) and timescale (e.g. oil price shocks vs. long term changes in the availability of oil).
- There is a range of strategies that governments and other actors can use to try to deal with the causes of insecurity – or to strengthen an energy system's ability to withstand disruptions.

To bring these three aspects together, we draw on a framework developed by Andy Stirling. This was originally developed to explore sustainability, but can be readily applied to explore the properties of energy system security (Scoones, Leach et al.

2007[v]; Stirling 2009a). Stirling identifies four such properties: stability, durability, resilience and robustness. These are summarised in Figure 3.

Figure 3: Four Dynamics of Energy Security



Source: Stirling 2009a[vi]

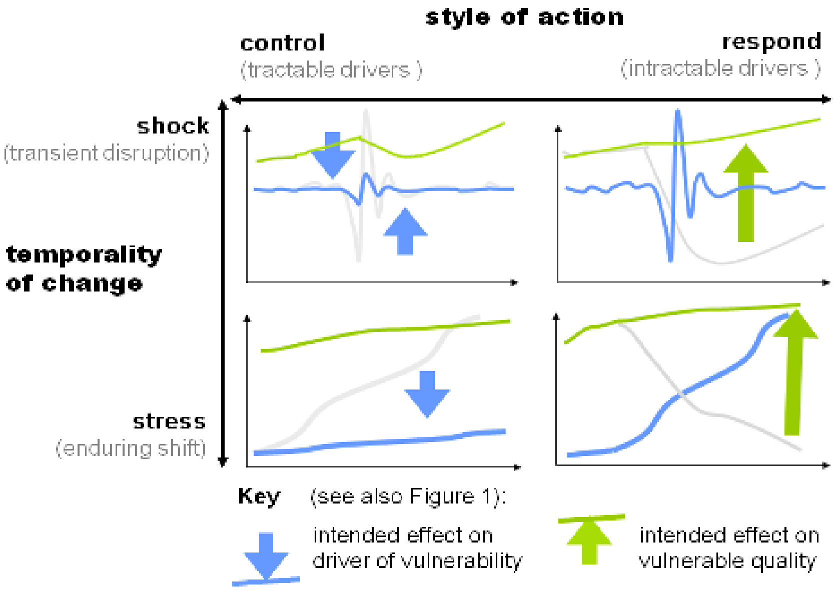
The vertical axis of Figure 3 focuses on threats or risks to energy security and captures the temporality or timescale of such risks. These range from transient shocks to more enduring stresses. Many energy security discussions focus on the vulnerability of energy systems and consumers to the former (e.g. a sudden disruption of gas supplies). However, there is also focus on the latter, more enduring changes (e.g. the possibility of a steady increase in the UK's gas import dependence on Russia over the next two decades). The horizontal axis focuses on the extent to which these changes can be controlled (e.g. by putting in place price controls for gas) or whether the main strategy available to governments or other actors is to respond solely in ways that maintain the level and quality of energy services for consumers. This would not necessarily mitigate the threat itself, but could instead comprise a fuel switching policy so that the UK energy system is less affected by future risks to gas supplies. These axes are then combined to provide the four properties of energy security: Durability, Robustness, Stability and Robustness.

Figure 4 takes this analysis one step further – and shows in outline form how the temporality of risks to energy security can be dealt with by different control and response strategies. In each quadrant (which represents one of the four properties of energy security), the risk is shown by a blue line. The impact of the risk on the target variable is shown by a green line, which also captures the impact of strategies for control or response.

The problem of energy security is thus essentially a question of ensuring the continuity of a certain target variable (the green line). Whether a strategy can be seen as control or response depends on how the system boundaries are chosen and which variable is chosen as a target.

- If the stability of the economy is chosen as the target, the provision of continuous energy services can be seen as a control strategy, while the resilience of the economy to changes in the provision of services, such as transportation, would be an example of a response strategy.
- If the continuity of energy service provision is seen as a target variable, the continuous provision of a certain fuel type, such as gas or oil, can be seen as a control strategy, while the resilience of the economy to disruptions of the fuel supply, for instance through fuel switching capabilities, would be an example of a response strategy.
- If the continuous availability of a certain fuel is seen as a target variable, the protection of the deliveries from a certain exporter against disruptions can be seen as a control strategy, while the resilience to disruptions through swing suppliers such as LNG would be an example of a response strategy.

Figure 4: Contrasting temporalities and actions in addressing technological vulnerabilities



Source: Stirling 2009b[vii]

One way of interpreting Figure 4 is that the 'control' end of the horizontal axis is concerned with shocks and stresses that are internal to a particular energy system i.e. where the security threat to part of the system can be managed by the political institutions with responsibilities and powers for that part. For the UK, this might mean those risks that occur within our borders are largely the subject to UK political control (although, for example with the multinational ownership of energy resources and utilities this is not 100%). Seen this way, the 'respond' end of the axis is associated with risks that are more external to the UK energy system. In other words, there is more scope in principle for the government and other actors in the UK to exert control over shocks and stresses that originate within the UK. However, this does not necessarily mean that a control strategy is not possible for more external shocks. For example, the UK may collaborate with other States to reduce the risk of shocks to fossil fuel supplies through using bargaining power, facilitating investment in multiple international pipeline routes or the joint development of new technologies.

Energy Equity

Unless there is a radical shift in the rate of improving energy access, the UN Millennium Goals of eradicating extreme energy poverty by 2015 will not be met. Currently there are approximately 1.4 billion people globally that lack access to electricity of which 85% are in rural areas. Furthermore, 2.7 billion people rely on traditional biomass for their heating and cooking, which has a huge impact on health due to indoor pollution levels. Addressing this situation needs a number of corrective measures:

- A commitment to effect the necessary change, through the setting of new policies and targets
- New Financial instruments and agreements on technology exchange and mutual development plans.

The IEA has assessed that to meet an objective of universal access to modern energy services by 2030, will require additional investment of $756 billion, roughly 3% of the anticipated energy investment over the proposed timescale[viii]. Factoring in these additional investment needs as well as the impact on global energy demand (a growth of 2.9% in electricity usage and 1% in oil usage is extrapolated), should be part of the discussion on global energy security.

Dimensions:

Governance

Governance is taken to reflect an appropriate set of interwoven multi-level rules and incentives which encourage energy secure behaviour by the multi-level relevant actors. Increasingly, energy security is multi-level and involves actors at the international, national, regional, local, communities or cities and individual level. One concern is whether the appropriate governance is in place at all levels, to encourage resilient supply chains. Another concern is, whether the appropriate technical "governance", i.e. the automated control of the network is in place to ensure a stable/secure operation.

Without adequate regulatory power and oversight States can lose control of their energy industries - as they become privatised and often owned by other or many governments or companies. This deregulation means that States have less ability to ensure the outcomes they want, although they still have powerful levers. This means that the governance of energy security can be broadly be divided between the areas that States have control over and those they don't, generally business interests. In the latter situation, States and multi-lateral bodies become more reliant on developing relationships of interests. Individuals also occupy an interesting position between States and companies.

Time scale

The time-scale refers to the speed with which the impacts of a threat are building up. Although the speed can be measured on a continuous scale, we can distinguish between the categories of disruptive shocks, gradual stresses and persistent scarcity and unavailability. Examples for short term disruptive shocks would be political embargoes, technical failure or natural disasters, while there are also shocks which have longer term impacts, i.e. the accident at Chernobyl. Examples for gradual stresses would be the depletion of fossil fuels, the accumulation of greenhouse gases or growing demand.

Responsibility

The assurance of energy security is clearly seen as the responsibility of the state and, for that reason, analyses of energy security tends to be state-centric in orientation. However, the provisions of energy security will relate to all public and private actors and will be determined by the governance structures, for example most cities have emergency planning and policies for energy, water etc. – in fact they're statutorily required to -. To be sure, there are plenty of examples where the state does own or control the key elements of the national energy system and where state-owned companies are the dominant players; but in the UK context the state has privatized the energy sector and plays the role of regulator. Furthermore, in the era of globalization it is widely recognized that the sovereignty and power of the central state is challenged by global processes from above, and by the forces of regionalism and localism from below. We have a global energy system with multiple actors who operate at and across multiple scales from the global to the national to the local and the individual. It is equally plausible to talk about energy security threats to a national economy and an individual household.

Internationalism and connectivity

It is necessary to break out of the traditional state centric mode of analysis to conceive of multiple scales of analysis. Furthermore, these different scales are not conveniently nested in a hierarchy of scales and influences like a Russian Mastroshka doll. Rather, energy security threats reach across scales and tie local events to global consequences. Thus, for example, a strike by Nigerian oil workers or an explosion on the drilling in the Gulf of Mexico can send shock waves through the system that influences the price at the pump in the UK.

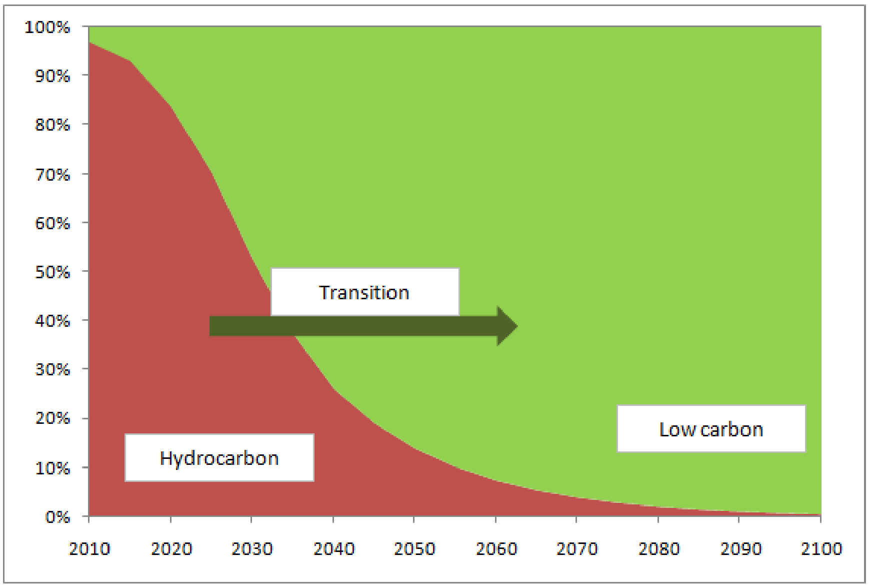
More generally, the UK now finds itself increasingly dependent on imported oil and gas that open it up to the challenges related to the geopolitics of oil and gas supply. Equally, the transition to a low carbon and renewable based system brings new locales and states into the forefront of global energy security concerns, be it lithium from Bolivia for electric batteries or rare earth metals for wind power from China. At the scale of the UK energy system, the transition to low carbon could also mean a shift from a highly centralized power generation system to a more dispersed system, or to more centralisation if largely nuclear or CCS. Thus, multiple ways in which scale influences energy security (and insecurity) need to be taken into account in our analysis.

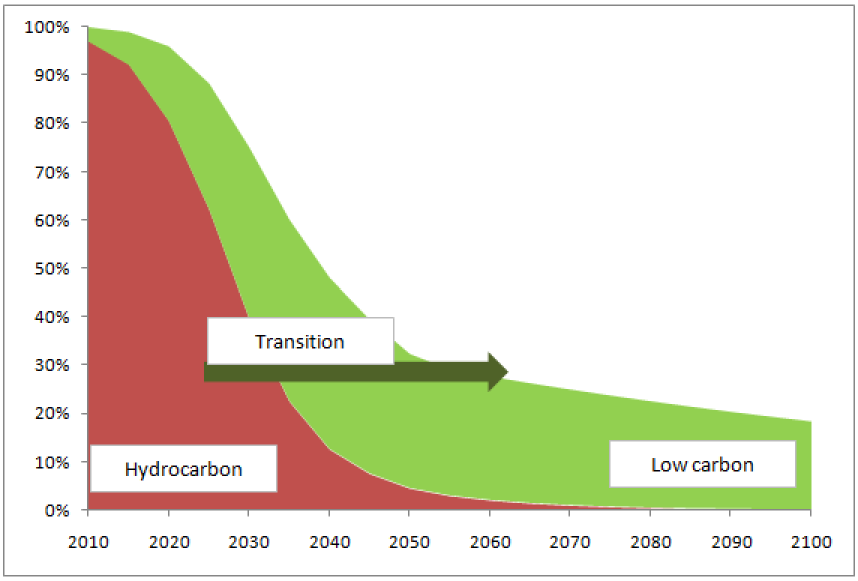
Influence of transitions on the concept of security

This is a particularly challenging time for those involved in shaping energy policy. It is now widely accepted that to replace depleting fossil resources and to avoid the catastrophic effects of anthropogenic climate change, the world's energy system needs to be transformed from one based primarily on the exploitation of hydrocarbons to one that is based on low(er) carbon sources of energy (this could include low carbon utilization of fossil fuels through carbon capture and storage and nuclear power). The relative importance of action on climate change vs. action on securing energy resources has changed and continues to vary between countries and regions, although either objective will require transformative action. In the UK context, the current target is to bring about an 80 percent reduction in carbon dioxide emissions by 2050. However, an even tougher target of 95% reduction may be likely to achieve global equity. A review of the current literature on energy security suggests two things: first, that the bulk of it is concerned with security of supply issues in relation to oil and gas, with no attention to the role of energy demand; and second, that there is relatively little research into understanding how the transition to a low carbon energy system will change the nature of the threats to energy security. Thus, there is an urgent need to think through the interrelationship between energy security and energy transition.

Directly replacing the current energy production (mtoe or kwhs etc) from unabated fossil fuels with 'low carbon' energy suppliers is not an option from a resource, economic or environmental perspective. Instead at the heart of any energy transition will be reduction in energy demand, without necessarily loosing energy services, and better energy management. As the figures below highlight reduction in energy demand both speeds up the transition and reduces the low carbon energy requirements. However, this may not necessarily led to a more secure energy system.

Figure 5: Stylised transition to low carbon





Source: Mike Bradshaw 2010

List of risks and threats to energy security

Any source of danger to the continuity of the provision and / or consumption of energy and energy services is conceived as a risk to energy security. Because energy systems are complex and diffuse, different elements of the system are exposed to a variety of risks and threats. The impact of damages can be felt at different time scales (e.g. over hours, years, decades), at a variety of geographical locations (e.g. local, regional, national and international), and in diverse parts of the economy (e.g. production, trade, end users). Protecting the system – or ensuring energy security – requires a good understanding of the causes of danger, the nature of the risks, the level of dependency between the risk sources, and what impact the damage has on the provision and access to energy services.

Some of the risks are less predictable than others e.g. depletion of fossil fuel reserves (known knowns), while others are not, e.g. fluctuations in energy prices or the occurrence of natural disasters (known unknowns). For some of these risks the probability can be calculated reasonably well, while the probability of others, e.g. political risk can only be speculated about. Likewise, the impact and magnitude of some damages can be predicted or estimated quantitatively, e.g. damage to a transmission line, while the impact of others is unpredictable e.g. the consequences of disputes international disputes between countries in the Persian Gulf. And finally there is the possibility of new risks of which we are currently not even aware (unknown unknowns) such as the environmental impact of new technologies).

Risks and threats could be broadly divided into four categories: Risks posed by humans and human activities; risks posed by technology failure; risks posed by factors related the nature of the energy resources; and risks posed by environmental factors. Some risks may fall under more than one category as they involve a combination of more than one category (technological failure and bad management, e.g. Chernobyl).

Human factors

Human factors could impact energy security directly and indirectly in various ways.

Direct causes include deliberate human acts such as strikes, domestic activism, and terror attacks on energy infrastructures. These in turn harm the supply of energy, and can cause disconnection the interruption of energy services or interruption to energy services.

Less immediate risks (time wise) are caused by lack of planning and the inevitably uncertain forecasting of future energy demand and supply and demand trends. These include for example policy failure in the national level that lead to lack of investments in energy infrastructure, energy demand management, or research and development of energy sources. Events in the international level and geopolitical changes over time, too, may threaten long term access to energy resources.

Less direct risks to energy security include policy and regulations that have implication on energy supply / consumption. These include for example strict health standard, emissions reduction goals and ethical standards that rule out the use of otherwise available resources (e.g. coal, oil from different regions of the world, bio-fuels). In this category we can include speculations in the commodity markets which cause high fluctuations in the price of energy e.g. Enron.

Technical factors

Energy systems rely heavily on primary energy resources, technologies and materials: from the production, through the transition, until the consumption of energy services. Technical failure in any part of the system may threaten energy provision. The implication may vary over space and time (e.g. local / global, short / long term).

Technical failure such as overload of transmission lines or transformers, the failure of safety switches or corrosion of gas pipelines could lead to disruptions and a forced outage. The likelihood of such events is determined by factors such as the age of components, the precision and quality control of the manufacturing process, the operation patterns or environmental variables such as wind-speeds and temperature. The duration of disruptions could last for minutes, days or months. The impact of disruptions depends on the length and magnitude of disruption (neighbourhood, town and region) but also on the management of the system and the availability and operation of forecast and emergency backup systems.

Energy resources

This category includes risks which are directly related to the nature of the resource. The most obvious example is the depletion of finite resources such as oil and gas. These are constantly consumed and at some point in the future they will be exhausted. Prior to this their more limited geological availability will affect localised accessibility in physical or economic terms.

Renewable resource potentials could become finite (in some places, not globally) if they are not managed well. For example biomass that is grown intensively may exploit the soil or consume all the ground water resources and consequently become not-renewable in that location for some time (or forever).

No energy source or technology is completely reliable and therefore all energy systems require back up options. However, some renewable energy sources are reliant on the weather, such as wind or sun. In order to secure sufficient energy provision when the system relies on these sources, demand needs to be managed (which links back to human factors) and backup, storage and transmission capacity needs to be planned for and made available.

Wider environmental factors

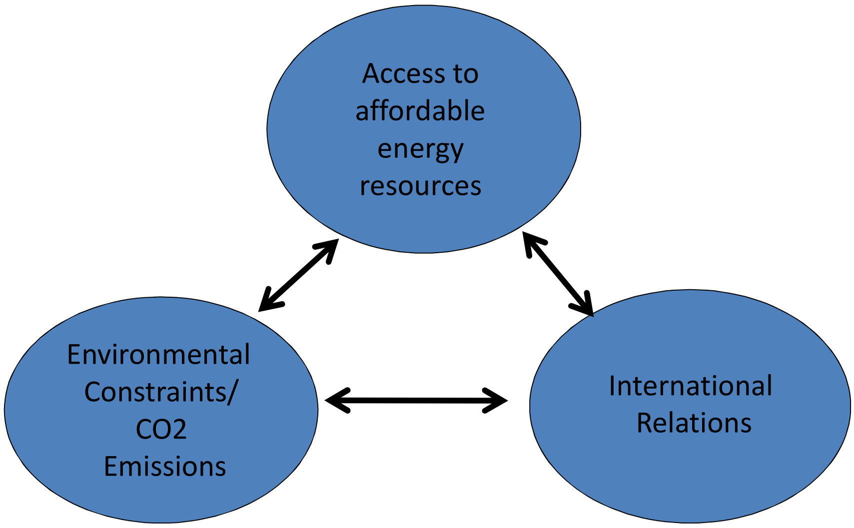
This category includes natural disasters that damage energy systems, e.g. hurricanes and earthquakes. Such disasters are a shock to the system and could have a short or longer term impact, such as drought and these events can be of local or international levels

This category also includes shortage in resources or failure of ecosystems that support energy production due to biodiversity loss or climate change. For example, the impact of climate change on the amount of precipitation could reduce the availability of water for hydroelectric power production. It could also reduce the availability of water for growing biomass, or for cooling power plants. Likewise, biodiversity loss (essential insects) could impact the growth of biomass for bio-fuel production.

The large variety of different threats and the complexity of their interactions make the problem of energy security highly difficult to quantify. In practice many authors have therefore focused of one or several of these risk categories and neglected the others. While this pragmatic approach allows the determination of the vulnerability to specific risks it does not give a complete picture of the overall security of a system. Even if all risk categories are included in an analysis, the result will only be an approximation as the possibility of an unknown or forgotten risk sources always remains.

Important Issues for the UK's energy security challenges

There is widespread recognition that the energy sector in the UK and globally must rapidly and fundamentally change. The rational for change has a multitude of policy and industrial drivers, most notably; environmental protection – overwhelmingly but not exclusively in relation of climate change-, ensuring adequate energy resources at affordable prices and the international relations impacts of the energy sector.



The priority given to each of these factors varies by geography and time. In many countries, current for example China or the US, much greater priority is given to accessing energy resources, than say in the UK or the EU in general, where climate change is perceived to be the dominant driver. However, the relative prioritisation is not pre-determined and changes with events. In Europe this was demonstrated by the Russia/Ukraine gas conflict in January 2006, which led to a change in emphasis of EU energy policy.

However, unless these three drivers are treated simultaneously and given equal attention there is a danger that incomplete assessments and subsequently policy measures will be introduced. All too often there is a separation between discussions on climate policy and energy policy – and yet energy policy is 90% of climate policy.

Further research

This paper has presented theoretical framework for energy security and has highlighted the current status and known and unknown risks that might have an impact. However, the items represented are by no means exhaustive. Therefore below are areas that require further research and discussion to determine their relevance and impacts.

Political

Electricity 'gaps': Closure of existing facilities as a result of redundancy or failure to meet new emissions regulations, coupled with uncertainty of future demand, create uncertainties and therefore investment risks for new capacity and infrastructure.

Terror: Energy infrastructure has been the target of terrorist attacks, a trend which is not expected to stop.

Civil unrest: Civil unrest as a result of the lack of access to affordable resources is not uncommon, particularly relating to food, but also oil. Continued price volatility will see this trend continue and potentially expand.

Policy failure: This can be the wrong policy or the right policy but badly implemented i.e. if energy efficiency programmes don't work then demand won't go down as much as expected and this may then lead to security issues with a lack of capacity or if supply policies don't work then can end up with only certain tech options or pathways because the other options haven't developed.

Energy security and foreign policy/diplomacy and development: To be included in ethical debate (John M, Dieter H's diplomacy gap) + securitization where security gets to such a situation that the military get involved and it becomes an issue above all other issues.

Technical

Failure: When technology goes down, one can either argue its human or technological but nevertheless when technology goes down it is down; e.g. nuclear power's closure during the summer of 2003 in France due to lack of river water; the rolling electrical blackouts in NZ at end of 2000; fleet failures i.e., of gas turbines in 90's when a technical problem across many power plants forced their closure.

Skills: Another dimension is the capacity to make the transition in term of available skills and competency e.g. do we have enough trained people to build the new technologies and/or how long does it take to establish these expertises? Finally whose responsibility is it to make sure these expertises exist in society?

Economic

Price volatility: The last decade has seen significant swings in the energy price and an overall increase. These price changes affect not only the energy sector, but the wider economy as a whole. These price changes affect the viability and economic attractiveness of alternatives and investment.

Environmental

Water: Water use is discussed in the context of climate change internationally, e.g. nuclear power and the rivers in France. However, water logging and sea-level rise is also an issue in the UK i.e. the issue of nuclear power on the coast. Radioactive waste will be active for hundreds of thousands of years so could be a problem with changing waster tables.

Climate Change: What is the impact of temperature changes on energy use – i.e. if warmer then will use less, but maybe summer use will be more through air conditioning? Climate change will also impact upon weather patterns and therefore affect generation from renewable energy.

Resource availability/domestic resource depletion

Import Dependency/Russian imports: Perceived as a big problem despite the fact we import only 2% of the UK's energy. However, this is not the case for other Member States of the EU.

Global depletion: We shouldn't make the mistake that if we move to low carbon that it will completely remove problems related to resource depletion i.e. uranium or thorium etc or materials necessary for renewable technologies, such as rare earth metals (used in the manufacture of turbines)

New technologies: The development of new technologies brings with it new resources risks, both from an availability perspective, i.e. electric vehicles and lithium, and environmental/security threats, such as plutonium reactors.

Equity:

Biofuels: The rise in the use of biofuels and its impact on food prices requires significantly more consideration, both as the use of biofuels is expanding as and new technologies are developed.

Conclusion

The complexity of energy security is plain to see with multiple policy objectives (sustainability, equity, international relations and affordability) needing to be addressed simultaneously and rapidly. As energy production and/or use affect all aspects of modern society, there are few other policy areas that will not be directly or indirectly affected by this transformation of the energy sector.

The British Government is producing policy with the ultimate objective of creating a low carbon economy – and therefore effectively a zero carbon energy sector –. At each stage Government should try to ensure that this is inclusive of the impacts on international relations and energy security. Given the scale of this transformation the plans must be, robust, durable, resilient and stable and able to withstand the inherent uncertainties and major shocks and stresses that will undoubtedly arise.

The process must be able to address risks that are known, unknown and also the unknown unknowns. The known threats directly facing the energy security include, human– deliberate and accidental-; technical; environmental limitations; and resource depletion and affordability. Outside these factors, but nevertheless important questions, are the consideration of global equality and inter-generational equity as they affect resource use and energy service availability. Research is also needed into the scale and potential scope of unknown risks. The paper attempts to identify the areas in which this research is needed.

The key dimensions of the threats to energy security relate to their governance and timing. Energy security is recognised as multi-level and involves actors at the international, national, regional, local, communities or cities and individual level. Without adequate regulatory power and oversight States can lose control of their energy industries. The time scale both affects the speed at which the impacts of a threat build up and how long lasts they are.

The UK finds itself in a relatively new position of an energy importer and therefore has less experience in accessing new oil and gas supply. At the same time it is also trying to build up its low carbon supply sector – particularly to capitalise on the marine energy. Furthermore, while committed to a low carbon economy, the Government has less opportunity for the financing of new energy infrastructure as a result of the global financial situation. The lack of financing also affects the private sector and increases their scrutiny of national policy measures. The research and policy challenges posed by these threats will require a radical rethink, starting with defining energy security through to policy recommendations and implementation. This process will be enhanced by developing a range of inter-related indicators, both qualitative and quantitative, that cover the range of international and UK related risks.

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