Change and Inertia in the UK Energy System – getting our institutions and governance right.

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Abstract:

The Innovation and Governance for a Sustainable Economy (IGov) website introduces the ideas behind IGov. This WP expands on this to explain what the IGov project will be focussing on over its lifetime.

IGov argues that governance of an energy transition is not just about understanding (1) its technocratic requirements; nor (2) is it confined to understanding the policy, regulatory, institutional and incentive requirements, and how they fit together. As important (3) is to understand the politics behind energy governance structure. This is not just what rules and incentives are in place but how and why they are in place.

The WP gives a brief introduction to the governance of the electricity and heat sector; asked how institutions, rules and incentives are put in place; gives examples of links between governance and innovation (change) or inertia; sets out the IGov early thinking on challenges in the current energy system; early thinking on governance issues; it sets out possible hallmarks of a governance system which encourages change; and it concludes.

Keywords: Governance, regulation, change, inertia, innovation

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1. Introduction

The Innovation and Governance for a Sustainable Economy (IGov) website introduces the ideas behind IGov, including the broad project aim of understanding and explaining the nature of sustainable change within energy systems, focusing on the complex inter-relationships between innovation and governance[1]. This short note expands on this to explain what the IGov project will be focussing on over its lifetime. This note introduces hypotheses and arguments about energy system transitions which are not currently substantiated from evidence but which will be explored in a rigorous manner during the project lifetime. This note is also primarily about electricity.

IGov will examine the inter-relationships of innovation and governance, for a sustainable economy. Sustainable is taken to mean a non-nuclear, primarily low carbon, low energy demand system which emits 80% per cent less carbon by 2050 from 1990 levels, and meets its European energy obligations. Within this, IGov has a focus on the governance of electricity and heat[2], and on the demand, rather than the supply, side of energy. It is also particularly interested in practice change[3] and whether this level of practice change can be reached in an evolutionary manner or whether it, inherently, has to be revolutionary. How Government's deal with the 'losers' of energy system change is at the heart of issues around energy system transition, and whether it occurs or not. IGov is also a comparative study of Britain, Germany, Denmark and two US States which reviews examples of practice change (or not) in these countries, and how that change has (or has not) come about.

IGov argues that governance of the energy transition is not just about (1) understanding its (very important) technocratic requirements, such as the rules and incentives which enable a second by second balancing of the electricity system, for example; nor is it (2) confined to understanding the policy, regulatory, institutional and incentive requirements and how they fit together efficiently – again, important though that is. As importantly, if not more so, is (3) to understand the 'politics' behind the energy governance structure. Politics is taken to mean the sum of the power and agency behind decisions. This is not just *what* rules and incentives get put in place but *why* and *how*. Who or what is benefitting, or being constrained by, the current

[1] http://projects.exeter.ac.uk/igov/about/about-igov/

[2] And transport to the extent of increased electricity demand as a result of electricity vehicles

[3] Practice change refers to change such as technologies used; new business models; ways that customers interact with the energy suppliers or the energy network; changes to the way markets and networks area designed and operated; customers becoming prosumers and/or investors; changing cultural and social attitudes to sustainable energy; a change from a supply orientated, unit based system to a demand side and services orientated system; and so on

governance process? How are governance processes and decisions undertaken and agreed, and again who or what benefits and who or what are the losers.

IGov is exploring how the three aspects of governance come together to enable or constrain the transition to a sustainable economy in Britain. IGov therefore has two levels of research: (1) the details of the institutions, rules and incentives which are in place but also (2) the why and how those institutions, rules and incentives were set as they are, and their implications.

2. A brief introduction to governance of the electricity and heat sector

Energy systems can be divided into a number of fundamental segments. For example, basic electricity system segments tend to be generators; distribution networks; a transmission network; a system operator; a market and its operators; and retailing to customers of different demand sizes (or supply, as it is known in Europe). In addition, there may be other actors and functions such as a Regulator; market information; market monitoring; metering; and data arrangements. The latter functions can all potentially be within the Regulatory function, or stand-alone outside it. Gas systems can be divided in the same way as electricity but with producers and shippers of gas rather than generators. Other energy systems, for example, heat, can be divided between providers (similar to electricity generators or gas producers) of heat and then the other segments.

Different countries have different combinations of these segments; energy markets and networks can have different rules and incentives; and Regulators (which often (but not always) oversee or develop those rules) can also be structured in different ways with different reach and responsibilities, and work to different legal Duties. This energy system chain can have different types of ownership of different segments (for example, State, private, co-operative or local/municipal) and establish different levels of choice and involvement for customers, of different demand types.

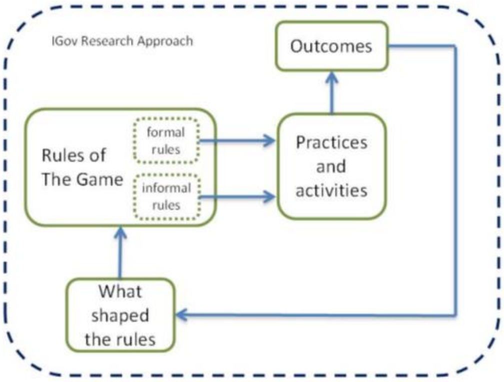
The structure, institutions, rules and incentives in place for markets and their economic regulatory systems therefore have enormous implications for the way energy is conceived of in everyday life for customers and citizens; for the total amount of, and way, energy is used; and for the change which occurs in the practices of running the electricity system - whether it be to do with the type of technologies used; the amount of innovation stimulated; the momentum or inertia exerted; the type of business models developed; and so on.

Together, therefore, the choices made when constructing or re-building an electricity (or gas / heat) system and establishing its structure, rules and incentives on use of, or access to, each segment of it has a central importance to the character of the system; its ability to meet environmental, social and security goals; the cost and distributional impact of doing so; its space for social innovation; and the degree to which customers are able to connect and interact with it.

3. How do these institutions, rules and incentives get put in place?

Establishing these institutions, rules and incentives of the energy system in Britain is broadly arranged by the Government (who establish institutions and policies) and the independent Energy Regulator Ofgem (who oversees the regulatory aspects of networks and the competitive aspects of markets). These Government decisions on policies and their details derive from a variety of factors – including lobbies for different stakeholders. The Energy Regulator is established, and works to Duties and Guidance set, by Government, although because of the Guidance's cyclical nature, Ofgem also influences its content. The voting public is instrumental in voting in (and out) Governments, and also in pushing for change. A simple figure of this is given below:

Figure 1 - IGov Conceptual Focus



IGov is also focussing particularly on the 'demand side' within this broad area of how an energy system innovates or changes. This is important for two reasons: Firstly, an energy system transformation based on selling will be much more expensive to transform to the system level; much less desirable from a resource perspective (ie much more resource is needed to make that system); and would be much more expensive at the household bill level. Arguably, a central focus of Energy Policy (EP) should be on helping customers to consume *less*. Secondly, it is becoming clear within electricity systems that increasing levels of variable power, while reducing carbon, also lead to a number of challenges related to system operation, profitability for fossil generators, potential investment concerns to ensure security of supply and the need for more flexible demand. In both cases, the demand side is a vital, economic dimension of an efficient, affordable future energy system. However, there are minimal incentives to reduce energy relative to supplying it or to make it more flexible. At root, IGov is trying to understand why governance of energy policy has been so unsuccessful in either reducing total energy use or in increasing the efficiency of use across Britain.

4. Case studies of change and inertia - links between governance and innovation

An energy system which meets its target of an 80% cut in carbon emissions by 2050 from 1990 levels will have to be a system capable of practice change. This section briefly explores 7 short case studies to (i) understand whether the rules and incentives in places are encouraging to innovation and (ii) to illuminate the ways that energy system development is channelled by governance:

- Exclusive rules which benefit the few
- Electricity Market rules
- Liquidity issues – customers
- Liquidity issues – trading issues
- Vertical Integration – bad news for customers; retail market regulation; affordability; price transparency
- Code Governance – not fit for purpose
- Supplier hub model - does not recognise embedded benefits

‘Exclusive’ rules that benefit the few

The UK energy regulator, Ofgem, oversees the UK gas and electricity markets and network infrastructure. Generation, network companies and supply are dominated by the ‘Big 6’ vertically integrated energy companies as a direct result of the original design of the industry at privatisation (Gas in 1986 and Electricity in 1989/1990). Despite legislative change to regulation (ie Utilities Act in 2000 and the forthcoming Energy Act 2014), the situation has not improved with independent suppliers providing 2% of electricity and gas supply (Ofgem, 2013).

The privatisation of the electricity supply industry (ESI) in 1990 established a number of large companies in Great Britain: 5 generators, 2 transmission and 14 distribution companies (regional electricity companies (RECs)) from the monopoly Central Electricity Generating Board. Independent suppliers could sell to customers of different demand sizes although the market opened at staggered times - 1990 to customers over 1MW; 1994 to customers with a demand of 1 MW; and in 1998 to customers of any size (ie households) (Surrey ed, 1996). The RECs were the companies with the direct relationship with household customers. They combined ownership and operation of distribution networks with retail supply until 1998. The gas structure is somewhat different but again the gas industry was divided into a number of large companies and distribution companies, some of which had a direct relationship with customers.

At the time of privatisation of the ESI, there was an intense campaign to raise share ownership across society. A key political design requirement of this was that these investors would not lose money from their investments, and preferably could make money. As a result, the design of the industries was set up so that they could not fail. The corollary of this has been the difficulty of stimulating any basic change to the structure and practices of the industry set up at that time, despite vast change in understanding the needs of climate change mitigation, technological change and expectations by customers.

A central governance aspect of privatisation was the implementation of rate of return regulation for the network companies. The companies had their assets valued at privatisation (known as the regulatory asset base (RAB) or regulated asset valuation (RAV)) and they were allowed to make a return on that asset base. Any expenditure on capital assets since that time has been added to that RAB. This set up the incentive to increase their RAB, and despite changes to this (RPI-X to RIIO), the fundamental incentive driver for the network companies remains on capital asset expansion and continues to be the fundamental driver to their behaviour. Reducing total energy demand would reduce the units of energy moving through the systems and this would both reduce income but also mean that capital expenditure would shrink in line with the infrastructural needs of lower consumption, neither of which is in the fundamental interest of the network companies.

It is these ex monopoly companies which have combined and been taken over to make up the Big 6. Practice change (including a refocusing to the demand side) and new entrants has been limited because the system incentives still remain based on sales; because it is hard to get customers to switch (see case study on liquidity below) and therefore difficult for new companies to develop new businesses (since they don't have customers to sell to); because transaction costs of entering the energy industry and markets remain high and risky (see market case study below); and because the network codes benefitted incumbent generators (see case study below).

To a large degree this is because policies, rules and incentives within markets and networks directly, or de facto, benefit the few rather than the general. In other words, they support exclusivity rather than inclusivity.

Electricity Market Rules

The Pool was in place from 1990-2001; New Electricity Trading Arrangements from 2001-2006; British Electricity Trading and Transmission Arrangements since 2006. Ofgem is currently undertaking a review of Future Electricity Trading Arrangements (FETA).

Annexe 1 sets out in more detail how electricity markets broadly work. In brief, in a 'generic' electricity Pool, generators and all distributors (suppliers) enter their bids for their generation and their demand for some time ahead. The System operator then 'stacks' the offers of generation ie the lowest offer for generation is taken first and then the next cheapest offer is taken and so on until supply matches demand for a certain period of time (half an hour in Britain). The final (marginal) generation offer becomes the electricity price for that half hour, known as the Pool price. Suppliers were price takers for each half an hour – in other words, they have no choice over the price paid – it was always the pool price, although that changes over the day and the year. In addition, some Pool markets have a capacity mechanism to cover the fixed costs of unused generating capacity.

In England and Wales (E &W), National Power and PowerGen were the only 2 privatised generators from 1990 until 1996. This was not the preferred option but was the result of the unexpected inability to privatise the nuclear portion of the electricity supply industry in 1990 (Surrey, ed, 1996). Once it became clear that the nuclear portion of the Electricity Supply Industry could not be privatised and was pulled from the privatisation, it was too late to redesign privatisation. With hindsight, the choice to not hold up the privatisation vesting date further was a key decision for the future of energy in this country.

Because of the limited number of power stations; because the costs of each power plant were roughly known; because of the limited number of generators; and because of the knowledge of customer demand it was possible to know the merit order of the power plants for most half hours. This allowed the two companies to roughly know the marginal pool price, and therefore the revenue they would make. It would then not take too much effort on the part of the generators to bid in a slightly more expensive plant to raise the marginal pool price – for the benefit of both generators but not of customers. Thus, even without collusion, the E&W Pool of 1990-2001 was not a successful design.

Given this situation, the Utilities Act (2000) was implemented to overcome what was seen as a lack of competitiveness and high prices in the electricity 'Pool' and a general lack of connection with consumers and their wishes. It is important to note though that 'the Pool' design is the most widely used form of electricity market throughout the world (Sioshansi, 2008 and 2013). Details matter, and if set up correctly can have considerable benefits over its successor: the bilateral market. Pools can be transparent and have less risk for new entrants and smaller players. The primary reason why the British Pool did not work was because of only having two players, and this was due to the design (ie institutions, rules and incentives) of privatisation.

Within the successor electricity market design of NETA/BETTA, generators and buyers inform the balancing mechanism market and system operator of their contracted position and how different they are from it. They will then have to match their contracted position through the balancing mechanism. Depending on supply and demand, these prices can be very expensive, and it is therefore particularly difficult for independent or small generators, particularly with intermittent generation, to take on these risks. The BM 'balances' the market – and it is only in this market that demand side bids operate. In total, the BM makes up about 3% of the electricity volume. It is therefore a very opaque market and, given the lack of liquidity in future markets (discussed below), it is difficult to know what the 'real' electricity price is for the majority of electricity traded. A new, or independent, supplier would like to buy the amount of electricity they need from a futures market but because of lack of liquidity they cannot be certain they will not paying too high a price. Or they could buy bilaterally from a generator but, again, the latter may have more market power than they do and so be in a position to ask too high a price. Finally, they could buy through the BM, but again they cannot be sure they will not be paying too much.

All companies over a certain size which wish to buy and sell electricity either have to become party to various Codes, which includes certain IT systems (see below), so that they can sell through the BM, or they have to sell their generation through a consolidator (an aggregator, a broker) which is signed up to the Code, and which makes their money via charges to the generator. Moreover, it takes about a year to get the various Licenses and memberships in order before a company is able to sell something, and that is if they are able to access enough customer to make their business viable.

This opacity of electricity price, penal balancing payments, market power of incumbents, start-up costs and transaction costs, and general lack of liquidity makes it very difficult for new entrants, particularly for variable power generators. Moreover, the demand side is of minimal importance.

Liquidity

Liquidity issues relate to two main areas, and both are being dealt with (or not) via first an Energy Supply Probe in 2008 (Ofgem, 2008) and then ongoing Retail Market Review which began in 2010 (RMR, Ofgem, 2010). The first area of concern relates to not having enough transparent trades within electricity markets, both intraday and forward trading, to enable sufficient liquidity to (i) minimise the risk of ending up without enough physical electricity or paying too high a price, and also (ii) to illuminate a transparent electricity price and trend. The second area relates, according to Ofgem's reading of the problem, to customers and the degree to which they 'switch' suppliers or the degree to which they 'stick' with their suppliers.

Sticky Customers

Good liquidity of customers is important for 2 reasons (1) if new entrants cannot access customers, they cannot provide new services; and (2) if energy companies expect to retain their customers, come what may, they can make more profit out of them than is warranted. From the suppliers point of view: sticky customers are good because (i) they are a dimension which helps the suppliers to understand how much energy they are going to sell and therefore what they have to do to remain in balance in the electricity markets; (ii) if customers 'stick' they don't interfere with the VI balance between supply and demand (see below); and (iii) energy companies are able to worry less about competition with other suppliers or retaining their market share. For all of these reasons, there is little incentive on suppliers to educate their customers to the possibilities of alternative tariffs or reducing demand.

The ongoing RMR has come to the view, stated baldly (Ofgem 2014a) that customers don't understand tariffs, and the differences between them, and so they don't switch. Ofgem said they would regulate and/or cap the number of tariffs on offer. It is not clear what the extra cost of this is – but to the degree that it introduces cost, it becomes more complex and more difficult for new entrants to enter. Moreover, it is also unclear what the benefits are to customers because it is not so much the number of tariffs which is the problem but the difficulty in comparing them. Regulating comparison sites would seem to be a vital aspect of market liquidity but as yet this does not occur. Electricity is the same product at the point of use, although very different in the ways it is produced. If tariffs and bills do not show this differentiation between suppliers, then customers have limited means of understanding what is different about the different tariffs, and therefore whether they would like, or benefit from, a move. Another solution is also therefore greater disaggregation of costs in bills so that customers can understand how the bill is made up and what the differences are. The Big 6 are opposed to disaggregation of bills because they argue it will add costs to keep them up to date. It would also be easier to work out what companies are making money on. Ofgem has not pushed the Big 6 on this point, despite it arguably being fundamental to customer choice.

Thus, the material issues on liquidity are the structure of the electricity industry – ie promoting VI as a way to reduce risk in markets (and discussed below), the lack of information in bills, and the lack of regulation in comparing sites.

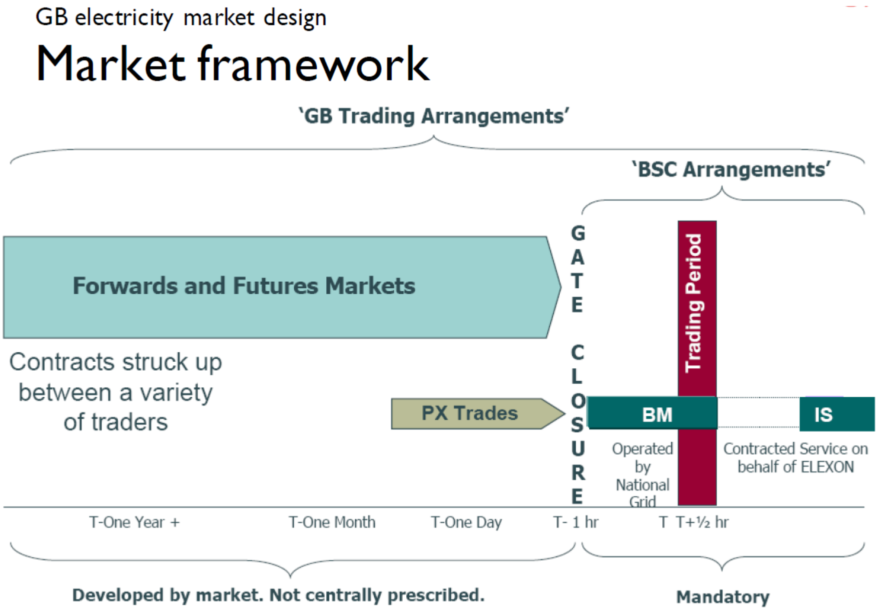
Liquidity in intraday and forward trading

All generators have to sell electricity in ‘real time’ when the physical generation is linked with the technical operating requirements of the network. Other names for ‘real-time’ markets tend to be ‘spot’, or ‘clearing’. Most countries have at least two markets, this ‘real-time’ market and the day ahead market. However, countries with actively traded electricity tend to have a real time market; multiple forward markets (ie markets which sell electricity at any point in the future ie for a day ahead, a week, month, year, 2 years ahead etc); and intraday markets.

These forward markets can either by physically based – meaning that their bids and sales end up being related to physical electricity – or they can be financially based – which means that they are essentially financial instruments to hedge the price of the physical electricity that generators and suppliers have bought and sold. These financial instruments do not finally trade out to physical electricity but to money lost or gained. These forward markets can be traded in directly from a company’s trading arm (which will have paid to be a member of the market) or they can be accessed via a platform (which the company will also have paid to access). A company like Bloomberg has a platform through which electricity trades can be made in many different markets around the world, whether physical or financial. Transaction costs can therefore be a problem for new or small companies.

The UK’s Balancing Mechanism (BM) is where only the balancing portion of electricity is traded. In general, buying and selling of electricity takes place between two parties. The generator or buyer only has to tell the BM market operator (Elexon) what their contracted agreement is and what they want physically to buy and sell in the BM to get themselves in balance with that agreement. They also have to tell National Grid (the system operator) what their actual output is going to be at gate closure (just before real time) relative to that contracted agreement.

Figure 2 – GB Market Design
Source: Cornwall Energy



Buying and selling electricity is a central part of the electricity business. Generators can sell into the future and buyers can buy ahead. Gradually time moves on to catch up with these forward trades, and the BM market operator balances all of the contracts for selling and buying electricity in one particular period of time – whether they were originally traded for a day ahead or two years ahead. Electricity participants tell the market operator and / or the system operator (depending on country) what their 'actual' position is at gate closure relative to their contracted position.

Buyers and sellers of electricity need to make sure that whatever contracted position they have made (in whatever futures market and/or with whatever bilateral contracts) 'unwinds' in such a way that they are in balance (ie buying and selling what they are contracted to do) and that they have not lost money in that process (ie for example, if they sold at £6/MWh for a certain amount in the future, it would not be good if all they could buy to balance that amount when that time period finally arrives was at £8/MWh). Buyers and sellers use various forward or intraday electricity markets to balance their contracted positions. It is therefore important that markets are 'liquid' meaning that there is enough electricity for sale for different time periods and in different 'clip sizes' to enable the buyers and sellers to match their needs.

The needs of different generators will differ. Generators of variable[4] power require liquid markets far more than generators of firm[5] power because they are more uncertain about what their actual output will be at any one time. Smaller generators need access to smaller 'clip sizes' and markets which don't have large up front transactions costs for users.

In some ways, limited liquidity works to the advantage of incumbents because it adds risk for potential new entrants. However, for fossil generators in a market with increasing amounts of low marginal cost carbon and / or zero marginal cost variable power, they have to ensure that they do not find themselves too expensive for a particular time period (known as being 'out of the money', and discussed further below). For example, they could have sold their physical generation for a certain time in a forward market at a certain price, say £8/MWh. When the time comes for their physical generation to be provided, the balancing market might clear at £6p/MWh. This would mean that the generators output would not be chosen by the algorithm, even though they had sold in the forward market. In this situation, the generator would be required to buy cheaper generation through the 'real time' balancing market to cover their contracted position. This means that the generator would be losing around £2/MWh, and if this happened too often it would cause their average revenues to drop below their average costs, and at that point it may be in their interest to cease generation.

Ofgem's latest announcement on actions to improve transparency in energy company profits include actions to increase liquidity in the traded markets (Ofgem 2014b). Essentially there are two basic concerns. One is about the transparency of prices (whether electricity or gas, wholesale and gas) and whether the markets reveal the 'real' price. But there is also the second concern at the *level* of prices, and whether they are either artificially high (as a result of internal selling from the vertically integrated generation arm to the supply arm, see below) or that they are higher than they might be were there greater competition and liquidity in the electricity markets. Ensuring transparency of prices is likely to help with the level of prices (through increasing competition and liquidity). Ofgem's latest actions are to increase auditor scrutiny; to undertake a transfer pricing review; and to establish greater insight into trading activities.

Arguably, this is not enough. To really increase liquidity supply and generation businesses need to be ring fenced; 100% of trades have to be external to generation and supply companies; all markets should publish all price and volume details; have an 'independent' market monitor; make sure transfer trading does not hide price or profits. There is also the much larger question

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[4] meaning that the output from the power plants changes depending on weather conditions and cannot be counted on to be dispatched when the system operator wants it
[5] Power is known as firm if it can be dispatched when the system operator wants it

of whether a 'Pool' or a Bilateral market is preferable, or even vital, to ensure transparency or liquidity.

Vertical Integration – bad for customers, new entrants and innovation

The rules of the bilateral electricity market (NETA and BETTA) encouraged the vertical integration (VI) of generation and supply companies. This was a response to mitigate the market risk of the bilateral electricity market and the potential high costs of being out of balance. Broadly this incentivises VI: meaning that customer demand of a supplier is matched to the generation owned by another subsidiary of the same parent company. The generator sells to a supplier – at an unknown price – and this also reduces liquidity in the market. Given that the energy suppliers do not want to lose market share, this means, at best, that (1) there is little (or no) incentive on the Big 6 to encourage their customers to be more engaged and proactive about their energy use. Arguably, it is positively not in their interest to get customers interested in their energy use in case those customers then leave them; and (2) they will not want their customers to use less energy partly because they want to sell as much as they can (ie maximise market share) but also because if they do not sell all their generation output to their customers, then they have to find other customers to use their generation capabilities and this will cost money.

This wish to match customer demand and supply has a number of knock-on effects. New entrant energy service companies (ESCOs) (whether generators, suppliers etc) can survive to the degree that they are able to attract/access customers to sell their products to. If an ESCO cannot access enough customers then they are unable to make enough money to survive as a business. Enabling access to customers is therefore vital, hence Ofgem's focus on retail market reform and 'switching' (see liquidity case study above). Thus, in a situation where all the large energy companies want to maximise their market share and want to match their generation to supply, there is a strong momentum to maintain the current system as it is, including keeping customers.

Interestingly, some of the smaller energy suppliers have developed new business models as a way to get round this conundrum. Good Energy, for example, has tried to match generation to its customer demand but rather than own the generation they are contracting with 'prosumers' or small, independent generators to buy their energy. GE now contracts with about 85% of the household, on-site photovoltaic producers. This also means that they have incentives to encourage a different type of customers. They want connected, engaged customers who both proactively 'switch' to them but who also think about where their energy is coming from. They provide newsletters and recently have offered a bond issue to access finance for investment in generation, which was oversubscribed within days. Even so, all the new entrant suppliers together only supply about 2% of the electricity market.

Codes and Licenses - Not Fit for Purpose

All electricity and gas actors sign up to Codes – there are 7 in all for electricity and generally electricity participants sign up to all of them. Uniform Network Code (UNC) is the Code users of the gas system are obliged to sign it. The Codes are the basis of the rules and incentives of all aspects of the energy system. Each code sets out the legally required behaviour within the area the Code is responsible for. In addition, actors require a License (for example, to operate, to supply etc) which tends to be more linked to general policy. Licenses require actors to sign up to a Code, and the Code sets out the detail of the behaviour. License and Codes are therefore entirely linked although the hierarchy of the two is unclear. As a right of joining a Code, for example the BSC, the signaturee has the right to change the Code via a Process set out in the Code, known as raising a Modification. This is known as a living rule. In effect, the incumbents are responsible for the operation of the network or the market (whichever Code) and this de facto enables incumbents to maintain their preferred rules and incentives.

Codes and Licenses are very complex. An illumination of this for electricity is: the Grid Code which National Grid and the users of the Transmission network are required to comply with; the CUSC is the framework for charging and connection to, and use of National Grids transmission system. The System Operator and Transmission Owner Code (STC) is the Code which governs the relationship between National Grid as a private company with its own incentives, and its System Operator (SO) arm which should act in the interests of the system. The Balancing and Settle Code oversees the rules of the market and the costs of day to day running of the transmission system. The BSC therefore interlinks with the STC because the BM works out how much has to be paid to keep the transmission system balanced and operating, and what the rules are for charging those payments. Ofgem then sets the incentives on the SO to manage the STC and BSC rules which are intended to incentivise the SO to operate the Grid efficiently. The Codes and Ofgem are therefore very interlinked.

At best, the Codes are fit for purpose for trivial change that few have an interest in. However, the Codes are not fit for purpose for significant changes because new modifications can be continually added thereby frustrating changes. A Code Governance Review in 2008 concluded that Codes were poor at enabling change. As a result of the Code Governance Review, Ofgem can now initiate a Significant Code Review (SCR) within a specific Code. While the SCR is open, other Code members cannot initiate / raise modifications. Project TransmiT was, for example, a SCR. Ofgem can raise a SGR but they cannot be sure they will get the outcome they want. Three SGRs have occurred in relation to transmission charging issues but none have led to change.

Thus, the process of change within the Codes is very slow and complex. Smaller companies have greater difficulties in being able to afford to keep an eye on all the Modifications to the Codes. Moreover, the remit of the Panels which oversee the process is also not keeping up with the technological and operational needs of the system. For example, the BSC Panel is meant to oversee industry markets. As technologies develop and change, eg smart meters and FITs, there should be synergies of data to enable better use of markets but also to keep costs down. The remit of the Panel does not allow this and changing the Panel remit requires Secondary Legislation.

The supplier hub model – excludes embedded generation

The GB electricity and gas system was very distributed until just after the World War 2 when all companies were nationalised into the CEGB or the Gas Board. Nuclear power and large coal electricity plants dominated the electricity supply industry for the next 40 or so years; and coal was the main source of gas until the 1960s. The electricity system was made up of a very few electricity power plants which injected generation into the transmission grid and then distributed it in one direction to customers via the distribution network.

At privatisation of gas in 1986 and electricity in 1990, a supplier hub model was introduced whereby the costs of transmitting, distributing and balancing the system were paid for by customers and then distributed back to the relevant company by the distributor, and then supplier when they were put in place. However, any distributed gas or electricity generation injected into the distribution networks was considered to be ‘negative demand’. This is still how embedded generation (and now embedded gas) is thought of in relation to the pricing of our energy.

For example, if a supplier needs 100 MWh of electricity in any one half hour, and has contracted for 10 MWh of Embedded Generation, they will buy 90 MWh via the electricity market. Embedded generation avoids paying various costs and these are known as embedded benefits yet all embedded benefits flow to the supplier rather than to the embedded generator. This is because the embedded generation which avoids certain system costs has never been routed back to the embedded generator in the supplier hub model. The supplier is not required to pass the benefits back to the embedded generator. Similarly, customers should not have to pay these costs if they were buying embedded generation and yet there is no differentiation in bills from distributed versus centralised energy.

It has taken years of arguments between Ofgem, generators and suppliers about this but the division of embedded benefits is still not 'institutionalised' in regulation. It is now accepted that a supplier should negotiate with generators so that the latter receives a division of the embedded benefits. Some smaller suppliers are absolutely fair about this but there is no set agreement and the independent generators are in a very weak position vis a vis suppliers which are buying their product.

Conclusion of Governance Case Studies

From these case studies, it can be seen that current governance is not on producing vibrant customer and demand focussed innovation. Unfortunately, governance of the British energy system appears locked in to a top-down, non-transparent system which favours incumbents and the status quo:

- where genuine oversight and transparency of Government decision making is limited (ie who is involved, who exerts what influence, evidence of how decisions were made, how much money do companies make etc);
- similarly, where transparency and oversight of decisions by the Regulator (and regulation) is process orientated and while set up to be transparent is, de facto, supportive of incumbents;
- where a new, clear process for accessing and applying the rapidly changing information about technological, integration and infrastructural economics and possibilities is lacking;
- where regulation across energy is not playing the role it could. For example, (i) it is relatively poor compared to other countries in some aspects, for example, building regulations; skills development etc, (ii) it is not keeping up with the huge technological, operational, and design changes happening within energy infrastructure, or current thinking (ie energy, waste and water overlaps); (iii) the rules and incentives in place maintain the current system and are not changing quickly enough to enable a transformation to a sustainable and secure system; and (iv) potential conflicts of interest in energy system transformation remain without wider discussion (ie National Grid as private, transmission company and system operator).

5. The Background Thinking to IGov – the challenges

IGov came into being because (1) while it is clear that a transition to a sustainable energy system is central to climate change mitigation, change within the energy system is slow in Britain, as shown by the case studies above; and (2) as some countries have increased their variable electricity proportions, technological and operational costs have dropped and system operational needs have become clearer, far quicker than expected. Whilst good in terms of displacing dirty electricity and in reducing costs to consumers, a number of challenges have become apparent: an undermining of the marginal cost way of pricing energy; concerns about stranded assets; concerns about security as a result of reduced investment; increasing needs for demand flexibility to match supply uncertainty. Getting the governance policies right to

enable a secure continuation of power plants which are wanted while not overpaying for those which are unwanted is at the heart of Governments decision-making concerns.
These challenges tend to relate to low carbon policies and increased variable power. Much has been written about the theoretical concerns of adding renewable electricity to the energy system. Most of that literature has been overly negative and/or conservative about the consequences, meaning that the costs to the system of greater levels of variable renewable power has been overestimated (as shown by eg Milligan, 2010; SSREN, Ch. 8, 2011; Borggrefe and Neuhoff, 2011; IEA, 2011). However, evidence from electricity systems where there is a high proportion of variable renewable electricity has shown that there are three serious market or operational challenges.

Hitherto, most electricity systems incorporate markets which are based on marginal cost pricing. A market operator via an algorithm takes the cheapest offer for a volume of generation first[6], and then the next lowest offer is taken and so on until there is enough generation to meet demand for any particular time period (for example, every half hour though out a day)[7]. The price of the last kWh of electricity supplied becomes the price paid for all generation bought in that half hour – marginal cost pricing. In this system, demand changes over the day in different half - hour slots and so the marginal cost of electricity changes over the day. Periods of greater demand lead to higher marginal prices than periods of low demand. The economics of electricity power plants has been based on the average of all these prices covering the total cost of the power plant, even if some power plants generate most of the time (base load) or for only some of the time (peak load).

This basic building block of conventional electricity economics is undermined by the combination of zero marginal cost renewable electricity and low marginal cost nuclear power. This electricity effectively increases supply and shifts the supply curve to the right bringing down both average and peak prices (Bauknecht et al, 2013; Cochran et al, 2013). An increasing share of nuclear power and renewable electricity in the absence of increased demand means that conventional generators will be displaced more often by low or zero marginal cost sources and sell electricity at lower prices when they are selected – and they therefore will run at lower and less predictable capacity factors and therefore earn less revenue.

This is a general result of increased low carbon electricity capacity without a matching increase in demand which, on the whole, is the intention of low carbon energy policies. There are only a few countries where there is sufficient low or zero marginal cost plant deployed to really make a

[6] This is necessarily rather simplistic and generalised.
[7] This can vary, see Table 1.

difference to electricity prices – and this is primarily in Denmark and Germany. Nevertheless, other electricity system stakeholders, including fossil generators, are watching the impacts with interest (Business Week, 2014).

It is also to be expected that the period of transition from a high to a low carbon energy system has winners and losers. However, appropriate electricity market design can both make this transition easier for those power plants finding themselves 'out of the money' and cheaper for customers which have to pay for it (Bauknecht et al, 2013). Closing a fossil fuel plant may be the economic answer if its average costs are greater than average revenues. However, it is not necessarily in the interests of the electricity system for fossil power plants to close. An electricity system may not use generation from the power plant often, but it may be very important for a few hours a year. Moreover, large amounts of variable power requires flexible reserve capacity and so efforts are being made to keep capacity on the system until such a time that it 'naturally' retires; until new forms of cheaper, cleaner, more flexible capacity comes on line; or as a way to manage the electricity system securely.

Thus, a growing challenge, and a side product of the move to lower carbon generation, is that of 'missing money' and what to do about it (Joskow, 2008). As said above, the price paid for electricity is, typically, no higher than the marginal cost of operation of the highest cost production, particularly if there is an electricity price cap (eg the Australian market NEM has a rule which set a maximum market price cap of AUD$13,100/MWh for the 2013-2014 financial year). This means that the highest cost producers which may be needed in periods of high electricity demand may not receive enough revenue to recover their fixed costs. Over time, this missing money may lead to generation being taken off line or reduce the incentive to invest in new electricity capacity. Furthermore, as more countries have targets for low carbon or renewable electricity, the investment risk in fossil generation is increasing. An investor in a fossil power plant has to be confident that they can sell their power plant output for enough years at a sufficient price to make their investment worthwhile.

As more and more low carbon or variable renewable power comes on the system, so there is less and less market demand to be met by fossil generation and the average system marginal cost may fall. The availability of flexible capacity and suitable ancillary services becomes more important in systems with high proportions of variable power in order to complement the uncertain output. This suits gas power plants because of their flexible capabilities, but less so coal or nuclear because of their ramping abilities (Keay Bright, 2013). There are therefore concerns that insufficient investment will come forward to provide the 'right' type of capacity and capabilities for a secure electricity system (Gottstein and Skillings, 2011; Hogan, 2012; Baker and Gottstein, 2013; Keay-Bright, 2013).

Finally, conventional electricity systems balance *uncertain* demand (ie customers around the system turning their lights, appliances and load requirements on and off, for example electric trains stopping and starting etc) which has certain regular characteristics from day to day with *certain* supply to match it (supply from firm, dispatchable coal, gas and nuclear power plants). As greater proportions of variable power are introduced into the electricity system, the system operator and/or balancer has to balance the uncertain demand with more uncertain supply. This is a fundamental change in the operation of the electricity system, and has major knock-on effects for the economics of energy. One way to respond to this is to make the demand side more flexible by a greater use of storage and demand side response mechanisms in markets, including load shifting via smart grids. While demand may be hard to predict, variable power is harder so trying to make demand more flexible is helpful, and also (once appropriate market rules are established) has many operational and economic benefits (Milligan and Kirby, 2010; Cochran et al, 2013; Miller et al, 2013; Reisz et al, 2013, Weber, 2010; Hurley, et al, 2013). There are still very few countries which operate markets to match supply and demand by changing demand, with the Pennsylvania, New Jersey and Massachusetts (PJM) market possibly the best known example. This new approach is sometimes called a demand-focused electricity system.

Thus, there are significant issues about how to ensure adequate, flexible capacity. Paying for inflexible capacity which does not help these challenges; or paying to keep on capacity which is unnescessary would be undermining policy goals. However, seeing flexible power plants close down because they cannot cover their costs is also unhelpful for the move to a sustainable future.

Incentives and rules to reduce carbon; to refocus on the demand side; to enable sufficient change; and the ‘right’ change is essential. The governance (or decision-making) process within energy systems has to be able to do this, and as the case studies have shown this is not currently the case in the UK.

6. The background thinking to IGov – Governance issues

The IGov hypothesis for the rate of or lack of innovation is related to the governance of the energy system. It seemed important to us that the impact of governance was explored more fully than has occurred in the academic literature to date.

The history of EP anywhere illuminates how deeply ‘political’ in a broad sense energy policy is.

Different fuel and technology pathway choices have very different distributional impacts on society. For example, a nuclear pathway has a particular supply chain and skill set requirement. A technology pathway of renewable energy, energy efficiency and natural gas – the 'cliched' alternative to a nuclear future - will have a different technology supply chain and skill set. Choosing one or the other pathway will lead to different societal impacts as different amounts of money is spent on the different supply chains; as different amounts of money filters down to the economy in Britain versus overseas; as different jobs are created and lost; as different spatial and local effects occur and so on. Moreover, different pathways affect the incumbents differently, and on the whole the incumbent supply chain suppliers have more influence than those trying to alter the system. This means that there is a huge set of lobbies in place all jostling to get 'their' preferred technology pathway maintained or implemented which are is not necessarily in the best interests of society.

While there has been a great deal of thinking about the various technological pathways to any given carbon future, there has been too little thinking about the governance framework which delivers both society's interests and energy practice transitions. Governance is a social construct: it does not just 'happen' to a society. One governance process will lead to a different outcome to another governance process. An appropriate governance process for a low demand sustainable energy economy is required and the constituents of this are not well understood. Nor is the cost effectiveness of different governance structures understood, which in turn means that the impacts of different governance structures on affordability issues are also under-examined. These are all issues which IGov wishes to examine.

Given this situation, IGov's overarching hypothesis is that governance is a central contributing factor to the success or failure of a country moving to a low demand sustainable economy. In addition, IGov has developed a number of sub-hypotheses based on the Case Studies provided in Section 4 which argue that the construction of a governance system will be more successful if:

- Firstly, institutional arrangements that are more inclusive are more condusive to innovation than those which are exclusive (discussed as a case study in Section below).
- Secondly, that new practices and outcomes for a sustainable future are delivered if the policy paradigm is consistent with, and gives strong value to, sustainability.
- Thirdly, the presence of a strong and deep knowledge base enables the effective delivery of sustainable practices and outcomes.
- Fourthly, ultimately, the practices and outcomes of the energy system will change in the direction of sustainable energy if (1) there are opportunities to capture flows of revenue for new practices which are greater than the costs which arise (2) if the impacts of the risks of moving in that direction is mitigated in ways which does not negatively affect the risk reward ratio of those revenues to costs (3) if that risk reward ratio of investment is greater than can be achieved elsewhere and (4) if that risk reward ratio fits with the required timescales of investors including shareholders.

- Fifth, if successful delivery of sustainable energy practices and outcomes is to occur, opportunities for revenue need to be sufficient to attract investors but not too great to impose unacceptable costs on different user groups.
- Sixth, the nature of the transition to a sustainable future will be related to the historical and available resources of that country.
- Seventh, the delivery of a substantial political change (or paradigm shift) over a short period of time will need to be linked to a crisis and/or sufficient new opportunities which is framed in such a way to have resonance with, and to be acceptable to, enough stakeholders.
- Eighth and finally, recognising and valuing additional impacts of policy to society are an important aspect of building committed stakeholders.

7. Possible Hallmarks of a Governance System which Encourages Innovation and Change

This section sets out a number of possible high level hallmarks of an energy system which encourages innovation and change: inclusive rather than exclusive governance; clarity in governance of who or what is in charge; a governance system which is open to learning; a governance process which tracks and incorporates change; a governance process which is able to value broader benefits and costs of different technology pathways than simply static costs. These suggestions are derived from the IGov hypotheses in Section 6 above, in turn derived from the Case Studies.

Table 1 at the end of this note sets out the possible characteristics of an innovative energy system. It does this from two perspectives: firstly, with respect to the current energy system; and secondly, it sets out the type of characteristics which may better suit an energy system capable of change to meet the various challenges it faces. This is undertaken in relation to its institutions, the political paradigm, the corporate-state relationships, the Regulator Ofgem, electoral policies, the place of local authorities; and the type of relationship consumers have with their energy use and their providers.

Table 1 aims to encourage debate about what a successful sustainable energy system might look like. Each of the countries or States that IGov is reviewing has a different energy system model, including different regulatory system and different cultural and customer perspectives on energy, often derived from the type of natural energy resources in place in a country. IGov research expects to note the interesting governance points of each country or State but it also wants to make sure that it has covered similar areas and these are the broad areas set out in Table 1.

The issues set out in Table 1, nor the ideas discussed further below, are set in stone. IGov research may highlight more salient factors and/or get rid of some of them.

Inclusive rather than Exclusive Governance

Governance rules and incentives can be established to ensure 'inclusivity', meaning that they are setup in such a way that they are open to all. The case of the feed in tariff in Germany is an example of an inclusive mechanism because it guaranties a price to be paid for all renewable output. It takes away the risk from the provider and places it elsewhere. Rules and incentives can also be established to be 'exclusive', meaning that they are set up to be eligible for a few; or 'de facto exclusive', meaning that although in theory they may be inclusive to all, in practice because of transaction costs and so on they are in practice exclusive. The renewable obligation in Britain is an example of an exclusive policy because the obligation is on electricity suppliers of above a certain size and they are allowed to set the details of their contracts. Electricity market rules in Britain are de facto exclusive, as are the Codes and Licenses overseen by Ofgem the Regulator.

Exclusivity makes it much easier for the few which benefit from those rules and incentives to prosper, and it makes it much harder for those which do benefit from those rules and incentives to develop.

Clarity within Governance of Who or What is in Charge

Energy policy is political (See Kuzemko, 2013 and 2014). The distributional impacts on society of different energy policies can have major impacts on society. The chain of command and responsibility for energy policy decisions is often not obvious and a clear governance process is needed for potentially society-changing EP decisions so that responsibility is transparent and decision-making is legitimate.

The current British electricity system is made up of (for electricity) generators, a transmission network, distribution networks, suppliers and customers of different types; and this is regulated by a regulator, Ofgem, who oversees all Codes and Licenses. The system is operated by National Grid, which is a privatised company but which is said to have separation between its private company and its system operator function. The gas system is similar but instead of generators there are shippers. New entrant gas (usually biogas) providers should be able to connect to gas distribution networks in parallel ways to distributed generators.

Whilst gas market rules are different from the electricity sector, the regulation of them is also by Ofgem via parallel Codes and Licenses. The monopoly segments are the networks but Ofgem also regulates for competition in the competitive functions of electricity generation/gas shipping and markets, including retail competition at the household level. Ofgem itself works to Duties set by Government, and helped by Guidance from Government.

The Department of Energy and Climate Change is the Ministry responsible for energy and climate change and has a Secretary of State for Energy and Climate Change, although many other important energy functions are elsewhere. For example, transport has its own Ministry – the Department of Transport; similarly buildings – a key user of energy – and building regulations is in the Department for Communities and Local Government. The current Energy Minister is also Minister of Construction – which should be useful - but is not based in DECC but in the Department of Business, Innovation and Skills.

Inter-departmental governance is therefore complex, as is the governance between Government and the Regulator. Moreover, the governance process behind the technical aspects of energy system operation are also complex – such as ensuring security of supply. Because of the complexity of EP; because of its political nature; and because of the huge societal impacts of EP there needs to be clarity on who or what has responsibility for the different steps in energy system transition. IGov will investigate how this issue is dealt with in other countries, and the pro's and con's of those models.

Learning from the myriad regulatory and market systems around the world

The British energy system structure however is just one of myriad different models around the world. A central aim of IGov is to learn from these different governance structures which seems best able to deliver a sustainable economy.

If we look at Denmark, a country which has increased low carbon generation and the energy efficiency of the economy, we can see vibrant new entrants to generation of electricity and vibrant new entrants to retail supply; a complex mix of public and private companies; an independent system operator which is responsible for the energy transition; and a regulator, which is only responsible for executive regulation and certain economic analyses. The Danish electricity market is embedded in Nordpool, a multi-country electricity market, and Denmark is one of the most interconnected of all European countries – including using its offshore wind farms as part of an interconnected system. It has an integrated heat, electricity and transport system. Markets and strategic regulations co-exist efficiently together. Loans for energy efficiency are easily and cheaply available from local banks, underwritten by central government. Other countries, such as Greece, have one State energy supplier which supplies 100 per cent of the retail market, and is regulated in a cost plus manner, as also occurs in some US States.

We can, and should, learn from experience of other countries. Answering questions (such as the place of centralised versus decentralised systems in undertaking a transition; the benefits of institutionalised inclusivity of governance rather than exclusive governance; the trade-offs between top down and bottom up decision-making; the relative merits of markets versus regulation for different outcomes; the value of integration; what to do about 'losers' in the transformation) can be helped by experience elsewhere. Similarly, experience of energy system structure and the value of different components can also be useful. For example, whether competitive or regulated retail markets are helpful; whether an independent system operator is important; what Duties and reach for energy regulators have been found to be helpful; what rules for energy markets increases new entrants or demand side take – up? These are all questions many countries around the world are grappling with and which we in Britain can learn from.

Implementing a governance system which tracks change and is flexible to changing situation

A 'learning' country would have a process in place to be able to (1) keep track of change and momentum of ideas, but (2) also could then feed it in to decision-making – whether Government (of any level) or the Regulator. A case study above examined Codes and Licenses which are overseen by the Regulator. A Review of them in 2008 (The Code Governance Review) concluded that they were not fit for purpose. Having a process which ensures keeping up to date on evidence and data changes – whether best practice policies, institutions, economics and so on - is vital for three reasons:

- Firstly, it allows us to 'learn', which might lead to a beneficial impact.
- Secondly, not only does it allows us to keep track of change but it also illuminates how long change takes, which is not necessarily a long time. Change in the current energy system is speeding up rapidly in some countries, particularly Germany and Denmark. The 'new' component of the energy system which is delivering the change is the combination of communication and information technology applied to the operation of the energy system; more efficient renewable energy technologies; and the rapid inclusion of new investors in new business models. Together this fundamentally questions the conventional wisdom on 'best' energy industry structure, and its economics. By default, these changes are having impacts on Britain.
- Thirdly, because of the rapidity of change, it is essential to have an options based, flexible decision-making process to incorporate technological or economic changes.

Connecting Society to Energy Policy: the ability to value the whole system costs and benefits to society of different technology pathways

It is becoming clear from the evidence of transition in other countries such as Denmark, Germany and Austria, that the distributional costs and impacts of it are extremely important, but can be significantly ameliorated by the extent to which society and stakeholders are engaged with the policy. If this is the case, then it implies that decision-makers need to understand (1) policies from the perspective of long term interests of society; (2) what policies result in practice change, but also (3) which policies are more successful in connecting society to energy use.

Society is, and customers are, currently, a largely passive recipient of energy, in part due to the rules and incentives within the energy system. As one of the case studies in the section below shows, the risk created from different electricity market structures influences how energy suppliers interact with their customers. Governance therefore clearly has an important role in changing the historical 'passive' customer relationship to one that is more active.

One example of this relates to a centralised versus decentralised energy system. There is a rapid change of economics of energy – where system rules and incentives allow it – which favours a more more decentralised energy system. This raises a number of questions for IGov: (1)) is the decision-making process in Britain capable of valuing the different technological futures in front of us, from a wholistic society's perspective?; and (2) is Britain's governance flexible enough to enable the new economics to come through without unnecessary stranded costs, and if not why not?

Traditionally, cost benefit analyses have worked out the cost of one policy instrument or the sum of a number of policy instruments. Usually, these are static evaluations meaning that the absolute cost of a policy is calculated. For example, the cost of deploying X amount of wind power relative to Y amount of photovoltaics. It is rare for cost benefit analyses to estimate dynamic costs and benefits – meaning the value of structural change which takes into account wider effects of the policy instrument, and even rarer calculate this from evidence ie from practice change. Finally, it is extremely rare to assess the value of policies or policy instruments to society as a whole, and over the long term, and in relation to practice change.

Ability of the Governance structure to neutralise losers in a Sustainable Energy Transition

The energiewende in Germany and the changes in Denmark are throwing up important questions about (1) whether governance can manage energy system change so that no particular stakeholder loses out significantly or (2) whether such a socio-techno-economic change driven by a time imperative, as carbon emission reduction is, inherently has losers to match the winners for society? So far, from the Germany experience, it would seem that the latter is the case. Greater understanding is needed to what extent this can, or should, be avoided or neutralised.

The structural change of an economy will always have winners and losers. Energy system transition began because of the needs of climate change and global oil depletion but has recently taken on a momentum of its own because of the changing economics of new technologies and system operation. The jury is still out on whether energy is undergoing a transformation like the telecoms and media sectors, as a result of information and communication technology. IGov certainly thinks this is the case. Managing the change from one system to another is fraught with difficulties but a country cannot endeavour to maintain an 'old' system without very serious negative economics impacts at some point.

8. Conclusion

This Working Paper has described a number of governance issues in Britain. It then put forward a number of characteristics which seem to be desirable in an energy system which is attempting to transform into being low carbon; low energy demand; and capable of innovation and change to enable that to happen. It is posited that governance is central to creating this desirable energy system. It is unclear whether the level of practice change necessary to reach an 80% cut in carbon by 2050 from 1990 levels can be reached in an evolutionary manner or whether it, inherently, has to be revolutionary. It seems likely that the way a Government deals with the 'losers' of energy system change is at the heart of issues around energy system transition, and whether it occurs or not.

Table 1 Possible Hallmarks of a Governance System Which Encourage Practice Change

	What we have	**Possible hallmarks of a governance system which encourages change**
Energy system characteristics		
	Captive customers	Active, connected customers able to make informed choice if they wish to
	Customers pay	Much more involvement / information for customers in energy decision-making; ensuring vulnerable or fuel poor customers are targeted for support
	Few and inflexible electricity generating technologies	Multiple technologies of all scales across supply, control and demand
	'Fit and forget' 'Predict and provide' mentality of electricity system	Stretch and Transform (Ravn and Smith, 2013)
	Selling	First focus on demand side
	Economics of scale	Include, economies of scope and system as well as scale through integration

Institutional (general)		
	Policies designed to mimic market principles and interfere as little as possible	Policies designed to be pragmatic, reduce risk for society benefit, and enable practice change
	Ideological support for market principles can increase policy costs and reduce success; minimises beneficial state support / financing for innovations	Clarity of responsibilities need to be established, recognising energy is 'political' and it should be politicians who make the big decisions which affect distributional impacts on society, from technological choice
	Short term decisions over longer term leads to fragmented actions and marginal change and mitigates against stronger co-ordination and non-marginal change	Needs clear, transparent decision-making process to be holistic, long term and firmly focussed on good of society rather than narrow business interests
Political		
	Disbanding Dept of Energy and creation of independent regulator has meant that technological decisions and perspective has dominated	DECC is a good combination but needs to be expanded to include transport, buildings and skills to become a big hitter. Nuclear waste responsibilities need to be sent elsewhere.
		Institutions overseeing energy to be re-evaluated (see below) but Regulator should not be responsible for such momentous decisions for society – needs an overarching, more accountable body
	Hollowing out of expertise has allowed secondees from incumbents; reduces civil service ability to advise; capacity too small to be able to undertake a 'mission' orientated, active policy other than in narrow sense, ie in situation where all effort was spent on supporting one dimension (in British driven by desire for nuclear power)	Civil servants need more experience and more focus on pragmatic, 'stretch and transform' holistic energy policy decision-making rather than current silo-thinking
Corporate – state reliance		
	Short term focus on shareholder dividends / profits	Profits/shareholder dividends sometimes right but in context of corporate responsibility and more justification to shareholder of longer term goals; also state or non-profit companies appropriate too in such situations ie System Operator
	Market concentration and large powerful incumbents who co-ordinate to strengthen barriers to entry for new entrants – mitigating against innovation / change	Need inclusive policies across board – whether Government or Regulator - to enable new entrants and new business models.
	Focus on big companies as a means to	Focus broadened to range of companies and

	reduce political risk	social innovation; understanding of value to society
Institutional (Regulator)		
	Duties too broad allowing Ofgem too much leeway in their interpretation of them; no incentive on them to deliver transition; too econ / techno viewpoint	Regulator needs new remit (aims, incentives, mission statement), relationships and reach; subsidiary to a new organisation which takes responsibility for energy policy.
	Culture dominated by economic thinking	Culture to be pragmatic, society and energy efficiency orientated
	Them (Government) and Us mentality	More consensual; reaching for answers; less technocratic and legal
	System operator; networks privatised dampening disruptive technologies / controlling operation and design .	Independent system operator more similar to (possibly) Danish model, and tasked to enable transformation by a certain time. Ofgem's role reduced.
	Market lacks transparency, incentivises VI, and too high transaction costs of new entrants	More market transparency and easier entrance by smaller / new entrants
	Codes, Licenses and RIIO all make change harder or against incentives	Codes and Licence change process to be overhauled.
	Too linked to incumbents; consultations and way of thinking exclusive	Inclusivity and society's interests broadened beyond price
	Parochial to Britain – not open enough to models and best practice in other countries	Process to keep track of economics, operation and management change, best practice
Electoral Policies		
	Historical depolitisation of energy via lack of transparency and debate	Increased energy literacy via concerted effort of Government, companies, regulator and inclusive policies enables greater involvement of wider group of people
	Central decision-making, often poorly communicated exacerbates individual distance from energy; passivity etc	More decentralised and transparent decision-making
	Liberalised market economy	Coordinated market economy
Local Authorities		
	Minimal involvement	Could be vibrant and helpful stakeholder in energy efficiency, fuel poverty reduction, connecting consumers to energy
Consumers		
	Passive householders, those who pay	Need to be central to debate about transformation; active, connected if want to be
		Living in energy efficient homes and surrounded

		by energy efficient public buildings which lead by example
	Industry, commercial and SMEs involved via price; Carbon Trust trying to improve their energy efficiency	Industry, commercial and SMEs need to have more encouragement and support to become more energy efficient

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Annex 1 A brief introduction to how the electricity system works

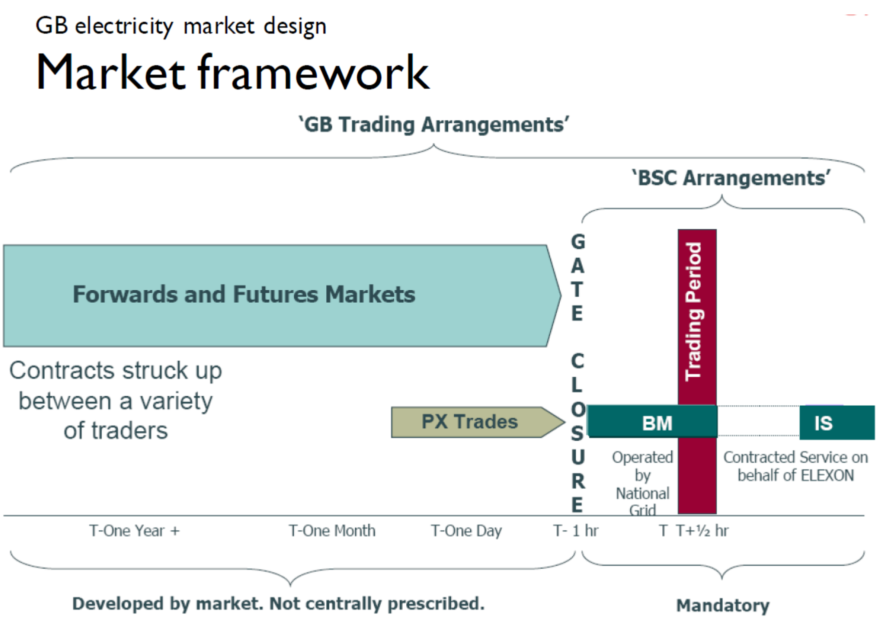
There is very confusing vocabulary about electricity markets – often because different countries have different terms for the same thing. The wholesale market for electricity is an overarching term which is used to describe all the various markets where wholesale electricity can be bought and sold, whether in the short term through to the far future. Moreover, electricity can be bought and sold in many situations and these are variously called markets, platforms, exchanges and mechanisms. It is therefore very important when talking about electricity markets, that discussion is kept very specific and not in generalities.

All generators have to sell electricity in 'real time' when the physical generation is linked with the technical operating requirements of the network. Other names for 'real-time' markets tend to be 'spot', or 'clearing', but even these terms can differ between countries. For example, in Nordpool – the Northern European electricity market – the one day ahead market is called the 'spot' market. Most countries have at least two markets, this 'real-time' market and the day ahead market. However, countries with actively traded electricity tend to have a real time market; multiple forward markets (ie markets which sell electricity at any point in the future ie for a day ahead, a week, month, year, 2 years ahead etc); and intraday markets.

These forward markets can either by physically based – meaning that their bids and sales end up being related to physical electricity – or they can be financially based – which means that they are essentially financial instruments to hedge the price of the physical electricity that generators and suppliers have bought and sold. These financial instruments do not finally trade out to physical electricity but to money lost or gained. These forward markets can be traded in directly from a company's trading arm (which will have paid to be a member of the market) or they can be accessed via a platform (which the company will also have paid to access). A company like Bloomberg has a platform through which electricity trades can be made in many different markets around the world, whether physical or financial. Moreover, as already alluded to, electricity markets are not necessarily country or State based. So for example, Nordpool includes Denmark, Sweden, Finland, Norway, Lithuania and Estonia and parts of Germany. The Central Western European Pool (CEWP) includes Austria, Belgium, France, the Netherlands, Switzerland (Europa, 2013).

Markets can also be 'mandatory' – ie where all participants who want to sell electricity in a country are required to sell through them – although there are many different versions of how this is set up; or they can be 'voluntary'. Voluntary markets tend to refer to forward markets where participants can choose to participate in them. Similarly, a 'gross' market indicates that all physical generation of an electricity system has to be bought and sold through them at a certain time, whereas a 'net' market indicates that not all generation has to go through them, as with the UK's Balancing Mechanism (and the reason why it is called a mechanism not a market!) where only the balancing portion of the electricity is traded. The latter is a bilateral, net, mandatory market. The buying and selling takes place between two parties. The generator or buyer has to tell the BM market operator (Elexon) what their contracted agreement is and what they want physically to buy and sell to get themselves in balance with that agreement and they have to tell National Grid (the system operator) what their actual output is going to be at gate closure (just before real time) relative to that contracted agreement.

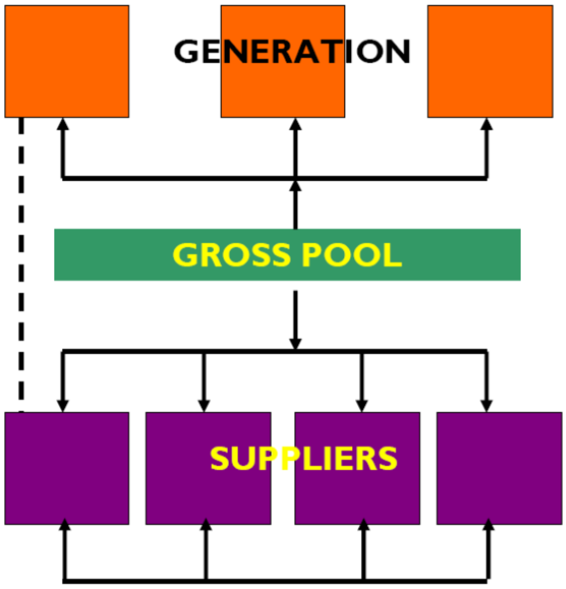
Figure 3 The Bilateral Market in Great Britain
Source: Cornwall Energy



A 'pool' real-time market is where generation volume is offered to, and demand volume is bid from, a central operating body at certain prices. These markets tend to be 'gross' , 'mandatory' and physical.

Figure 4 A conceptual Model of a Pool Electricity Market[8]

Source: Cornwall Energy



Electricity has to be balanced in a moment to moment way, and response capability is divided into primary (30 seconds to 15 minutes); secondary (within 5 minutes) and tertiary (15 minutes to an hour) response (Boggrefe and Neuhoff, 2011). The balancing of the system is done via a combination of a market operator (ie the balancer in a balancing market or mechanism (BM)) and a system operator. These two functions are usually separate but they can be combined together. This balancing occurs in 'real time' in all types of electricity markets, whatever their details. All BMs require generators to notify the BM market operator of their output for a balancing period (and this is made legal through Codes and Licenses of that country), and are therefore mandatory.

Buying and selling electricity is a central part of the electricity business. Generators can sell into the future and buyers can buy ahead. Gradually time moves on to catch up with these forward trades, and the BM market operator balances all of the contracts for selling and buying electricity in one particular period of time – whether they were originally traded for a day ahead or two years ahead. Electricity participants tell the market operator and / or the system operator (depending on country) what their 'actual' position is at gate closure relative to their contracted

[8] The dashed line from generators to suppliers indicates the potential for Contract for Difference type contracts around the electricity price

position. Electricity system rules differ but in the UK, Gate Closure is 30 minutes ahead of 'real time'. And 'real time' is when scheduling occurs (in other words, when the decision of what generation to bring on line, take off is implemented). These intervals can also differ between countries (see Table 1).

The point to understand in electricity system operation is that the sale of physical electricity happens in a market at a snapshot, real-time moment after gate closure. Choice of these set times to 'clear' the market are necessary to reconcile trades, to establish 'system' costs of operating and managing the electricity system, and to establish electricity prices. The reality is that the electricity system is being managed all the time in a second by second manner by the system operator so that the voltage / frequency etc is at the right levels. This electricity system management is continuous but , in effect, the real time market, which occurs every half hour, hour etc, is superimposed on that technical requirement. The linking of the contracted positions from all the trades occurs when the market bids and offers in the 'real time' market are reconciled by an algorithm, and it is from this algorithm that the 'price' of electricity is established for this period of time. The algorithm decides which generation from which generator at which price should be taken first, and so on until generation matches the required demand of that time period (discussed in more detail below).

Buyers and sellers of electricity need to make sure that whatever contracted position they have made (in whatever futures market and/or with whatever bilateral contracts) 'unwinds' in such a way that they are in balance (ie buying and selling what they are contracted to do) and that they have not lost money in that process (ie for example, if they sold at £6/MWh for a certain amount in the future, it would not be good if all they could buy to balance that amount when that time period finally arrives was at £8/MWh). Buyers and sellers use various forward or intraday electricity markets to balance their contracted positions. It is therefore important that markets are 'liquid' meaning that there is enough electricity for sale for different time periods and in different 'clip sizes' to enable the buyers and sellers to match their needs.

The needs of different generators will differ. Generators of variable[9] power require liquid markets far more than generators of firm[10] power because they are more uncertain about what their actual output will be at any one time. Smaller generators need access to smaller 'clip sizes' and markets which don't have large up front transactions costs for users. Limited liquidity works to the advantage of incumbents because it adds risk for potential new entrants.

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[9] meaning that the output from the power plants changes depending on weather conditions and cannot be counted on to be dispatched when the system operator wants it

[10] Power is known as firm if it can be dispatched when the system operator wants it

However, for fossil generators in a market with increasing amounts of low marginal cost carbon and / or zero marginal cost variable power, they have to ensure that they do not find themselves too expensive for a particular time period (known as being ‘out of the money’, and discussed further below). For example, they could have sold their physical generation for a certain time in a forward market at a certain price, say £8/MWh. When the time comes for their physical generation to be provided, the balancing market might clear at £6p/MWh. This would mean that the generators output would not be chosen by the algorithm, even though they had sold in the forward market. In this situation, the generator would be required to buy cheaper generation through the ‘real time’ balancing market to cover their contracted position. This means that the generator would be losing around £2/MWh, and if this happened too often it would cause their average revenues to drop below their average costs, and at that point it may be in their interest to cease generation.