Energy governance and regulation frameworks - time for a change?

A paper for the ETI

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1. Introduction

In March 2015 the ETI published its Patchwork and Clockwork scenarios as part of the "Options Choices Actions" report[1]. Following on from this, it has postulated that there is potential for significant economic advantage in reforming the broad governance and regulatory frameworks for energy network infrastructure as part of the transition to a decarbonised energy system.

This paper explores some of the potential drivers for change, particularly with regard to the energy networks. They must play a big part in the large scale transition that the energy system is facing, but are also very dependent on decision making in this wider system.

For any modifications to be worthwhile, they must be justified by improved outcomes and/or costs when compared to the status quo. The paper selects some illustrative examples of issues which could support the hypothesis that a new framework should be considered, and analyses the potential impacts in terms of both physical delivery and economics.

Chapter 2 starts by looking at the process of decision making, analysing what has worked successfully in the past in the UK and in other countries, and how lessons can be learnt from this about how to develop and enable decarbonisation at a requisite scale and pace while at the same time minimising the cost.

Chapter 3 looks at the existing energy system and some of its key underlying characteristics. It shows how it is necessary to fully understand how these underpin the current energy system and operate across the three main sectors – heat, transport and electricity - before designing the new one and defining what must be created, recreated, changed or enhanced to deliver it. As well as looking at the final destination, it also considers some of the critical challenges that will arise during the transition, and whether these might influence the choice of that ultimate end point.

Chapter 4 focusses on some of the values and costs associated with the energy system, its different component parts and the services provided by it, and how these could be better reflected in market pricing and/or regulatory incentive structures in the future.

Chapter 5 examines the different roles that could be played by a variety of players in the public and private sectors, both with regard to decision making and delivery. It considers where and how the benefits of competition can best be employed.

Chapter 6 analyses the issues raised, discusses a potential option and looks at how changes to governance, regulation and market structures could be delivered.

[1] www.eti.co.uk/wp-content/uploads/2015/02/Options-Choices-Actions-Hyperlinked-Version-for-Digital.pdf

2. Energy system decision making and governance

Achieving the changes that are needed to decarbonise the energy system on the scale envisaged will be a massive task over not only years, but decades. As well as being dependent on new ways to produce and use energy, delivering on the objectives will require significant changes to existing network infrastructure (electricity and gas, transmission and distribution) as well as the development of new ones (e.g. vehicle charging and refuelling, district heating and CO2 transportation). The important role of networks was highlighted by the European Commission[2] which estimated that, of the €1 trillion investment needed in the EU energy system to 2020, €600 million would be for networks, with two thirds of this in distribution.

For this long term process to be successful, it will be important to learn from the past and to determine which approaches to decision making worked well and which did not, in order to guide how this can best be structured in the future to effect the necessary changes, in particular for the network elements.

2.1 Historic drivers of energy system change

2.1.1 Geo-politics

Some of the biggest changes to the energy system have arisen through 'uncontrollable' major geo-political events and 'shocks', e.g. wars in the Middle East, tensions in Eastern Europe and accidents like Fukishima.

These have significantly changed the availability or cost of energy sources as well as impacted on their public acceptability in ways, and at time points that could not have been readily foreseen.

Any energy governance framework must be able to create and maintain a system which is as resilient as possible to such events, and capable of reacting appropriately to manage and mitigate the impacts, since such system shocks will, by definition, remain outside its control.

Resilience to such disruption is often improved by diversity – in technology, in fuel or wider supply chains – as well as through contingency resources. Such an approach is akin to a 'just in case' production strategy and not one that is naturally developed in competitive markets which have generally moved to a leaner 'just in time' system. A resilient system is likely to require greater intervention by the relevant authorities to set standards, to encourage the additional diversity and capacity as well as to ensure the 'insurance premiums' to cover these risks are paid for by wider society.

2.1.2 Legislation and regulation

A great deal of positive change has been achieved in a controlled manner by proactive governments and regulators.

As well as major political initiatives which resulted in significant legislative change, like privatisation and liberalisation, some of the biggest successes, particularly in reducing energy consumption or emissions have been achieved through regulation:

- Clean Air Act (1956)
- European product standards for appliances and lighting
- Building Regulations requiring the fitting of condensing boilers and energy efficiency measures
- Large Combustion Plant Directive (LCPD) and Industrial Emissions Directive (IED)

[2] Slide 6 at ec.europa.eu/europe2020/pdf/energy3_en.pdf

Success has also been achieved through obligations which have been placed on organisations in order to drive change:

- Renewables Obligation
- A series of energy efficiency obligations (e.g. ESOP, EEC, CERT, CESP and ECO)
- Emissions performance standard for average fleet emissions in road transport
- Renewable Transport Fuel Obligation

Incentives for deployment by end users have also been used, albeit with varying degrees of success and cost effectiveness:

- Feed-in tariffs
- Renewable Heat Incentive (RHI)
- Boiler and vehicle scrappage schemes
- Green Deal.

It will be important to achieve the right balance between regulation and incentives – too draconian an approach may lead to poor acceptance and political risk, whereas high levels of financial incentive may be considerably more costly than regulation and could prove less effective as has been the case with the RHI and the Green Deal.

2.1.3 Network monopolies

Regardless of the market's role in supply and demand side activities, networks nearly always sit 'outside the market' - the vast majority are owned by regulated monopolies where there is simply no market to decide.

There are historic examples with railways and utilities, where market players alone developed infrastructure, but this often led to a series of deficiencies:

- impartial cover (cherry picking)
- social iniquity (nothing is built for customers who cannot pay; no socialisation of costs; inconsistent pricing)
- multiple standards and limited interoperability
- unsustainable business models and stranded assets.

As a result, even where such initiatives did start off in the private sector, like with the original multiple developers of the London Underground, early gas and electricity systems, many companies went out of business, or it became necessary to take them into public ownership, or to introduce regulation in order to remedy the deficiencies.

In the UK, the process was partially reversed with the utility privatisations in the 1990s. However, in the energy sector, although the ownership of the monopoly network organisations for gas and electricity, transmission and distribution was transferred to private companies, their activities were strictly regulated by a series of mechanisms, including RPI-X (where allowed earnings were reduced by a fixed percentage below inflation in order to encourage cost efficiency in investment and operation) and, more recently the RIIO scheme (Revenue = Incentives + Innovation + Outputs, which aims to provide a more sophisticated and balanced mechanism with greater attention paid to stakeholders' needs).

Even though the regional asset owners and operators involved were monopolies with no traditional competitors, these regulatory approaches have been successful in introducing 'comparative performance competition' between the organisations, and limited external commercial competition for activities like new connections. The pressure on costs had anyway already led to most companies contracting out many of their activities to gain the benefits of cost efficiency not possible previously with direct labour. The overall outcome has been significantly improved standards at lower cost and with a lower cost of capital.

In the early 2010s, a scheme was introduced to cover new offshore transmission network owners (OFTOs), who tender for the ownership and operation of offshore network assets built (so far still exclusively) by the generation developers as part of their overall projects. This scheme has been successful in lowering costs through operational and capital efficiencies and is also claimed to have lowered the cost of capital, although there is a view amongst generators that this has only been achieved by leaving performance risk with the generator who, in turn, faces a disproportionate increase in costs and cost of capital to cover a risk that can only be managed by others.

This example shows the importance of taking a system view with regulation, to avoid trying to optimise the individual parts while potentially sub-optimising the whole. It also demonstrates the importance of allocating risk to those that are best placed to manage it in order to keep the overall cost of capital lower.

In the absence of clear regulatory frameworks which secure returns on the asset investments and provide operational powers, like compulsory purchase of land and wayleaves, or impose service standards and guarantees, it has so far proven difficult for private organisations to develop, or gain customer acceptance for new network infrastructure for, e.g. district heating or CO_2 transport.

2.1.4 The market

Very little has developed in the energy system through market decisions alone – at best there has been a strong market reaction to legislation or regulation, although this is often rather binary – either full speed ahead or emergency stop.

One illustration was the so-called 'dash for gas' which led in the early 1990s to the large scale development of Combined Cycle Gas Turbines (CCGT) for electricity generation. This happened in response to the liberalisation of the electricity generation sector and the removal of the ban on using gas for electricity generation.

This example showed, and continues to show, how sensitive such developments are to politics and regulation - the dash was followed by an investment hiatus in 1997 when the government introduced a moratorium on further CCGT build in order to protect the coal industry, then by a renewed dash once this was lifted, and by another hiatus since 2009.

This latest slowdown in investment has been the combined result of a failure of EU Governments to set low enough CO_2 emissions volumes in the Emissions Trading Scheme, meaning that the resultant carbon price has been insufficient to encourage the intended coal to gas switching; as well as of the many government interventions which have been introduced to encourage investment in renewables, which have adversely impacted on the business case for CCGTs (this is discussed in more detail in Chapter 4.3).

With the announcement in the recent energy 'reset' speech by the Secretary of State[3] that she wishes to support large volumes of new CCGT build, there is likely to be another swing in this pendulum in the coming years.

Even within the limited scope that markets have for decision making, there is evidence that the government does not always accept the decisions made and intervenes to counteract them. This may be for good reason – as previously discussed, diversity and contingent capacity are an important consideration when it comes to the resilience of the system. Pure markets will avoid over-capacity since this adversely impacts on price, therefore some intervention is needed to correct this natural market failure. However, without an explicit strategy to cover the approach to diversity or contingency and the resultant interventions, investors will be very hesitant which pushes up the costs and the cost of capital.

[3] www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy

An example of this was the Renewables Obligation which was introduced as a technology neutral mechanism that obligated energy suppliers to buy a fixed percentage of renewable energy to supply their customers. As might be expected, the market choice was to develop the lowest cost solutions, mainly land fill gas, co-fired biomass and onshore wind. However, the government soon decided that other, more expensive and/or less developed technologies should also be encouraged, and introduced a series of technology specific bands in an attempt to achieve this. It has continued to adjust these over time in order to try to persuade investors to make 'non-economic' choices or to deliver other Government preferences. Such examples of intervention against natural market choices have continued in other schemes, including the small scale feed-in tariff and low carbon contracts for difference.

2.1.5 Encouraging and protecting investment

Until quite recently, when changes were made to government interventions, 'grandfathering' was applied - this were particularly important for investors in long term assets, often with payback periods measured in decades. The principles adopted by the government were to:

- protect investment decisions made on information available at the time
- avoid change which would be detrimental [… if investors] could not have reasonably anticipated […] and made any contingency for this[4].

This has now been put in doubt by recent decisions which have not respected the principle, e.g. changes to the Solar PV tariffs and the Energy Company Obligation, the abandonment of the Zero Carbon Homes standard, the abolishment of the Climate Change Levy Exemption and changes to the eligibility and end dates of the RO.

All this has the potential to make markets very hesitant about investment. In contrast to the regulated networks where long term frameworks have led to reducing costs and cost of capital, these examples illustrate the risk that the unregulated sector may shy away from the investment in innovation, standardisation and production which is needed to reduce costs, and of only developing projects at higher costs of capital, if indeed projects are taken forward at all – not investing could become an increasingly attractive option. The recent decision[5] announced in parallel to the Autumn Statement and Spending Review to abandon support for CCS is only likely to worsen the situation.

It is therefore perhaps no surprise that currently, the main projects for new, large scale electricity generation are ones being developed and financed by organisations who themselves, or whose consortium partners, have significant balance sheet strength and are more familiar with political risk – i.e. state owned organisations – offshore wind by the Scandinavians (Dong, Statoil, Statkraft and Vattenfall), CCGT by the Irish (ESB) and nuclear by the French and Chinese (EdF, CGN).

Uncertainty can have knock-on consequences for network owners when their customers no longer have the basis to plan ahead, and neither they nor the regulator are prepared to underwrite the necessary developments, as may well soon be seen, for example, with the abandonment of electricity transmission links to the Western and the Northern Isles.

2.1.6 Optionality and scenario planning

For a variety of reasons UK policymakers have tended to stress the need to keep options open, support a broad variety of approaches and technologies and avoid 'picking winners'. This concept was right at the heart of the Government's Carbon Plan in 2011 where it announced (rather inaccurately as it turns out) it would be running a "low carbon technology race"[6].

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[4] Paras 3.2, 3.23 webarchive.nationalarchives.gov.uk/20081229194152/http://www.berr.gov.uk/files/file49342.pdf
[5] www.londonstockexchange.com/exchange/news/market-news/market-news-detail/other/12597443.html
[6] Para 2.151 www.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf

However, the concept of technology 'lock in' may actually be an essential feature for investor confidence, when assets are long lived and payback takes many years, as is the case with networks. Competition is not always a useful concept, particularly where new solutions are required and a collaborative approach would bring speedier and more efficient results. This is particularly true for networks where only one solution may be justified and is also a major challenge for emerging technologies, like CCS, where uncertainty extends beyond volume and timing, into questions about the fundamental economic and technical feasibility.

Therefore, in an increasing number of areas, if the goals for decarbonisation are to be met, then strategic decisions are needed, so that technologies and systems can be developed and implemented efficiently at scale – particularly where new or modified supporting network infrastructures are needed, large scale investments are required, and large volumes of end user solutions must be rolled out.

Keeping options open has led to a plethora of scenarios all showing different potential decarbonisation pathways. A recent paper[7] evaluated historic energy system scenarios dating back to 1978 and amongst its findings were a number of cautionary notes:

- Scenarios in the past were not just wrong, but real outcomes lay outside modelled boundaries, and developments considered too unlikely, did materialise
- Scenarios mirrored the biggest concerns of the time, but what turned out to be the most important was not always captured – this was especially true of institutional, political and governance elements
- Communication of results is important and should recognise that, on the one hand, ambiguity will often be ignored or used as a reason to discredit and reject findings as unreliable, while on the other, quantification can often be too precise and created a false impression of accuracy and certainty
- Actual pathways were more challenging than 'least-cost' models suggested.

This is perhaps unsurprising - many scenarios make use of an idealised central planning approach and the system is optimised by 'perfect' market allocation. However, in the current energy system there is no central planner and certainly not one with perfect foresight. Since, as discussed in the previous section, key decisions are not being made by the market, it seems an inappropriate assumption to incorporate at the heart of scenario planning and modelling.

It is clear that the scenario outcomes are determined to a great extent by decisions about the key inputs and parameters applied. In this respect a direct parallel can be drawn to the real world where outcomes will also strongly depend on the decisions that are made, or indeed, not made.

If the UK is to get even close to the desired decarbonisation outcomes, important choices have to be made. Once there is clarity about the destination, it is easier to decide what to do as crossroads and barriers are encountered - corrective action can then be taken, even if there is uncertainty about exactly which pathway is correct, how some participants might behave, or whether each and every policy will be a success.

It is therefore essential that scenarios are used as a means to inform and expedite the necessary decisions, not to encourage politicians in the belief that the necessary changes will happen on their own.

2.2 Timing and sequencing

The justification for network investments follows the needs of the system users both on the supply and the demand side. Nevertheless, the supporting infrastructure is also a key determinant in whether or not a 'market' change can take place at all, or at what pace it will happen, with development times often significantly longer than those for the demand or supply side measures that they connect and support.

[7] www.ukerc.ac.uk/publications/ukerc-energy-systems-theme-reflecting-on-scenarios.html

For instance, a new CCGT could be operational within 7 years from the initial plans and three years from Financial Investment Decision (less still for onshore wind or Solar PV), while a major transmission line, like the one from Beauly to Denny in Scotland which is needed to harvest the power from renewables, can take about 15 years from initial scoping through to commissioning.

This is a particularly difficult issue because it often means that infrastructure investment is required 'ahead of need' and leads to 'chicken and egg' decisions which can prevent progress – e.g. without a charging infrastructure, electric vehicles are less viable yet, until electric vehicles appear in large numbers, the case for creating a charging infrastructure is limited.

In such situations it is essential that all those concerned in the process – government, regulators, network owners and market participants can jointly plan what is needed. A good precedent for this approach has been demonstrated in the past by the work of the Electricity Networks Steering Group (ENSG) on long term transmission investment needs. This identified three categories of investment:

- those of low regrets that were needed in nearly all scenarios and which could be progressed without delay
- those where there were known path dependencies, which could be initiated once appropriate trigger points were reached
- those which were still speculative, but where preparatory investment could be made.

2.3 International comparisons

International experience confirms that utility network infrastructure is most likely to develop either in the state sector or in regulated monopolies. Because of the high capital costs and the long pay back periods involved, networks will only be built when there is sufficient guarantee of future demand and revenue. This is particularly true of heat networks which have played a much greater role in other countries.

Much of the challenge facing the UK, particularly for distribution, is about network transitions rather than new build. Some key findings from a literature search[8] for infrastructure transitions are listed below:

- Most studies only deal with transitions' theory – there are few real world examples at scale
- Networks grow slower in existing cities because of the cost of digging up the roads
- Public ownership and local authority involvement is important for success with district heating
- Co-ordinated, concerted local action backed by central government is most effective
- Projects tend to be driven by motivated and informed champions
- District heating works best where there is guaranteed demand and it is possible to start with a blank canvas
- Networks in general need sufficient demand and, without intervention, roll out more slowly to poorer areas
- Even where novel end-use technologies drive change, this starts off imperfectly and expensively before potentially scaling up to drive the transition albeit at a slow pace
- It is challenging to access large numbers of homes
- Gaining and maintaining consumer trust is essential
- "Predict and Provide" and "Muddling Through" strategies may work for incremental change but a more flexible approach including investment ahead of need is required for large scale transition.

[8] Unpublished paper by MacLean, Sansom, Gross and Watson, copy available on request

2.4 Summary

Based on past experience, a major task, like energy system decarbonisation will not be achieved on a piecemeal and incremental basis, nor by leaving decisions to the market, although this does not automatically mean that everything will have to be delivered by the state.

Alongside clear central decisions about what is to be achieved and what the rules and standards for delivery should be, regulation in the form of obligations as well as product and performance standards can be very effective, both in terms of physical delivery and cost efficiency.

Scenarios should inform and expedite decision making. Options will be narrowed down as decisions are made, but this is essential to underpin investment and achieve the desired outcomes.

For networks it is essential that there is a clear, long term and flexible framework that encourages performance competition and enables sensible levels of investment ahead of need – this means it is a prerequisite that decision making in the non-network areas must also function effectively.

Many developments will be local or regional in their nature and therefore strong involvement of local authorities is desirable.

Lower costs and cost of capital will be achieved within a framework that offers clarity on desired outcomes, a long term perspective and a sound legal basis, including grandfathering principles.

3 Designing the system and the transition

By definition, decarbonisation is going to mean a move away from fossil fuels and this brings with it a number of consequences which will drive changes to the physical characteristics of the energy system, the market and the economic structures within which it operates, as well as to decision making and the delivery processes. This chapter discusses an illustrative selection of critical issues and highlights them with some often neglected examples of design considerations that will be essential for the move away from a fossil fuel based system.

Even, with an ideal framework of governance and regulation and a perfect supply chain, unless there is a full understanding of the characteristics of the current fossil fuel based energy system, it will be difficult to make good decisions about how to design its replacement or to manage the transition towards it. Energy is now so central to nearly all aspects of everyone's lives that continuing, uninterrupted availability is a political imperative. It is therefore important to avoid pulling the plug on the old solutions until there is confidence that the new ones will work, securely and affordably.

3.1 Defining the energy system

There are many characteristics to define in an energy system which go beyond the average energy consumption. For example:

- Peak demand and maximum capacity
- Diurnal and seasonal variations in demand and production
- Rate of change of demand and production
- Storage capacity
- Storage duration (seconds, minutes or months)
- Reliability and flexibility of supply (including fuel)

Therefore, a good understanding of all of these, how they are currently provided and how this will continue or alter as the system evolves, will be essential. This will also be needed to determine what the future role for various networks might be – networks must be designed to deal with peak demand, not just average levels, and must able to access, transport and deliver energy where and when it is needed, across the day and the seasons.

3.2 Fuels and storage

Some of the above characteristics are well covered in future energy scenarios and economic models. However, fossil fuels have become ubiquitous to the point where their advantages (and disadvantages) are often invisible, or simply ignored. This can be illustrated by looking at the benefits of storage currently embodied in fossil fuels, often as an integral part of the overall infrastructure, and in the case of the gas grids, of the network itself.

It is easy to forget that during the miners' strike in the 1970s, without adequate fuel stocks, coal power stations became very 'intermittent' in their output – this is not a new characteristic exclusive to renewables. In the 1980s it was the vast coal stockpiles which the government had built up that allowed uninterrupted production of electricity, and overcame the miners' strike on that occasion.

Storage is what provides resilience and flexibility to the energy system to a point where it has now become so reliable and flexible that it is taken for granted. However, although these benefits are very high value, at the same time they have been achieved at a very low cost. The fact that little is paid for storage has probably contributed to the lack of proper recognition of the importance of incorporating storage, or whatever may replace it, as well as the costs of this, into models and designs of the future system, and into comparisons with the existing situation.

There has been a reaction of surprise, or sometimes denial, as early symptoms of deficiency have become evident - e.g. intermittency concerns in electricity and range anxiety in transport. This has led to the questionable conclusion that new market or regulatory models must be developed to support ***electricity*** storage.

The challenge should be examined at a higher level and focus on how to continue to maintain acceptable levels of system security and performance at a price that remains affordable. The table below summarises current UK system storage capacities[9] as well as the relative costs[10], and highlights why it may be ill-advised to first seek the future solution in electricity storage technologies.

System	Transport (car tanks)	Gas	Coal (for electricity)	Heat (dom. hot water)	Electricity (Pumped storage)
Storage (GWh)	10,000	50,000	30,000	65	27
Cost ratio	1			100	10,000

Fossil fuels are currently the only means of providing large volumes of long duration storage over a period of months. The value of this is particularly high in the heat sector where peak demand in winter is about 12 times the summer levels. Even in the electricity sector where absolute variations are much lower, current fuel levels maintain a buffer equivalent to several months' output.

Going forward, as well as for daily fluctuations, solutions capable of dealing with variations over several weeks, if not months, will be needed to come close to maintaining current security standards and to complement natural variations in renewables production – solar does not contribute to winter peak for domestic electricity or heat demand, and wind production can be negligible at periods of high winter demand during long anticyclonic weather patterns lasting weeks and stretching across all of the UK and its interconnected neighbours in north west Europe.

Without proper examination of these requirements, their implications and costs, it will not be possible to determine, at a system level, what the optimum solution might be. For example, if an alternative to natural gas, like bio-methane or hydrogen is compared in isolation on the basis of unit fuel production cost, it may seem unattractive. However, if it allows continued use of the gas networks and storage facilities, provides an alternative fuel for road transport and removes the need to deploy new power or heat networks combined with much more expensive heat or electricity storage solutions, the system level cost benefit analysis may well be much more attractive.

3.3 Systems thinking and governance

This is only one example that illustrates there is a risk that not enough thought is given to the design of the future decarbonised system nor to the issues of scale involved and what the infrastructure implications might be. The debate so far often appears incomplete and very technology focussed, either on the roll out of large supply side measures or, to a lesser extent, on the mass roll out of end-user appliances, mainly in the electricity sector. This means that large areas of the system, like heat and transport and their supporting networks, have been under-represented in the process.

Over the last decade, after many rounds of policy making, ever more layers of complexity have been added to the energy frameworks, and the government now has more powers than the CEGB ever did and itself admits that little, if anything can be built in the electricity sector without some form of

[9] erpuk.org/wp-content/uploads/2014/10/52990-ERP-Energy-Storage-Report-v3.pdf
[10] www.svenskfjarrvarme.se/Global/EU-fr%C3%A5gor/Consultation%20Forum%2009092015%20-%20Issue%20Paper%20IV%20-%20Linking%20heating%20and%20cooli.pdf

contract with the government or one of its agencies[11]. However, this was never the explicit aim of policy and it is highly questionable whether it has been accompanied by the build-up of the necessary institutional competence and resource to exercise all of these powers.

There are now nearly 40 organisations and agencies across DECC and other government departments that are involved in decision making and the delivery of energy. At best, this means that the process is extremely complex, at worst it means that bad decisions may result or that they come late or indeed not at all.

Due to unbundling, which has removed vertical integration and created distinct organisations that no longer naturally examine issues from a whole system perspective (or may even be prevented by law from exchanging information), and to liberalisation which has led to multiple, competing players in each sector, the energy industry is now very fragmented which means that there is little, or no counterbalance to the decision making or the exercise of the many powers by the government – there is no single body or strong figure, like the Chief Engineer at the CEGB to authoritatively and convincingly talk for the industry.

It is now becoming apparent that significant refocussing of the agents of decision making and delivery is essential to re-establish the institutional competence needed to consider whole system issues and to manage the decarbonisation challenge successfully and cost effectively.

3.4 Physical and special requirements for network developments

Over 80% of the UK population live in urban areas[12]. Most networks were deployed incrementally over time under the access-road infrastructure as part of the development of these residential areas as well as ones for commerce and industry. As a result, urban roads have filled up with a combination of water and sewerage, gas and electricity as well as telecoms assets which has led to a very congested utility environment, which is not conducive to retrofit or additional networks. There is poor public acceptance of over-ground solutions, which means that the roads will be a key determinant to whether, where and how networks can develop in the future.

There is very little historic evidence in the literature for major national transitions from one energy infrastructure to another, or for significant network retrofit solutions[13]. Where such programmes of work are carried out, like the ongoing gas mains replacement programme in the UK, they can cause disruption to people's lives and economic damage to businesses especially through access and transport restrictions.

Although the telecoms industry has achieved some additional deployment, the space requirements for their cables is a fraction of that required for water, gas, electricity or heat networks and many of the solutions have been wireless or satellite which do not require road works and can be installed in remote locations.

Reaching the high proportion of buildings in urban environments that would be required for mass roll out of most heat and electricity distribution developments, will be a significant challenge for the development of new, or modified networks. One possible exception to this would be the repurposing of the gas distribution network for other gasses like bio-methane or hydrogen where the existing infrastructure could be reused. A number of organisations are investigating this option[14].

Depending on the approach chosen, refuelling and non-domestic charging infrastructure for transport as well as CO_2 transport for centralised CCS applications could be structured to avoid such immediate

[11] Reference 3, above
[12] www.ons.gov.uk/ons/dcp171776_337939.pdf
[13] Reference 8, above
[14] e.g. Northern Gas Networks www.smarternetworks.org/Project.aspx?ProjectID=1630

urban impacts. This makes the physical choices easier, but in no way diminishes the major planning, economic and financing barriers to sufficient and timely investment.

In all cases, careful and coordinated planning will be essential and ideally involve local authorities and communities in order to optimise cost effectiveness and achieve the necessary degree of public acceptance.

3.5 Managing the transition

Only once it is clear what the actual starting and desired end points are, will it be possible to evaluate the achievability and desirability of potential transition pathways.

The illustrative examples below show how important the transition issues can be, even though before and after the projects the transitional impacts are 'invisible':

> ***Edinburgh Trams***
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> *For the Edinburgh trams project to progress there was a need to first reroute utility networks in the city centre to allow the tram rails to be installed. The extent and cost of this disruption both economically and politically was seriously underestimated and so led to 'unexpectedly' severe adverse impacts on traffic, business and people's lives over a period of many years. Once underway, the project, even when much reduced in scope, only just survived a number of serious challenges and obstacles, but ended up over budget (three times) and very late (built over seven years instead of two).*
>
> ***Rail Electrification***
>
> *The Public Accounts Committee has recently heavily criticised Network Rail for the mishandling of the project to electrify the network[15]. Highlighting the example of the Great Western route from London to south west England where Network Rail admit that a combination of inadequate planning, estimates that were based on outdated knowledge of the railways and a change in the flexibility of the regulatory regime had led to delays and a tripling of the cost estimates between 2013 and 2015. The delays are likely to have further consequences for costs and carbon emissions since existing, low efficiency diesel trains will have to operate for longer and new trains must be ordered with a hybrid diesel and electric drivetrain at extra cost.*
>
> ***Heathrow Terminal 5***
>
> *In order to build Heathrow Terminal 5, before the final lay out was achieved, many interim changes were needed to allow the different stages of the project to progress. As well as rerouting two rivers, other major developments were required to the infrastructure including nine tunnels to provide drainage, rail and road access. One of the roads involved was the busiest motorway in the country, the M25. The project was well planned and managed – it didn't just happen by chance – and meant that disruption was kept to an acceptable minimum and the project delivered on time and to a budget that had accurately established the challenges and costs.*

These examples in their different ways show the importance of understanding, planning and managing the transition pathway and not just thinking about the final desired outcome, in order to successfully deliver not only a big major project but, as will be necessary particularly with heat infrastructure, a very large number of individual smaller ones.

As discussed earlier, accurate impact assessments will be particularly critical for any network solutions in built up areas, because of the congested nature of the utility environment under the roads. Not only are there possible interactions between networks, but also significant adverse impact on road transport as

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[15] www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/news-parliament-2015/network-rail-investment-programme-report-published-15-16/

well as access to homes, businesses and services. A series of developments at this scale is likely to carry on over decades at a national level, and months or years at a local one.

Depending on the outcome of the assessments, an option previously favoured for its ultimate characteristics may have unacceptable impacts in the transition. It may therefore be necessary to review the characteristics, or the timing of implementing the solution.

It will be essential that this iterative process of decision making and evaluation involves all the relevant public and private sector participants in a coordinated manner. Local authorities could be key participants in making this process effective and efficient, combining the requirements set by central government with the local knowledge and contacts needed to properly formulate and evaluate the proposals for individual projects in their areas of responsibility.

3.6 Summary

Decarbonisation could, inadvertently, have adverse impacts on the energy system unless the characteristics of the existing system are fully understood and the new system is designed only to remove those elements that are undesirable (carbon emissions) but maintain those that are desirable (security, resilience and affordability).

The role of storage has been particularly important in the fossil fuel based system and recreating it in another form, or maintaining the benefits it provides through alternative means, must be given particular prominence in the design of the new system. This may have significant impact on decisions about the optimum network solutions.

The governance of the decision making process must be capable of covering all of the energy system – heat and transport as well as electricity – and fully consider the networks alongside the supply and demand side measures.

The institutional competence to govern energy decision making must be re-established and rebalanced, taking into account the predominance of central government decision making, the complexity of the institutional framework and the fragmentation of the industry through unbundling and competition.

The impacts and costs of transition must be part of an iterative decision making process to determine not only the optimum end state, but also to minimise disruption and maximise public acceptance of the measures.

4 System values, costs and benefits

4.1 Existing, energy only markets

In the historic fossil fuel based system, a simple energy or fuel price sufficed in the retail and wholesale markets to reflect the combined and mostly interchangeable values of the services provided – e.g. energy, capacity, storage or flexibility. Fuel represented the greatest cost component so matching payment structure to this minimised the risks and, in turn, the cost of capital.

4.2 Network costs and charges

4.2.1 Historic model

In contrast, most of the costs of the networks are fixed and independent of the number of units transported. Nevertheless, a variable use-of-system charge has been used to recover most of these costs from those connected to the networks – both on the supply and demand sides. This has made it readily compatible with the simple energy, or fuel price charging systems used in electricity and gas.

As long as all users are paying their fair share and a reconciliation process is in place to deal with any shortfalls or overpayments, this approach does not add any risk to network operators and therefore does not impact on the cost of capital. Where such protections are not available, as in unregulated heat networks, this makes the business case for investment much more difficult and the cost of capital much higher – often to the point where no investment is made unless underwritten in some way, perhaps through an anchor client or a local authority.

4.2.2 Impact of interventions

In recent years, some interventions have been introduced which impact on the charging basis and this has had unintended consequences. For instance, those generators receiving small scale feed-in tariff payments only pay for the residual level of units that they consume after netting off what they have produced. Despite still requiring the full capacity of the network to provide back-up and to export any power not used on site, they pay considerably less, and in some cases no contribution towards the network costs.

As a result of the reconciliation mechanism, these costs are spread over all other network users. This can be socially iniquitous, since it will generally be the lower income consumers who have to pick up the extra costs from those who have been able to afford to invest in self-generation. (This adverse distribution effect is exacerbated further since the levies to pay for the subsidy to the generator are also raised on a unit basis.)

In Australia, increased network charges have driven an ever greater number of consumers to seek 'off grid' solutions, and created a vicious circle of spiralling costs being spread over ever fewer consumers[16]. Although the initial trigger was over-enthusiastic investment in the transmission network which created a backlash to the cost increases, it demonstrates how network charging can quickly become an issue for consumers and investors alike.

In isolation. this already highlights some reasons to examine whether the old charging basis for networks should continue. The following sections examine some other drivers signalling reasons to consider change across the wider energy system which may influence any decision on network charging.

4.3 New payment mechanisms are emerging

One result of the increasing deployment of large capacities of zero (or low) short run marginal cost (SRMC) plant is the 'merit order effect', whereby plant is despatched in reverse order of SRMC, meaning that fossil fuelled plant is displaced whenever nuclear, wind, solar and hydro are running. This leads to a

[16] reneweconomy.com.au/2015/networks-propose-compulsory-fees-for-all-to-stop-grid-defections-28523

reduction in the average wholesale price as the more expensive SRMC plant sets the price less frequently and as the number of occasions reduces at which higher peak prices occur.

However, that is not the whole story and this apparently beneficial reduction in the wholesale price cannot be seen in isolation, as some would wish. The long run marginal costs of all plant, including all the repayment of capital and financing costs, still need to be recovered, and if the wholesale price falls too low, then even the low SRMC plant will not receive sufficient return to amortise its investment – this cannibalisation of the business case is a problem that the high SRMC plant faces much sooner.

As a result, in order to provide sufficient earnings to the low SRMC plant, contracts for difference have been introduced through the Government's EMR programme to guarantee a minimum level of payment per energy unit to the low carbon plant.

Additionally, to maintain sufficient fossil fuelled plant, storage or demand side response on the system for the provision of security at times of low wind, solar and hydro production, there has been a need to introduce a capacity mechanism to supplement the energy earnings and to secure a return to investors that is no longer provided through the wholesale energy market alone.

There are also growing operational requirements for the system operator to increase the procurement of system services like short term operating reserve and frequency response. System adequacy concerns have also led to the introduction of new schemes like the Supplemental Balancing Reserve. The costs of these schemes and services also have to be paid for by system users. Therefore, despite falling wholesale prices, retail prices are actually increasing as all of these additional or reallocated costs are recovered from retail consumers through network charges, levies and taxes.

4.4 Drivers for investment

It is important to recognise and understand the difference between the drivers for investment as opposed to operations and reflect these in regulatory and market design.

For investors, any uncertainty about recovering initial investments through variability in long term revenue earnings will lead to a higher cost of capital. The less certain an investor can be, and the longer payback may take, the greater the risk premium that will be applied and the resultant financing costs.

For vertically integrated companies, under the original British Energy Trading and Transmission Arrangements (BETTA), the supply business provided a natural hedge between supply and demand, and an incentive for the generation business to invest on behalf of the customer base (although more true of the domestic sector than industrial and commercial one where there was much less loyalty and much greater volatility). In this system there was also an incentive to hedge against the fuel price through investment in renewables. The introduction of CfDs, has almost completely removed both of these market incentives to invest in generation.

Contrary to initial suggestions from DECC and Ofgem in the EMR development process, increasing imbalance costs (through cash out) to suppliers and generators, would not, on their own, be a replacement driver for investment in new capacity, rather only one for short term operating behaviour.

This was another reason that alongside CfDs, EMR also had to introduce the Capacity Market to provide the signals needed for long term investment in system adequacy.

4.5 Negative pricing

In energy output terms, replacing high load factor plant that runs most of the time at its name plate capacity with low load factor plant that mostly runs well below it, does not make much difference. However, in capacity terms it means that the system becomes much larger and capable of significant over-production under some circumstances, e.g. on a sunny day with a strong wind.

So, the system operator also faces another new challenge - not only the risk of too little capacity, but also of too much. The market is currently incapable of sending adequate, 'normal' energy price signals to stop some generators producing, even when there is no demand for their product. Not even the emergence of negative prices has been sufficient to stop some plant running.

In order to deal with such over-supply, the system operator ends up paying generators outside the wholesale market even more to stop producing than they would have received if they had produced. This is done through a combination of constraint payments (when there is demand somewhere but not enough network capacity to transfer the power) and curtailment payments (when there is insufficient demand anywhere in the system). This phenomenon is not new and not exclusively used in the context of renewables, however it is now becoming increasingly prevalent and that trend will continue with further deployment of low SRMC plant, especially for 'must run' plant like nuclear and CHP, which demand the most significant payments to compensate for the very high costs of stopping and restarting.

4.6 Pay for what you value

In a decarbonised electricity system where many of the supply side solutions no longer necessarily provide all services, it may become desirable to price them separately – most successful markets price what customers value. There are already at least five distinct elements which could be charged separately:

- Energy - a variable cost element which is proportional to the fuel costs (high for gas, coal and biomass; low for nuclear and near zero for renewables)
- Capacity and system adequacy (essentially the fixed capital costs)
- System services (a combination of fixed and variable costs)
- Network costs (predominantly fixed capital costs)
- Taxes and levies (fixed and variable costs)

This can be complicated as each of these has differing and sometimes interlinked pricing impacts. Some examples:

- the wholesale energy price is primarily driven by the SRMC of the plant at the margin, which historically was predominantly coal or gas. The fuel price (plus the taxes imposed) set the basis for the wholesale price. However, increasing deployment of low carbon plant (with the exception of biomass and, potentially CCS plant) will lower the wholesale price but increase the CfD and Capacity levies as well as the system service costs. (NB reducing the wholesale price increases the costs of guaranteeing earnings to generators through contracts for difference and capacity payments. Within a fixed budget for these costs (the Levy Control Framework or LCF) this means that less volume of plant can be supported, so the consumer is paying the same amount for less. The alternative is to allow the levy costs to increase, in which case the consumer will simply pay more.)
- greater deployment of low load factor plant will increase the network costs to cover the additional wires needed for connection at the maximum, albeit rarely achieved nameplate capacity. This will also increase curtailment payments (and constraint payments if there is a delay in building the necessary networks).

The overall system costs, especially in heat and electricity, are now increasingly dominated by high, up-front capital outlays, although this has always been true of networks. Therefore, to match this shift in the cost base and risk profile, a rebalancing of the charging regime could also be considered.

A shift away from variable charging tariffs has been seen in the telecoms market where greater use of fixed bundle charging, rather than variable unit tariffs is made, and service characteristics rather than 'fuel' are valued.

However, it could be argued that reducing unit costs would reduce the incentive for efficiency, which is certainly an issue for fossil fuel based production where resource availability and emissions reductions would be impacted. However, in a system with a high proportion of renewables, there are fewer concerns about resource availability or emissions and when this plant has zero or very low SRMC there is also a weaker underlying economic benefit from reduced demand, unless this were to counter a need for an overall increase in the system capacity.

4.7 Summary

Partly to fit in with historic energy only markets, network costs have been recovered by a use of system charge related to the number of units transported, even though the main costs are up-front capital and are almost invariable to throughput.

Distortions are beginning to emerge where not all users pay a fair share to use the system and which could lead to a vicious circle of consumers seeking off-grid solutions and ever higher costs to those who remain connected.

The way the wider energy system is configured and operated, as well as its charging framework will impact significantly on networks. All aspects must therefore be considered together.

Changes to the investment and operating model of energy suppliers and generators is driving a move away from energy only markets to payment solutions likely to embody considerably greater fixed charges and less variable ones.

A new decision making framework must be capable of recognising and assessing these factors and managing the transition to a charging system better suited to future needs of networks as part of the overall system.

5 Assigning roles

In addition to other political dimensions that impact on energy decisions, like industrial policy, inward investment, international development and social considerations, the nature and scale of the challenge involved with decarbonising the energy system and its associated costs mean that only governments (central and local) can legitimately make the fundamental decisions about what should be done and create the necessary delivery frameworks to make it happen.

This does not mean that delivery should also be the role of government. The efficiencies that markets and healthy competition can bring should be captured, and the capacity of the private sector to finance investment will be essential to this large scale, long term transition.

However, careful thought must be given to role and risk allocation if private sector investment is to take place at all, and if the cost of capital for the large sums involved is to be kept low.

In recent years this has not been the case and the role of the market has significantly diminished as the level of intervention has grown, and market risks which can be managed, and to which operators should be exposed are being replaced by political and regulatory risks which operators cannot manage, and to which it is questionable that they should be exposed.

This needs to change to meet the challenge of decarbonisation and potential options are discussed below.

5.1 Differentiated delivery

In the current supply side delivery model single organisations will carry out the four main delivery stages associated with high capital cost, long life assets, like generation assets or networks:

- Design
- Development
- Construction
- Operation.

This is proving increasingly unsuited to dealing with the new level of political risk. Even some regulated network investments are becoming difficult, partly due to the inability or unwillingness of the supply side (and in some instances demand side) players to individually, or in aggregate, underwrite the necessary investments to the satisfaction of the regulator (or the network owner) and because there is no adequate model to plan and allow 'investment ahead of need'.

The risk and funding profiles should be matched appropriately for each of these stages to optimise the cost of capital as well as the capital costs - these will usually be dependent on a minimum and steady predictable volume – another reason for a clear and long term plan.

The funding and hurdle rate requirements vary depending on these discrete phases:

- Design and development are almost entirely funded by higher cost equity
- Construction can attract less expensive debt funding, but many lenders are extremely wary of taking on construction risk which will limit the proportion of debt and/or impact on its cost
- Operation is capable of funding with higher proportions of less expensive debt.

A one step project will be assessed on its ability to provide a return for the higher risk, higher hurdle rate development and construction phases and, without refinancing, higher rates could apply to the lifetime operation phase as well. This means that the hurdle rates applied are higher for a single project than they could potentially be for ones split into separate phases.

Alternative models are developing where delivery is split into these discrete steps and then tendered and/or financed separately. Some examples of this are:

- In Denmark, offshore wind projects are designed and developed by the state and a contract for construction and operation tendered to the market
- In the UK, offshore transmission assets that have been developed by generators are then transferred to independent operators (OFTOs) for operation (and potentially construction) through a competitive tender process
- Across Europe, organisations have specialised in the design and development of energy projects and others in the construction and/or operation of the resultant assets – at each stage appropriate financing or refinancing packages are put in place to best reflect the risk profile and funding structure of the respective activity.

5.2 Competition - auctions and tenders

To maximise the constructive role of competition despite the high levels of intervention that are emerging in this major decarbonisation transition, tenders for each of these stages could be held separately, for the categories shown in the above examples.

However, there are inherent risks of tenders and auctions for both sides:

- **The winner's curse** – bidders underestimate the risks and costs and tender a price which is too low to deliver the project. The more complicated the project and the less predictable the outcome, the greater the risk of this phenomenon. It is worth noting that less than 25% of the successful bids in the NFFO (Non Fossil-Fuel Obligation) auctions were ever built[17] (and only 15% of the capacity)
- **The disappointed bidder** – to be successful, any auction must have more than one bidder which means that at least one will be unsuccessful. If the cost of this failure is too great or the overall success rate in multiple tenders deemed too low, the bidder will seek to avoid future losses and avoid the process from the start. For example, to develop a large offshore wind farm to the point of entering into a CfD auction could cost more than £100m – few Boards are happy to risk that level of potential 'disappointment'
- **Misleading price discovery** – to accurately reflect the sustainable costs of what is being procured, an auction must recognise what is likely to be driving price. For example, if there are distressed assets seeking any route to market, rather than abandoning a project and writing off the costs, then a lower price may be tendered which will not give an accurate reflection of future sustainable levels.

These risks can all be minimised by using a staged approach and by ensuring that there is long term visibility of the likely tender process to allow supply chains to develop with the confidence needed to invest in innovation, standardisation and production efficiency to keep capital costs down, and to minimise overall risks to optimise the cost of capital applied.

The principles could apply to all sectors of the industry, regulated networks as well as unregulated assets.

5.3 Summary

A clear allocation of roles for decision making and delivery is essential to establish clarity about what is needed, and to encourage learning effects as well as the long term investment needed to reduce costs.

A staged approach to tenders for delivery, will be the best means to maximise the role of competition while optimising the allocation of risks to keep down the cost of capital.

[17] "Harnessing Renewable Energy in Electric Power Systems", Boaze Moselle et al

6 Discussion and conclusions

6.1 Issues summary

In the preceding chapters, a number of issues have been highlighted which should be considered when answering the question of whether, or what changes to the governance and regulatory frameworks are required in response to the decarbonisation challenge, both for the energy system as a whole and, in particular for network infrastructure.

Chapter 2 concluded that, based on past experience and international comparisons:

- Energy system decarbonisation will not be achieved on a piecemeal and incremental basis or by leaving decisions to the market
- Options will be narrowed down as decisions are made, but this is essential to achieve the desired outcomes
- Clear decisions are needed about what is to be achieved and what the rules and standards for delivery should be
- This should be supplemented by regulation in the form of obligations as well as product and performance standards
- For networks it is important that there is a clear, long term and flexible framework that encourages performance competition and enables sensible levels of investment ahead of need.
- Many developments will be local or regional in their nature and therefore strong involvement of local authorities is desirable
- Lower costs and cost of capital will be achieved within a framework that offers clarity on desired outcomes, a long term perspective and a sound legal basis, including grandfathering principles.

Chapters 3 and 4 highlighted

- The need to better understand the characteristics, values and costs of the existing system before deciding on the design of the future system or the transition towards it
- That governance of the decision making process must be capable of covering all of the energy system – heat and transport as well as electricity – and fully consider the networks
- The institutional competence to govern energy decision making must be re-established and rebalanced, taking into account the predominance of central government decision making, the complexity of the institutional framework and the fragmentation of the industry through unbundling and competition.
- The impacts and costs of transition must be part of an iterative decision making process to determine not only the optimum end state, but also to minimise disruption and maximise public acceptance of the measures
- Changes to the investment and operating model of energy suppliers, generators and network operators are already suggesting a need to move away from energy only markets to payment models likely to embody considerably greater fixed charges and less variable ones.
- A new decision making framework must be capable of recognising and assessing these factors and managing the transition to a charging system better suited to future needs.

Chapter 5 described

- The potential options for allocating the roles of decision making and delivery across, government, regulators and the private sector and
- how this can optimise costs through competitive tendering and competition in performance, as well as reduce the cost of capital by reducing political risk and better apportionment of the residual risk.

6.2 Discussion

6.2.1 New frameworks could be beneficial

The preceding evaluation of these issues supports the ETI proposition that changes to the governance and regulatory framework are desirable to support the challenge of decarbonising the energy system and that these changes could lead to reduced costs and cost of capital for the investment needed. This applies to the system as a whole and not just to networks. Indeed, the major benefits for networks will only be accessible after adjustments to the overall system framework are achieved.

6.2.2 Reasoning

Some of the highlighted reasons to support the conclusion that change is needed are:

- the current decision making frameworks have already evolved well beyond what they were originally created to do
- there has already been a fundamental shift back to state decision making, but without establishing the necessary institutional competence, resource and counterbalance
- the changes needed for decarbonisation require a whole systems approach and current frameworks are focussed on an unbundled and fragmented one
- for the scale of the challenge, an unplanned incremental approach will be ineffective and inefficient
- the long duration of the transition requires long term clarity which is not provided currently
- investor confidence has been badly damaged and must be re-established.

There is an argument that more change and uncertainty at this stage will make things worse, not better. In the short term this is undoubtedly a risk, however, the long term nature and the scale of the challenge mean that change is inevitable and that it would be better to start as soon as possible and to establish clarity for all concerned. Since investor confidence has been hit so badly by recent announcements and the investment hiatus is already likely to spread if there is no change, it is anyway hard to see how matters could deteriorate much further.

There are other theories which suggest all that is needed is more investment in innovation and that markets will then provide the right solutions[18]. There is little historic evidence to show that this has succeeded in the energy industry and a number of recent papers[19] have highlighted that even successful innovations take decades to come to fruition, and of course many will fail.

Some will argue that the Government is not well equipped to make such decisions or commitments - that is currently a valid objection. Since there has been little explicit recognition of the recentralisation of decision making by the state over recent years, the necessary institutional support structures have not been developed.

There are therefore strong reasons to propose an alternative framework – one possible approach to this is described in the following section.

6.3 Proposed solution

Based on the previous discussion, it is clear that the current approach is not working and is likely to become ever less fit for purpose. It is therefore important that a new framework for energy governance and regulation is considered, which recognises the changes that have already occurred, creates effective new structures and allocates roles and responsibilities appropriately. The proposed 'mixed economy' approach combines a clearer role for government decision making and a greater recognition of the importance of system wide design, with truly independent regulation and competitive, efficient market investment and delivery. This would be better suited to dealing with the difficult cross vector issues and

[18] e.g. Dieter Helm: The Carbon Crunch

[19] e.g. www.ukerc.ac.uk/asset/ADA12E92-C1DC-4033-8CFA63AC9EA9FE59

weighing up the opportunities for synergy and the necessary trade-offs. Overall, this creates a better platform for markets to function on a day-to-day operational level and for better customer service provision.

A simple analogy to what will be needed is the approach taken for the Olympic Games where clear high level decisions were made at a political level, but an independent body oversaw the detailed design and delivery which was carried out by private organisations, to time and on budget.

The suggested framework would have the following component parts and responsibilities:

Responsibility	Institution(s)
Decisions (central) • Outcomes and objectives • Outline budgets, funding and finance • Supporting legislation and regulation • Boundary conditions	Central government
Coordination (local) • Local knowledge, planning and standards • Zoning of solutions • Anchor demand • Investment	Local authorities
System design • Concrete design and delivery plan • Coordinate expertise across individual specialisms • Detailed budgets • Monitor, feedback and revision	Independent system architect
Regulation, • Price controls • Detailed licences and codes • Oversight and policing of delivery • Scheme administration	Independent regulator(s)
Delivery • Development • Construction • Operation	Private sector organisations
Wholesale, retail and service markets • Service delivery • Customer service	All market participants

Considering these in turn:

6.3.1 Decision making

This is the most important area requiring change and will need:

- Explicit recognition of the extent of government decision making (both central and local)
- Abandonment of the pretence that 'the market' will be left to make key decisions
- Establishment of the institutional competence to support the decision making process
- Redefinition of the role of the independent regulator to oversee and police delivery
- Rebalancing of the role that industry can play in supporting and informing the process, recognising the current weaknesses resulting from fragmentation through unbundling and competition.

From this it will be essential that the following outputs are produced:

- Clear, credible and long term outline of the objectives and outcomes to be achieved
- Long term commitment to provide funding or facilitate the private financing of the costs
- A suite of supporting regulations, obligations and, if appropriate, incentives
- A 'rule book' covering boundary conditions - the important 'dos' and 'don'ts' of delivery.

Some of this is in line with current trends - it has previously been discussed that in the electricity generation sector, the Government already effectively decides what is built by issuing contracts (directly or through its agents), either in the form of CfD, Capacity or other service contracts/agreements.

The Government has recently been unusually clear about what it wants and does not want in the electricity system ruling that, at large scale, it will now only support nuclear and new CCGTs, with the potential for this to be extended to offshore wind if costs reduce sufficiently. It has announced the phase out of coal generation and an end to support for onshore wind, solar PV and CCS.

It is possible to debate whether this was the right outcome, or if the correct process has been followed to reach this point, but it is nonetheless a response to requests for a clear set of decisions. One big difficulty remains however – will investors believe that these decisions will be adhered to in the long term? The less rigour applied to the process, the less coherent the policies appear and the more often changes are made, the less likely it is that credibility and confidence can be re-established, especially since grandfathering principles have already been eroded. This is why the process has to be much more explicit in its nature than has been the case to date, and a clearer exposition given of the principles that will be applied to decision making going forward.

This could be further improved by radically refocussing the current fragmented and overly complex organisational landscape to provide a few centres of excellence with the necessary knowledge, competence and resource. Suggestions for one way to approach this have been outlined in a recent paper[20].

To build on some of the most successful and effective means of establishing system change on the supply and demand side, especially with regard to emissions reduction, a suite of regulations, obligations and incentives should be laid out in line with the long term objectives of energy policy and consistent with carbon budgets, as well as security of supply and affordability criteria. Many of the changes will require decades to complete and many years to prepare. It is therefore essential to begin this process quickly and give consumers and the supply chain the necessary overview and opportunity to adapt.

This is particularly important to allow the network owners and the regulator to establish the necessary plans to invest in sufficient time to enable the measures to be deployed.

6.3.2 Local and regional aspects

Although national standards and support are important, many elements of the energy system can (and should) develop at a local and regional level. Local authorities also have responsibility for local planning, building standards, council tax and a number of other administrative functions which could be central to the success of decarbonisation investment.

For instance, a significant proportion of the necessary carbon emissions reduction from the heat sector needs to come from energy efficiency investment in buildings. Local authorities will have better access to such information and to many of the tools needed to implement, support and police the necessary

[20] www.policyexchange.org.uk/publications/category/item/governing-power-improving-the-administration-of-the-energy-industry-in-great-britain

investments. They are well positioned to coordinate the delivery of such investment and, in many instances as building owners, will themselves have the direct responsibility for making the investments.

In contrast to the electricity system where many future developments are based on the ***de***-centralisation of energy production, most current heat solutions are already highly decentralised with, for instance, individual gas boilers in about 85% of homes[21], and decarbonisation solutions based on district heating would actually require a ***re***-centralisation of supply.

With a variety of potentially mutually exclusive infrastructure solutions to decarbonise space heating and hot water provision, local authorities could play a critical role in determining which solutions are best suited to which areas, building types and occupier profiles and use this knowledge for zoning the solutions into appropriate areas, planning the transition and communicating with those affected.

Otherwise, there is a real risk that a piecemeal approach could develop and, in the worst case scenario, a consumer could be persuaded to replace a gas boiler with a heat pump, only to find that a new district heating scheme will be on offer shortly (but will be difficult to justify since too many consumers had moved to the heat pump), and/or that after some have switched to heat pumps and others to the heat network, a new scheme replaces natural gas with hydrogen and the original gas boiler could have been retained and reused at a fraction of the cost.

With regard to heat and transport solutions local authorities can also act as anchor clients:

- For heat solutions, local authorities could use municipal buildings like schools, hospitals, offices and leisure facilities to provide some guaranteed demand for heat providers (potentially themselves as investors). In general, mixed-use heating systems (commercial, leisure and domestic) spread peak load better across the day and the week providing additional benefits.
- For transport, local authorities could convert their own transport fleets – busses, HGVs, LGVs as well as passenger vehicles, and provide initial refuelling or charging point infrastructure for low carbon transport solutions like, hydrogen, biofuels and electrification which could then be accessed by all users.

It could be argued that local authorities do not have the resources or competence to carry out such responsibilities and this is indeed currently the case. It would therefore be essential to enable local authorities to make the necessary investments, not only in the energy system, but in the necessary human resources. To avoid every authority replicating the expertise and support facilities, national or pooled schemes should be considered – some examples of this already exist[22].

The proposal could be rejected on the basis of additional costs, but if decarbonisation is to happen costs will arise regardless of whether it is driven nationally or locally. Some of the investment costs, like energy efficiency, will offer significant value through returns and pay-back over time. For others, it is important to look at the most effective and efficient means of achieving the objectives, and experience elsewhere has shown that, for investment in buildings and heat infrastructures, this is through the involvement of local authorities[23].

6.3.3 System design

Perhaps one of the greatest weaknesses in the current system is the lack of the design capability needed for a full cross sector development of the energy system. Therefore, decision making could be further improved by having a body responsible for designing the system, and which could also provide expert, informed advice to decision makers.

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21 www.delta-ee.com/images/downloads/pdfs/Delta-ee_ENA_Full_Report.pdf
22 www.districtheatingscotland.com
23 Bolton, R. and Foxon, T. (2015) Infrastructure transformation as a socio-technical process – Implications for the governance of energy distribution networks in the UK

Some elements of this role exist under the current frameworks, largely as part of National Grid's responsibilities where it is well placed to provide at least some of the necessary overview and expertise across electricity, gas and heat. However, its position is currently under examination[24] by the Government and regulator due to the significant potential for real and perceived conflicts of interest between the elements of its businesses that variously involve commercial, network owner, system operator, government advisor and government agent activities.

There have been suggestions by the IET for a fully independent system architect, mainly with regard to the electricity transmission system[25]. The role of an architect embodies a number of concepts which could be well suited to an energy system designer:

- Develop the outline ideas of the client into a concrete design and delivery plan
- Pull together the necessary expertise from the individual specialisms (rather than having to be an expert in everything)
- Develop budgets
- Maintain an overview of delivery and deals with unplanned issues as they arise
- Feed back to the client on an ongoing basis, agree any revisions and refine the plans accordingly.

To work for the energy system, the IET's basic idea would have to be extended to also cover gas transmission and all distribution networks, as well as national level issues covering the energy impacts of the heat and transport sectors. This could be further enhanced through a network of local architects working with, or for, local authorities and dealing with the regional aspects of distribution, heat and transport.

Only with such a comprehensive approach to design will it be possible to recognise and value the system characteristics (examples of which were given in Chapter 3.1), and to optimise the respective costs, benefits and values for the whole system rather than just its individual parts, which risks a higher overall cost and sub optimum system performance.

6.3.4 Regulation, oversight and policing of delivery

The current regulatory system is generally recognised to work well for regulated monopoly networks but has suffered some criticism with regard to its activities in the 'competitive' parts of the industry - supply and generation.

The role going forward should be to independently (of government) oversee the delivery of the high level objectives set by government. This will be more akin to the successful work carried out by the Monetary Policy Committee and the Committee on Climate Change, as well as with regard to the responsibilities that Ofgem has carried out for monopoly network regulation and the administration of schemes like the RO, feed-in tariffs and the RHI. Indeed, it is only by reinforcing an independent approach that such difficulties as experienced in supply and generation because of politicisation, can be rectified or avoided.

With regard to decarbonisation and the focus of this paper, the main elements of regulation that arose from the issues discussed earlier are:

- **Investment ahead of need** - when government lays out a long term framework of decisions and supports this with the legislative basis for the suite of interventions necessary to reach its objectives, and once a system architect is in place, the main pre-conditions to allow sensible investment ahead of need are met

[24] See 3, above

[25] www.theiet.org/factfiles/energy/brit-power-page.cfm

- **Independent oversight of delivery** - the regulator develops the necessary regulations and administers the tenders for the development, construction and operation of non-regulated assets
- **Network charging** - the regulator develops the associated network investment plans and negotiates the resultant price controls. At a minimum these should address the charging anomalies and iniquities that were discussed in Chapter 4.2.2
- **Heat networks** - the regulatory regime and statutory frameworks that currently apply to other utility networks should be extended to cover heat networks in order to support developers and operators in their activities, as well as to protect consumers and investors in a manner they are accustomed to from other energy service providers. It would appear logical to extend the remit of the existing regulator for gas and electricity to cover this, rather than to create a separate body.

There is an opportunity, as part of the restructuring of the organisations involved in decision making and delivery discussed in Chapter 6.3.1, to reconsider Ofgem's current dual role as regulator and administrator.

6.3.5 Delivery – development, construction and operation

The role of the private sector, and competition within it, should be strengthened and used to maintain a downward pressure on costs as well as an efficient approach to delivery. This can be best achieved by encouraging private sector organisations to respond competitively to tenders for the element(s) of the delivery process for which they are best suited. Following the experience of the OFTO regime, this is likely to encourage additional players to enter the market, enhancing competition and stimulating innovation.

Although, as discussed in Chapter 5.2, some questions remain about the accuracy of the price discovery achieved in the first rounds of the CfD and Capacity auctions, there is strong evidence that the competitive process has the potential to push costs down. This is likely to be more pronounced as companies can better match individual hurdle rates to the risk profile of each step rather than having to cover all aspects with one. Combining this with a decision making framework that provides long term clarity and a governance structure that removes, or at least lowers political risk, and which suitably allocates the residual risks will bring further optimisation to the cost of capital.

Long term clarity about the Government's objectives can also encourage collaborative investment in innovation and standardisation as well as efficient production facilities in the supply chain, and allow these to develop over the many years and decades needed to bring them to readiness for deployment at scale. Therefore, a considered strategy and coherent policy framework which focusses support and resource on a limited number of options in the short term, can actually lead to greater diversity and competition in the long term, in a way that competition from the outset may not – CCS being an unfortunate example of the latter.

6.3.6 Wholesale, retail and service markets

Earlier chapters have discussed the potential drivers for a change to the charging structures for various energy services across both electricity and heat. The interactions and dynamics of the various charging elements is very complex and it is somewhat outside the scope of this paper to make specific proposals for these, other than to stress that the case is strong for greater value differentiation, and for better reflection of the changing risks and associated financing needs which accompany the shift from low capital cost/high running cost systems to high capital cost/low running cost ones.

6.4 Sequencing or priorities for the issues/solutions

The order of steps laid out in Chapters 6.3 also represents a natural, logical sequence, although once the intent to proceed is clear, a number of the steps could be developed in parallel.

- Explicitly recognise and define the role of central government in decision making
- Allocate appropriate decision making and support resources to local authorities
- Re-focus the government departments and agencies to create necessary competence and resource
- Legislate for the necessary regulations, standards, obligations and incentives to achieve the stated objectives
- Set up system architect(s)
- Establish the independent regulatory approach to oversee and police delivery
- Start the ongoing process for tendering of development, construction and operation of large scale assets
- Establish the independent regulatory approach to network planning and price control
- Adapt the market structure and charging system

6.5 Summary

- There is a strong case to support the ETI suggestion that changes are needed to the governance and regulatory framework for energy networks.
- Some of these changes cannot be made in isolation and would need to be part of those in the wider energy system.
- The suggested changes are not particularly novel, other than that they require a quality of long-term decision making and independent delivery that has not been evident in recent memory, if indeed, at all.
- Some of the changes are already underway – the Government is already making decisions, payment methodologies are already being adjusted, differentiated auctions are taking place.
- Local authorities' involvement could be crucial to success, especially for heat and energy efficiency investments.
- System design capability will be central to dealing with cross vector issues, synergies and trade-offs
- The role of competition could be strengthened by (continuing or extended) enlightened regulation and tendering appropriate projects
- Costs and cost of capital could be reduced.

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