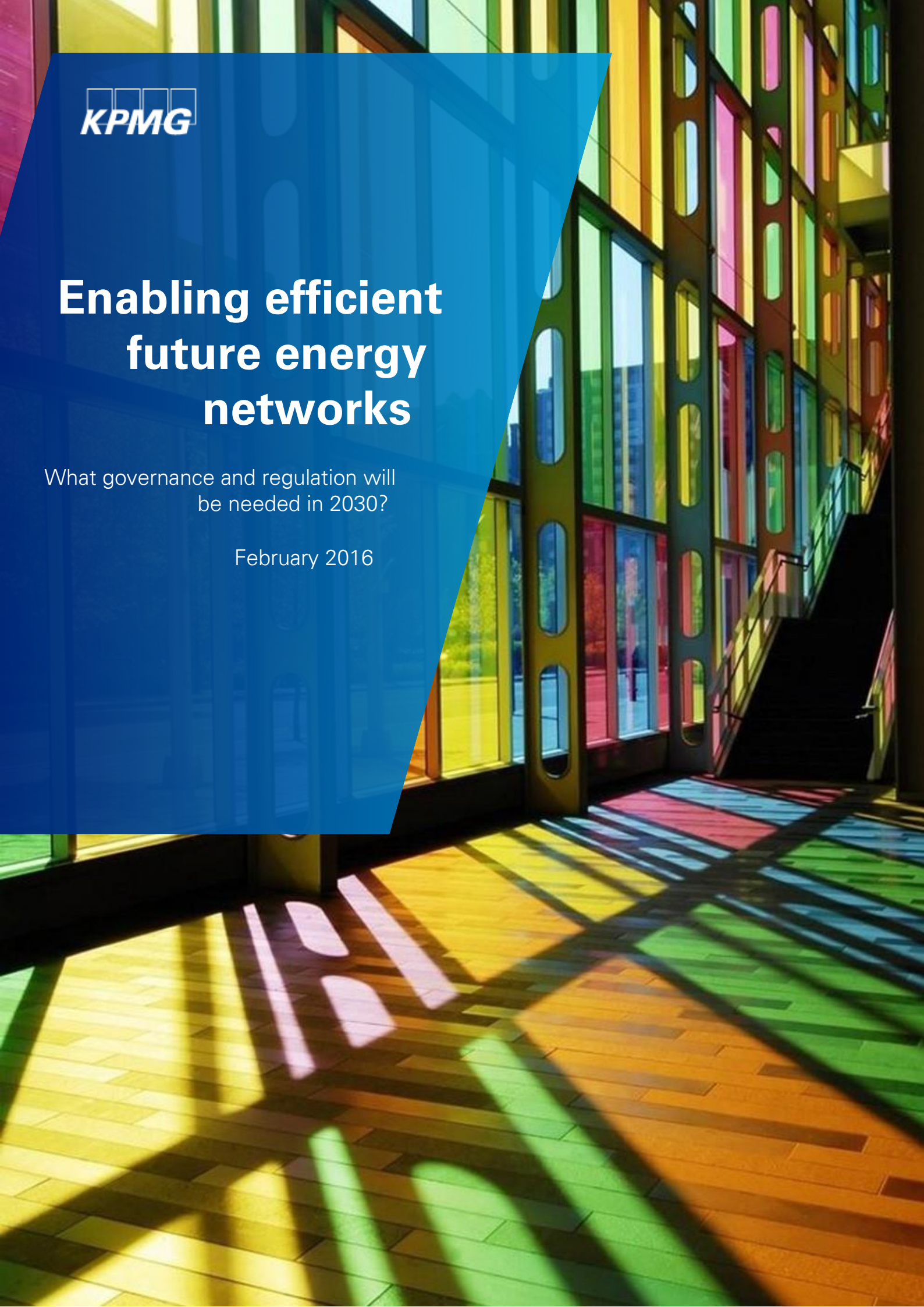


KPMG

Enabling efficient future energy networks

What governance and regulation will be needed in 2030?

February 2016

Contents

1 Executive summary

By 2030, the UK energy system will be very different from today – decarbonisation means the energy mix for electricity, gas, heating and transport is likely to change significantly, and be more closely interlinked. Regulatory frameworks for energy networks must also adapt to enable an economically efficient transition to low carbon energy. This paper provides a view on the possible reforms needed to the UK's governance and regulation framework for network infrastructure, suggesting that:

- New governance institutions ('Energy Commission' and 'Independent System Operator') may be established to advise on, and help deliver, 2030 whole energy system policies respectively.
- Existing regulatory and market regimes should evolve to address whole energy system issues, both optimising and providing certainty for future network investment decisions.
- Competition for new asset ownership should be deployed (where advantageous) for new discrete network infrastructure, bringing benefits of efficiency and innovation.

Electricity and gas networks in the UK have grown significantly over the last 100 years or so from discrete local networks to complex integrated energy systems where national, and increasingly international, energy transportation is provided in a highly effective and reliable way. The industry governance and regulatory framework has similarly evolved over time through state ownership, through privatisation, to one where decisions to meet decarbonisation targets are made by government within a market structure. Network regulation has evolved from RPI-X to RIIO where network output performance is incentivised rather than only targeting efficiency savings.

Over recent years, the UK has made good progress in decarbonising the electricity sector, with rapid growth in renewable electricity. There has been increased investment in networks, especially the electricity transmission network to connect wind farms in Scotland and offshore. New electricity interconnectors to Europe are being built. Gas networks now transfer gas from interconnectors and LNG terminals instead of the North Sea. Electricity distribution networks have had to adapt to large amounts of new distributed solar energy, as technology advances are reducing costs. Renewable heat installations have grown significantly as well, reducing gas demand.

The decarbonisation pathway to 2050 has a critical impact on energy networks as a whole energy system view is taken. In particular, the heat sector, which accounts for roughly 40% of total final UK energy demand, is lagging significantly and heat networks are underdeveloped. Decarbonisation of transport remains at very early stages and substitute fuels are uncertain. The future of gas and gas networks is uncertain but they remain valuable because of the fuel's versatility, flexibility, and lower carbon emissions compared to other sources of heat and power.

For example, should we anticipate turning away from large, remote gas and electricity inputs to our energy networks, to one that is based on more decentralised whole energy systems, or both? Might hydrogen substitute for natural gas? Such change will have a profound impact on network planning, investment and operation, and on the governance and regulation needed for the industry. Clear policy making, governance and regulation is critical for long term investment decisions, and 2030 is not far away! This paper suggests potential changes to governance and regulation – all will take time to introduce. This paper has been produced with the support of the Energy Technologies Institute (ETI). We are grateful for their support and contributions to this paper.

What governance and regulation framework is needed?

As well as ensuring security of supply, the future priority for decarbonisation of the whole energy system will need to take account of electricity, gas, heat and transport energy use, within an overall affordability agenda. It will be critical to clarify responsibilities within Government and Industry for:

- Designing and implementing a 2050 'whole energy system' policy solution.

- Delivering decarbonised whole energy systems, including transport and heat.

This paper suggests that central Government should retain – for the short term at least - leadership of strategic policy decisions within a market structure, with evaluation and decisions on whole energy system policies taken in a holistic way across Government. This view fully recognises Amber Rudd's ambition to return to the market such leadership roles in due course. Delivery decisions should be devolved to both companies and regulator. Ofgem has a clearly defined duty in this regard, having been awarded a sustainability primary duty in the Equality Act 2010. In the regulatory arena, Ofgem's strategy should also consider whole energy system issues e.g. decarbonisation of heat and transport sectors. The forthcoming DECC Heat Strategy may help to address some of these points.

While Government is advised on future carbon budgets by the Climate Change Committee (CCC), there is no equivalent body to advise Government on such major deployment options. Given the significance of future energy decisions, it could be appropriate for a senior advisory body (perhaps an 'Energy Commission') to be established to contribute to long term policy direction. It is recognised that the Coalition and now Conservative Governments do not want to create 'Quangos' and so imaginative thinking is needed in how best to implement. This could be a standalone body comprised of technical experts, or a widened role for the CCC or another body.

The transition of governance and regulation to whole energy system solutions will also impact on bodies performing energy system operation and administration. The need for a wider energy planning and operational role may require an Independent System Operator (ISO) to be established. National Grid are seen by many as performing well in a similar role at present, and the role is an administratively complex and burdensome one.

Similarly, if evolving sector administrative functions are to be performed clearly and efficiently in future, then reform and consolidation of the various existing institutions may be needed. Reforms are already underway, and KPMG has been working closely with several organisations involved in these administrative functions in efforts to improve workings.

Turning to the future of network regulation, Ofgem's RIIO regime would seem to continue to be an appropriate framework especially in a time of future investment uncertainty. The next 8 year price controls are due to be in place in 2021 and 2023, so key investment incentives for 2030 will need to be designed by then.

Where and how investment decisions should be taken?

Difficult decisions lie ahead. One of which is the future of natural gas in the energy supply mix. While decarbonisation to date has focused on electricity, if 2050 targets are to be met then gas will need to be decarbonised. Another difficult and potentially conflicting decision concerns the deployment of heat networks and associated energy saving measures. Major national policy decisions may be required, for example, to promote the replacement of natural gas with hydrogen, or to possibly substitute (where appropriate) gas networks with decarbonised heat networks, or electric heating. Such decisions will require examination of costs and benefits on a whole system basis.

Once an investment framework is set, individual network companies could proceed with investment decisions within this approval framework. The RIIO can be easily adjusted to provide new decarbonised incentives and output measures that are both demanding on the companies and gain customer support. For example, network companies might be incentivised to enable local heat networks or other local energy solutions.

Where and how should competition in networks be maximised for efficiency and innovation?

Competition is an important enabler for efficiency and innovation. It can provide the delivery mechanism for the investment decisions that have been taken. Ofgem has already successfully introduced competition in distribution connections and offshore transmission. Offshore transmission

competitions have helped to demonstrate the benefits of auctions. Ofgem is now developing a similar regime for competing the design, construction and ownership of onshore transmission assets.

There are a number of other opportunities for design, build, finance and maintain models to be pursued through competitive processes. For example, local heat networks, and integrated distributed energy installations could also be attractive for tendering. These may involve the delivery of electricity, gas and heat energy as well as infrastructure to a particular community.

2 Concept Summary

Strategic concept for reform

Clear governance and regulation is critical for long term investment decisions. The future of gas and gas networks is uncertain, and the electricity sectors rapid decarbonisation is creating new pressures. New governance institutions, rationalisation of existing administration, and further competition where advantageous could provide the necessary toolkit for enabling efficient investment in energy network infrastructure for low carbon futures.

Key priority measures

This paper provides a view on the possible reforms needed to the UK's governance and regulation framework for network infrastructure, suggesting that key priorities are:

- New governance institutions:
  - An 'Energy Commission' may be established to provide advice on 2030 whole energy system policy. This could be a standalone, time-limited, independent technical body, or be part of an expanded Committee on Climate Change (CCC)
  - An 'Independent System Operator' may be established to help deliver 2030 whole energy system policies.
- Existing regulatory and market regimes should evolve to address whole energy system issues, both optimising and providing certainty for future network investment decisions. Industry rules and codes should be simplified and made more responsive to engage new entrants and new business models. Clean energy incentive administration should be the simplified, perhaps relying on a 'Clean Energy Delivery Agency' in place of some existing administration.
- Competition for new asset ownership should be deployed (where advantageous) for new discrete network infrastructure, bringing benefits of efficiency and innovation. This could involve in due course further competition in onshore transmission and in distribution network connections. Heat networks may also provide a potential route for competition to help enable efficient investment.

Supporting analysis

Key challenges

The moves to a low carbon economy are producing a series of challenges for investment in, and the governance of, energy network infrastructures. These key challenges include:

- Increasing reliance on intermittent generation (and the potential range of back-up generation, storage etc. required);
- The supply of heat through conventional gas networks, heat networks and renewable heat solutions (e.g. biogas, heat pumps); and
- The potential emergence of locally planned energy microgrids, including heat networks, where communities are in control of their energy use and deployment.

Issues identified

The current market and regulatory approach is imperfect, and could become more so over time if key issues are not addressed. The key issues identified in this report include:

- Industry administrative complexity adding costs and delaying activity in the system; and
- The need for a coherent strategy, regulatory and administrative landscape for emerging whole energy system complexities including heat delivery and distributed energy.

3 Introduction

This paper has been prepared for the Energy Technology Institute (ETI). It provides an independent view on the possible reforms of the governance and regulation framework for network infrastructure to enable an economically efficient transition to low carbon energy in the UK.

In line with global and EU commitments to deliver reductions in greenhouse gas emissions, decarbonisation targets for the UK have been set under the 2008 Climate Change Act to mandate 80% emissions reductions by 2050. The UK has established an independent Climate Change Committee (CCC) which advised Government on the levels of future 5 year carbon budgets and decarbonisation targets. The Department of Energy and Climate Change (DECC) is primarily responsible for realising these targets.

By 2020, the UK expects to reduce greenhouse gas emissions by 20% below 1990 levels. This will largely be achieved by sourcing more electricity production from renewables by 2020, with wind, solar and biomass technologies substituting for coal and gas. While the 2030 target for electricity appears to be on track, it has resulted in significant long term subsidy payments being needed to incentivise these renewable technologies, and associated new electricity network investments. Today, in 2016, the affordability of increasing energy subsidies is of growing political concern, as is the weakening of security of supply resulting from electricity market changes. Mandatory emissions reduction targets for 2030 and beyond and policies for delivery have not yet been agreed.

By 2030, alongside decarbonisation targets, energy will remain an essential public service, needed to be available instantaneously on demand. However, the UK energy delivery system will be very different from today. The energy mix for electricity, gas, heating and transport is expected to change significantly, and be more closely interlinked. Heating and transport in particular will need to significantly decarbonise, and consequently will impact on demands for electricity and gas, and their associated networks.

The impact of the decarbonisation targets, along with other key factors such as demand changes, technology innovations, consumer behaviour, and potentially more decentralised energy systems are very uncertain. For example, will existing electricity and gas networks still be needed as key national energy assets? Will new heat networks be developed and with what energy source? Will new energy infrastructure for transport be required?

As the energy system changes, the governance and regulatory regime will need to adapt as well, not only to ensure that the correct incentives and markets are established to allow the most efficient delivery of Government policy, but also to identify when future regime improvements are needed. From a networks perspective, governance and regulation for 2030 will need to take a whole energy system perspective to:

- Enable and incentivise investment to adapt and enhance existing networks.
- Incentivise clear and efficient planning and investment decisions for new networks.
- Optimise energy operation across power, heat and gas.

This paper proposes a new framework for regulation, governance and markets in 2030 to enable efficient investment in energy related network infrastructure (of all types). It sets out views upon:

- What governance and regulation framework is needed?
- Where and how investment decisions should be taken?
- Where and how should competition be maximised to promote efficiency and innovation?

4 The evolution of UK energy governance

4.1.1 Empowering a nation

First a look backwards. The first commercial gasworks in the UK was established in Westminster in 1812, and the first commercial electricity system in Godalming in 1881. Since then, electricity and gas transmission and distribution networks have grown rapidly to transport energy from various sources of supply or production to businesses and homes. They provide an essential, safe and reliable public service.

Up until the 1940s, decentralised planning and operation of the energy industry was the norm. UK electricity and gas networks were part of a localised utility patchwork which grew rapidly in response to greater urbanisation, but which was generally un-coordinated and offered variable standards of service.

In 1948, nationalisation of the electricity supply industry led to the creation of the Central Electricity Generating Board and Area Supply Boards for England and Wales, and two Scottish electricity companies. A central planning approach led to major investment in a national 'SuperGrid' transmission system, connecting large coal, oil and nuclear power stations to supply increasing energy demand and drive economic growth. The gas industry was also nationalised in 1948 but it was the transition to natural gas in the 1970s that led to major investment in a national gas transmission and distribution system, owned by the newly created British Gas Board.

For around 40 years following nationalisation, the electricity and gas industries were centrally planned by Government owned companies which invested in R&D, built skills and capabilities, and invested in assets to deliver a high quality service that was respected worldwide. However, over that time, while technically very able, the companies became more and more regarded as inefficient monopolies and barriers to change. Privatisation and competition were therefore introduced.

4.1.2 Privatisation and competition

By 1990, privatisation transformed the industry from one where Government led all aspects, including price setting, to one where markets and customer choice determined energy prices. In order to open up competition in wholesale and retail energy markets, the industry was unbundled to separate generation/production, transmission and distribution, and supply to customers. Open, transparent energy markets enabled new entrants to compete alongside incumbents.
Key events included:

- Gas privatisation took place in 1986, placing the £9 billion British Gas monopoly company in the private sector, and setting up its regulator, Ofgas. The market was not opened fully to competition until 1995. Subsequently, in 1997, British Gas demerged into Supply (Centrica), Exploration and Production (BG) and Network (Transco) businesses.
- The £32 billion electricity privatisation took place in 1990, with the industry restructured into generation, transmission, distribution and supply, before sale to private sector parties. The industry regulator, Offer, was established to regulate monopoly businesses and facilitate competition. New industry codes and agreements replaced old public sector arrangements.
- The electricity market at privatisation consisted of a 'pool' design. Administration tasks of market operation and settlement, industry-wide code governance, and system operation and planning were performed independently (of generation or supply activities) by National Grid, the transmission company for England & Wales.

- Once the new arrangements were in place, the Department of Energy was subsumed into the DTI (in 1992), leaving the industry largely being governed and regulated through market forces, within regulatory frameworks and regulatory oversight.
- During the 1990s major efficiency improvements were realised in all utility company operations, combined with a major shift towards gas-fired power stations that were low cost and quick to construct. The decade also saw increased integration between gas and electricity supply companies. The later 1990s saw a continued increase in industry self-governance of common industry rules and processes, encouraged by regulators and Government.
- After 2000, the increasingly integrated nature of the electricity and gas sectors saw the merger of Offer and Ofgas into Ofgem, and also a merger between National Grid and Transco. New electricity trading arrangements were implemented to replace the 'pool' and introduce greater competition into electricity generation in England & Wales, and later into Scotland as well. The sale of a number of National Grid Gas Distribution companies took place in 2005.

Over this period, under private sector ownership, the combination of competitive energy markets and effective regulation saw significant cost savings being delivered to businesses and customers alongside significant improvements in safety and reliability of services. The monopoly electricity and gas networks in particular represented an attractive proposition for investors, with long term regulatory and financial stability in place. All the network companies are investor owned.

4.1.3 Government leadership of decarbonisation

From 2000 onwards, international and UK Government priorities turned to reducing carbon emissions, and a major change of energy policy direction took place. By 2007, as part of an EU-wide agreement, the UK agreed to source 15% of its energy in 2020 from renewable sources. Environmental legislation included the Climate Change Act 2008, the EU renewable energy and energy efficiency targets for 2020, and measures to reduce local air pollution such as the Large Combustion Plant Directive and Industrial Emissions Directive. The Government created the Department of Energy and Climate Change (DECC) in 2008, to ensure that policies for decarbonisation were developed and implemented.

The energy sector, and particularly power, led decarbonisation. Government subsidies to encourage renewables led initially to the rapid development of onshore and offshore wind. Other subsidies and regulations were used to encourage energy efficiency, renewable heat, solar, nuclear, Carbon Capture and Storage (CCS), and biomass. In 2014, electricity market reforms were introduced so Government could run auctions to ensure value for money low carbon generation. However, while on track to realise 2020 targets, the subsidy costs committed to incentivise renewables were now higher than originally budgeted.

Over this period, Government has made several legislative changes to introduce and amend policies to balance the 'trilemma' of decarbonisation, affordability and security of supply. While ongoing wholesale and retail markets are seen by many as functional (a view many expect to be taken by the CMA investigation due to complete in 2016[1]), issues remain and generation investment decisions are largely reliant on Government policy. Given the increased scale of decarbonisation ahead, this is likely to continue.

The transition from coal, gas and nuclear generation to one where renewables dominate new investment has led to challenges for security of supply. In response to generation capacity margins falling, caused by the closure of old coal and nuclear stations and the need to decarbonise, the Government introduced Electricity Market Reform (EMR) in 2014. These reforms have sought to encourage investment through a new capacity market. However generation margins have fallen to less than 5% as new gas-fired plant is not being built. Emergency short term measures have led in recent years to the construction of small scale diesel and gas generation which can be installed

[1] https://assets.digital.cabinet-office.gov.uk/media/567a9a31e5274a1385000013/Energy_market_investigation_case_timetable.pdf

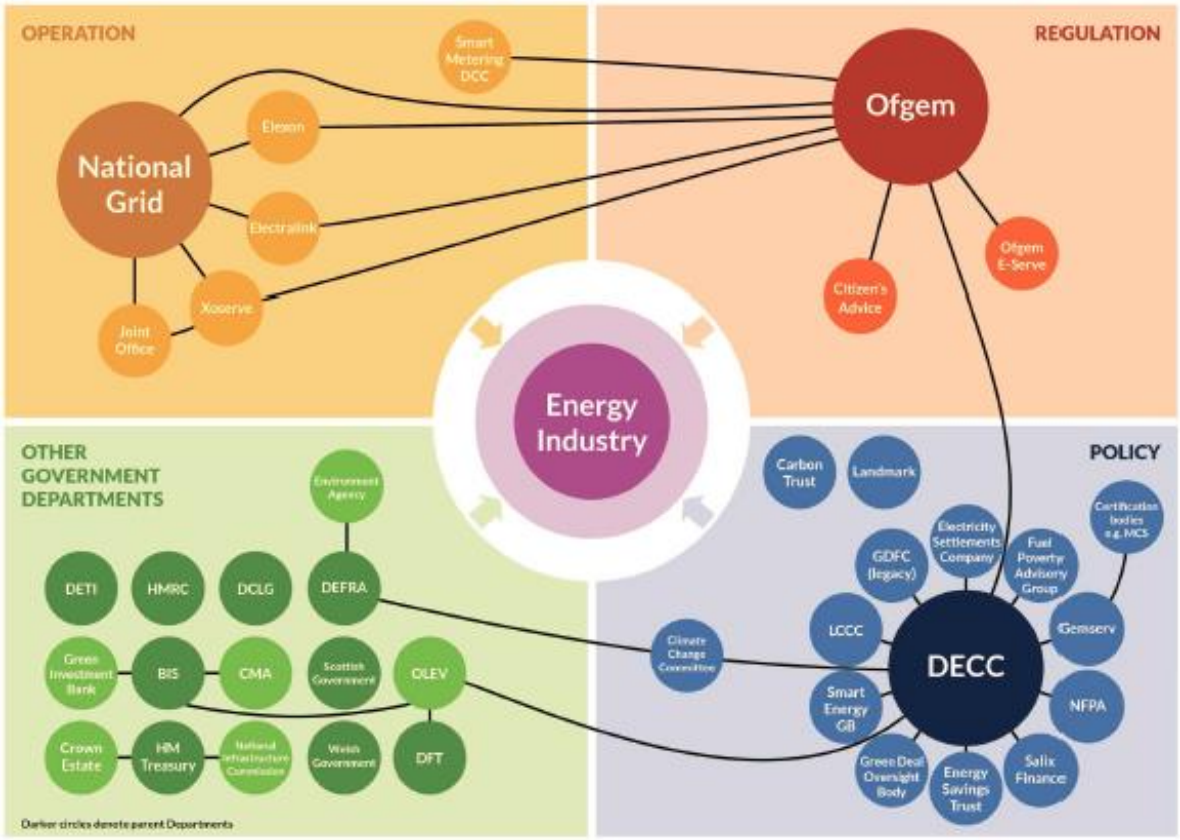
quickly. The Government has signalled its intent to address this challenge through adjustments to the capacity market.

4.1.4 Industry administration complexity

The energy industry in Great Britain has undergone major changes since privatisation, with new policies, industry regulations and market reforms being continually introduced. Complexity has increased as new policies for clean energy, smart energy, security of supply, and retail competition have been overlaid on legacy arrangements. Further change is expected as the transformation towards a low carbon energy system gathers pace.

Over time, new bodies, institutions and agencies have been established and there are now more than thirty such bodies actively involved in the administration of the energy industry – centred around DECC, Ofgem and National Grid. These are the bodies that create, deliver and administer the energy policies, regulations and rules that govern electricity and gas industries and markets. Administrative responsibilities split across these different bodies result in costs of around £500 million per annum (excluding DECC), which are paid for from general taxation and charges on consumer bills.

Diagram 1 – The industry administration landscape[2]



The energy industry is undergoing a significant transformation in order to meet decarbonisation objectives, which will involve new technologies, products and services, and business models. The fragmentation and complexity of the current policy and regulatory regime may act as a barrier to this innovation, as well as undermining its responsiveness and flexibility during this period of rapid change.

[2] Policy Exchange – Governing Power, November 2015 (with supporting analysis provided by KPMG).

4.1.5 What has this meant for networks?

After privatisation, network costs fell by 45% in real terms, in part due to efficiency improvements, but as new investment started after 2005, costs rose and by 2015 were 17% below 1990 levels. Network costs currently make up around 23% of the average domestic customers energy bill.[3]

The connection of large amounts of new generation (especially onshore and offshore wind, and solar) resulted in significant new network investment both for transmission and distribution networks. In particular, large amounts of wind generation in Scotland has driven major new transmission network reinforcement. Furthermore, major new gas interconnection and LNG capacity has been built and several GW of new electricity interconnection is under construction. Large volumes of ageing assets have also needed replacement to maintain reliability. Between 1990 and 2020, £80 billion is expected to be invested in energy networks.[4]

While new network investment is not directed by Government, the regulatory regime in place since privatisation has ensured that new sources of electricity generation or gas supply must be offered terms for timely connection into the respective electricity or gas networks, only limited by the ability of network companies to consent and build the necessary assets. Codes for access to, and performance of, networks have been established, and charging methodologies developed to recover costs and incentivise efficient use of network capacity.

[3] https://www.ofgem.gov.uk/publications-and-updates/charts-outlook-costs-make-energy-bills

[4] https://www.ofgem.gov.uk/publications-and-updates/ofgem-announces-%C2%A317-billion-electricity-network-and-cuts-bills-consumers

5 Evolution of network regulation – Where are we now?

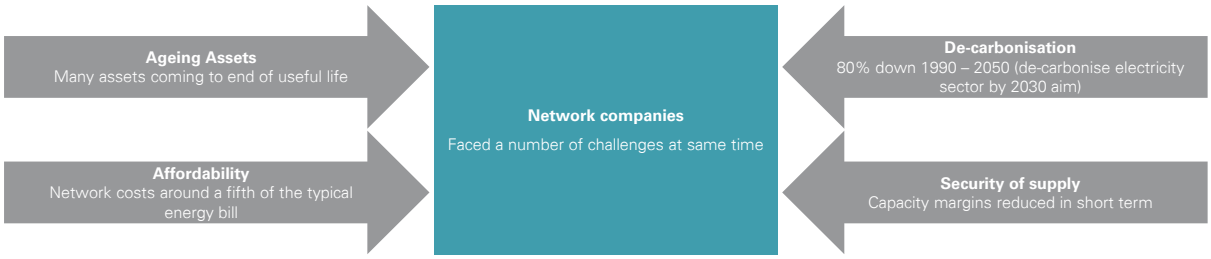
5.1.1 RPI-X model

Following privatisation, the Great Britain (GB)[5] monopoly network companies were regulated under an RPI-X model, where X was an efficiency factor set by the regulator. Under this regime revenues were set for 5 year periods and companies had strong incentives to cut costs further so they could keep the savings. This model brought about significant benefits, including major savings for energy customers, and increased service and network quality.

UK regulatory experience is that there remains a significant asymmetry of information in favour of the regulated company. A key benefit for regulators from industry restructuring was separation of monopoly networks (and their individual costs) such that performance comparisons could be better made. However, while 5 year controls allowed regulators to learn from company performance in the previous period, preparation for the next control started at least 2 years in advance so that companies and regulator were generally only free from price control negotiation for 3 year periods.

Once decarbonisation and major asset replacement commenced, Ofgem thought that the challenges facing the industry, as demonstrated in diagram 2 below, would accentuate the problems with the RPI-X model. This led it to conclude that a new regulatory model was needed to incentivise efficient new investment while maintaining network performance and ongoing efficiency improvements.

Diagram 2 – The perceived shortcomings of RPI-X regulation



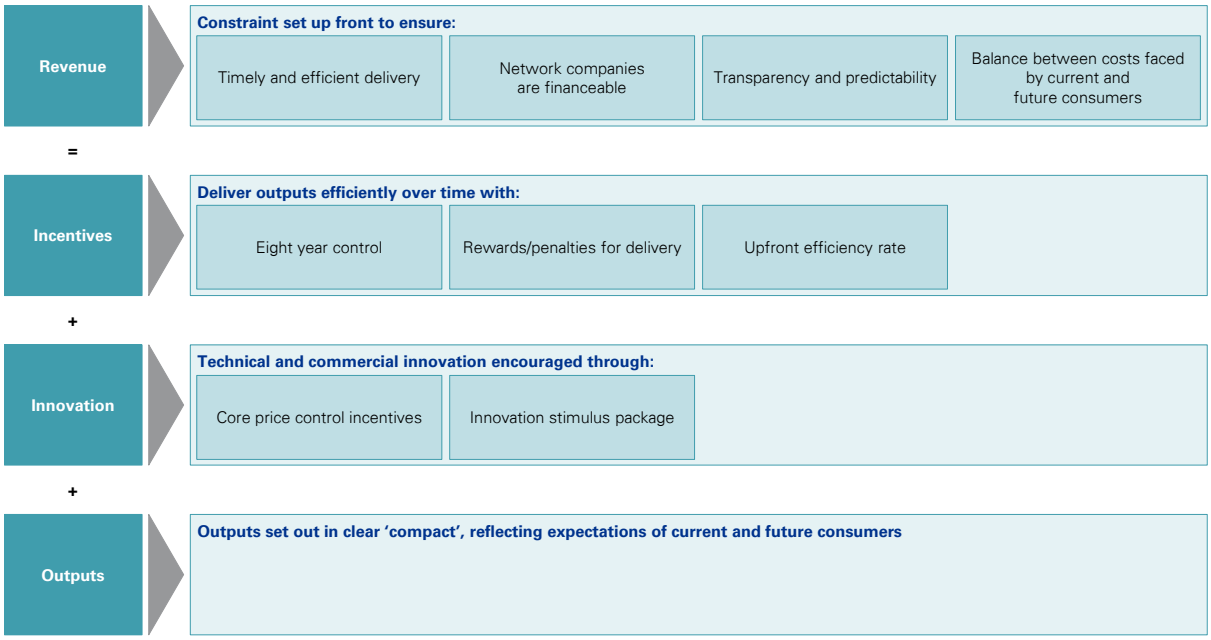
In 2009 to 10, approximately 20 years after the RPI-X model was first implemented, Ofgem conducted an extensive review of the RPI-X regulatory model called RPI-X@20. Although the employment of RPI-X regulation in the GB energy markets was seen as a largely successful approach, Ofgem's review highlighted a number of shortcomings:

- Network Companies were too focussed on the short term.
- Cyclical business flows caused difficulties for the supply chain.
- There was not enough R&D and innovation.
- There was an inherent bias towards capital expenditure which the network companies were 'gaming' to enhance returns.

The RPI-X@20 review put forward a new model of network regulation which it called 'RIIO' as set out in diagram 3 below.

[5] Northern Ireland followed a different model.

Diagram 3 – RIIO approach to regulation



RIIO is an 'outputs' based model under which Ofgem incentivises outputs covering, reliability, safety, customer service and connections. Each company is given an allowed total expenditure (known as Totex) with which to deliver these outputs. In previous price controls network companies preferred Capital Expenditure over operational expenditure as this increased their Regulatory Asset Value (RAV), which is the main measure of their market value. The Totex approach removes this bias by pre-determining the percentage of its revenue that is added to a company's RAV, thereby removing the link between a network company's capital expenditure and its RAV.

Elements of the RIIO model had started to be deployed in the price controls prior to 2010, as a greater emphasis was placed on incentivising performance outputs. Moving to an 8 year regulatory period was intended to reduce the regulatory burden, and give companies a greater ability to realise benefits for investors and consumers alike from long term investment or operational decisions. The new network regulatory periods are set out below.

Table 1 – RIIO price control periods

Network	Known as	Period
Gas and Electricity Transmission	RIIO-T1	1 April 2013-31 March 2021
Gas Distribution	RIIO-GD1	1 April 2013-31 March 2021
Electricity Distribution	RIIO-ED1	1 April 2015-31 March 2023

The aim of this regime is to enable outperforming companies to earn higher returns because they embrace incentives that promote a better outcome for British consumers. This incentive is available to all network companies and has enabled Ofgem to set a slightly lower base RoE (Return on Equity) which has appealed to consumers and other industry stakeholders.

The overarching efficiency incentive which applies to all of a network's allowed revenue is the Totex efficiency incentive. Under this incentive networks keep a set percentage of any underspend on their allowed revenue, with the remainder going back to customers and vice versa. This percentage is the Totex efficiency rate, also known as the 'sharing factor'. On top of the Totex incentive is a series of additional incentives which seek to incentivise particular outputs. These incentives can be

symmetrical (reward or penalty depending on if a set target is met/missed) or asymmetrical (reward or penalty only). Incentives can also be from a set pot of funding for carrying out certain activities.

Under RIIO, network companies submit a 'well-justified' business plan that is informed by extensive engagement with its customers and stakeholders. Ofgem assesses these plans and could decide to accept the network's business plan and settle the price control – this is known as 'Fast Tracking'.

Western Power Distribution (WPD) (in distribution) and the two Scottish transmission companies Scottish Power and Scottish-hydro (part of SSE) were fast-tracked under the first RIIO price control. Those who do not pass the fast tracking assessment are subject to further scrutiny (known as slow tracking), which usually results in Ofgem reducing allowed Totex compared to what a network asked for in a business plan. Fast tracking can have significant advantages for companies, as they get their price control settled a year early and automatically receive an Information Quality Incentive (IQI)

The early outcomes from RIIO (mainly Transmission and Gas Distribution which have been in place for longest) seem to indicate that most companies are achieving the output performance requirements and benefiting from these incentives.

5.1.2 Network innovation

A widely held view is that since privatisation there has been little network innovation, particularly large scale transformative innovation, in that time. Innovation funding competitions were introduced by Ofgem to try to counter concerns that network companies were too risk averse to come up with the innovative solutions needed to solve the big challenges of the next decade. The Low Carbon Networks Fund (LCNF) and Network Innovation Competition (NIC) are designed to pool risk, granting funding to riskier projects that would otherwise not be undertaken by the risk averse network companies.

There is an acceptance from Ofgem that some projects may not be successful but even unsuccessful projects may contribute some learning that can be used to benefit network customers in the long run. As the risk is shared by all customers, Ofgem expects that benefits should also be shared, meaning companies cannot keep any innovative learning to themselves to gain an advantage.

5.1.3 Competition for network asset provision

Where possible, Ofgem has sought to use competition in the provision of new network connections to ensure value for money is realised. Regimes have developed where independent gas transporters (iGTs) and independent distribution network operators (iDNOs) can successfully compete with incumbent networks to build and operate connection assets.

For connections to offshore wind farms, Ofgem has introduced and run competitions for some £3 billion of new (already constructed) offshore transmission links. This offshore transmission network owner (OFTO) regime has allowed new entrants to enter the transmission infrastructure market and has realised both innovation and significant additional savings for consumers compared to onshore price controls. Ofgem's analysis of OFTO tender round 1 (which comprised £1.5 billion of lifetime revenues) showed competition delivering savings of between £200 to £400m, with a further 20-30% of savings forecast for later tender rounds.[6]

Ofgem is in the process of extending competitive tendering regime to onshore transmission assets, and expects the first competitive tender to take place in 2017. The onshore regime is expected to extend to design and construction as well as ownership, financing and maintenance. Grid operation remains the responsibility of the National System Operator.

[6]https://www.ofgem.gov.uk/sites/default/files/docs/2014/09/draft_letter_on_outcome_of_consultation_on_the_evaluation_of_ofto_tender_round_1_benefits_20140919.pdf.

6 What might the energy industry look like in 2030?

The two previous sections have considered how the governance and regulation of the UK electricity and gas industries have evolved over time, and particularly through significant change at industry privatisation followed by the start of decarbonisation. Before going on to look at the potential future governance and regulatory reforms that may be required, this section looks at what the industry may look like in 2030.

6.1 Key influences

By 2030, energy systems will need to change significantly from today. Key influences are likely to include:

6.1.1 Consumer behaviour

Energy today is seen by consumers as an essential service that must be available on demand. Similarly, the networks that supply it to homes and businesses are seen as an essential public service where reliability and safety are critical.

This is expected to continue, but energy consumption decisions may be different, as well as the way that people engage in their energy choices. Households, as well as businesses, may increasingly engage in managing the cost and efficiency of their own energy consumption, producing their own energy, and potentially engaging in demand response services.

Demand for energy and the associated networks are likely to change as well. Currently we might expect a future where overall energy use is reduced as decarbonisation targets are realised. A commonly expected future is where greater use is made of electricity for electric vehicles, energy storage, and heating. However, futures where cheap renewable energy is available at large or small scale, will have a significant impact on how customers may decide to use energy, and new energy-hungry applications may emerge.

6.1.2 Technology

The impact of subsidies to encourage the deployment of certain technologies has had a significant impact on their development cycles. For example, solar costs have fallen by around 75% over the last 5 years[7], and further reductions are expected. Solar costs are already comparable to some conventional technologies, and costs are expected to continue to fall.

Similarly, costs of energy storage, especially batteries, also show signs of a similar decline and may form a valuable energy combination with intermittent solar and wind technologies. On the demand side, developments of electric and hybrid vehicles are advancing quickly, and their market share is expected to grow quickly.

However, picking the right long term technology to back is difficult and incorrect choices can be expensive. At the same time, technology advancements may only emerge if demand is large enough to trigger significant research and development.

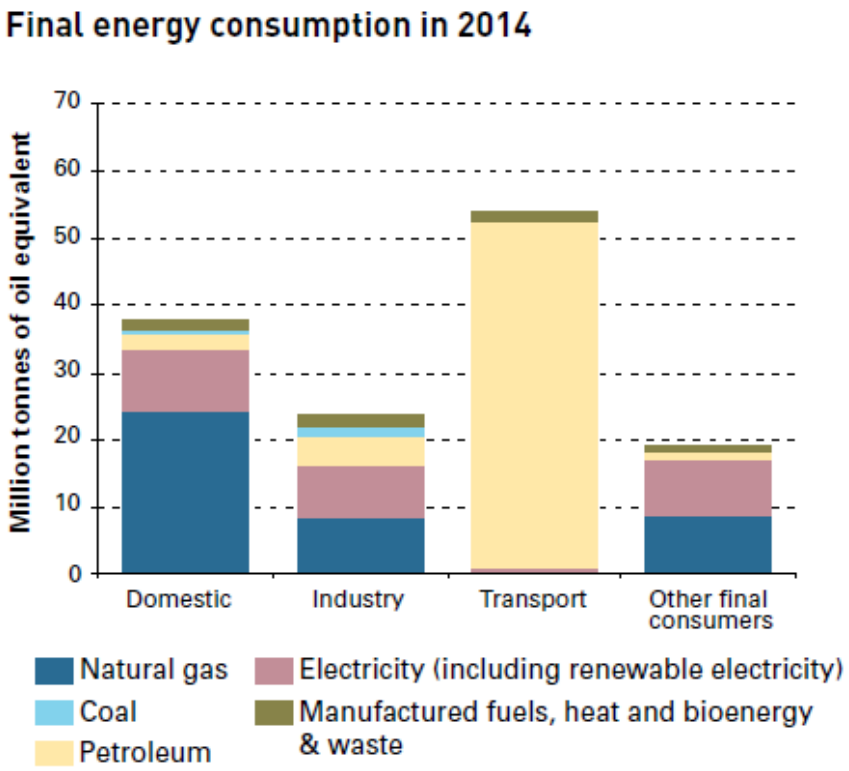
[7] Source: IRENA

6.1.3 Politics and policies

Affordability, security of supply and decarbonisation all remain critical elements of UK energy policy. The costs of achieving the decarbonisation element are now becoming clearer. In particular, if the price of natural gas (as the marginal cost fuel for electricity generation) remains low, then the subsidy cost of renewables will remain relatively high with consequent impacts on energy bills. The affordability of energy (and cost of decarbonisation) is becoming an increasingly important political and public issue.

Energy decarbonisation targets through to 2050 will remain the most challenging and dominant feature for future politicians and their energy policy. The current split of energy demand is shown in the following chart[8], showing the significant proportion of heat and transport decarbonisation that will be required to achieve 80% decarbonisation targets by 2050.

Diagram 4 – Final energy consumption in 2014



6.1.4 Institutions

While the UK Government currently has a Department (DECC) responsible for energy and climate change, there are many other parts of government e.g. transport, environment, treasury, business, science, etc., that have significant interest in the design and implementation of energy policy. The sector regulator, Ofgem, licenses and regulates energy companies. Key directions will also come from the EU which is pursuing Europe-wide energy policies to enable decarbonisation and competitive energy markets.

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449060/Energy_Flow_Chart_2014.pdf.

Each of these institutions will have some influence over energy policy delivery, markets, and investment decisions. They have different priorities and certain decisions e.g. exclusion of aviation and shipping from carbon targets, development of electric vehicles, will have significant impacts on the aims of other institutions.

6.1.5 'Lock-in'

A factor that is particularly relevant to energy networks is the concept of 'lock-in'. These networks are national assets that transport energy in a highly reliable manner. They account for significant levels of investment that existing and future customers are paying for.

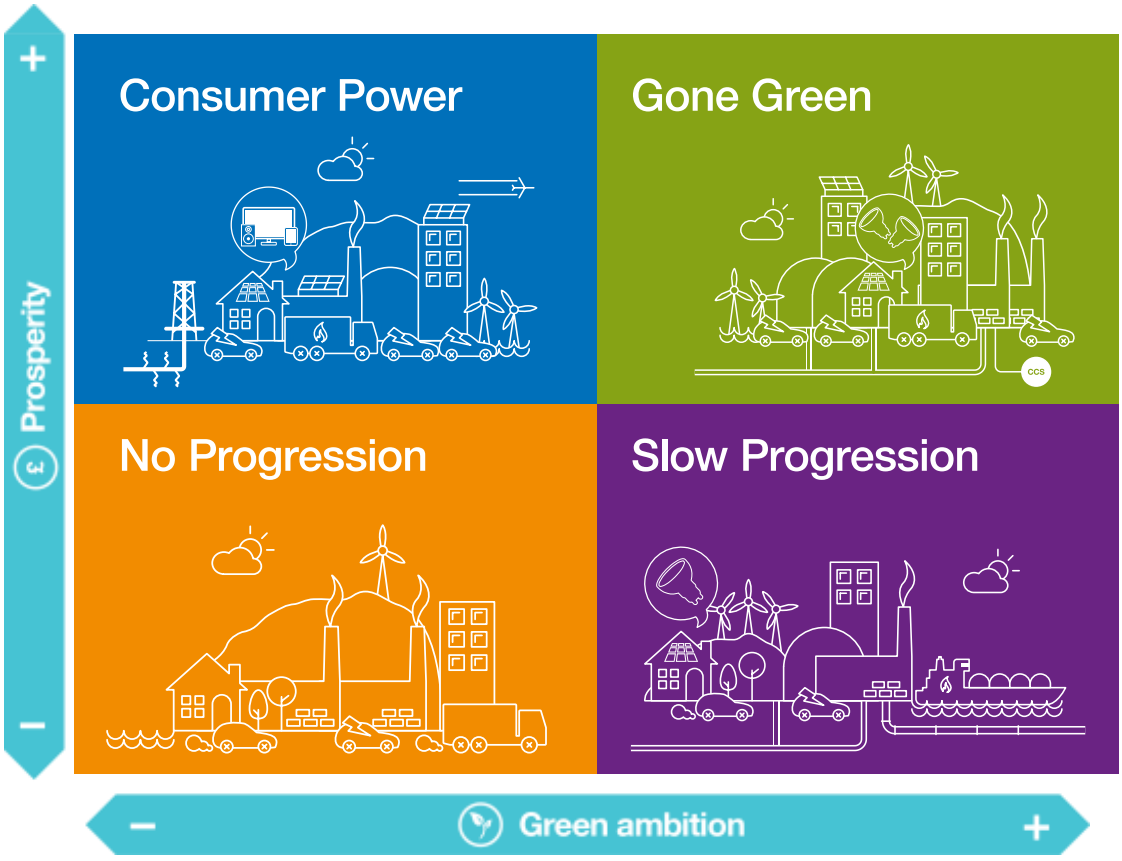
In developing scenarios for energy future, it is important to take account of existing assets and expenditure. Network assets typically have lifetimes of several decades, and will be available for 2050 and beyond. Furthermore, the rights of way that route these networks between production and demand are valuable assets in their own right, given the challenges in obtaining consents for new rights of way.

6.2 Whole energy system scenarios for 2030

6.2.1 Building Scenarios

Many energy scenarios have been produced looking at 2050. Most look primarily at different combinations of decarbonisation technologies and demand for 2050 and how these impact upon the sector. In its role as National System Operator, National Grid produces annual scenarios for electricity and gas planning purposes as illustrated below.[9]

Diagram 5 – National grid energy scenarios



[9] Source National Grid

- **Consumer Power**: A world of relative wealth, fast-paced research and development and spending. Innovation is focused on meeting the needs of consumers, who focus on improving their quality of life.
- **Gone Green**: A world where green ambition is not restrained by financial limitations. New technologies are introduced and embraced by society, enabling all carbon and renewable targets to be met on time.
- **Slow Progression**: A world where slower economic growth restricts market conditions. Money that is available is spent focusing on low cost long-term solutions to achieve decarbonisation, albeit later than the target dates.
- **No Progression**: A world focused on achieving security of supply at the lowest possible cost. With low economic growth, traditional sources of gas and electricity dominate, and little innovation affects how we use energy.

ETI's 2050 energy scenarios[10] are 'Patchwork' and 'Clockwork', which consider scenarios for power, heating, transport, energy and infrastructure. In summary, Clockwork sees a more centrally planned decarbonisation transition whereas the Patchwork transition is initially more societal led, with national solutions overlaid later:

- **Clockwork** – Well-coordinated, long term investments allow new energy infrastructure to be installed like clockwork. The regular build of new nuclear, CCS plants and renewables ensures a steady decarbonisation of the power sector. National-level planning enables the deployment of large-scale district heating networks, with the local gas distribution network retiring incrementally from 2040 onwards. By contrast, the transportation system remains in the earlier stages of a transition and vehicles are used in a similar way to today.
- **Patchwork** – Central government takes less of a leading role and a patchwork of distinct energy strategies develops at a regional level. Society becomes more actively engaged in decarbonisation, partly by choice and partly in response to higher costs. Popular attention is paid to other social and environmental values, influencing decision-making. There is a more extensive decarbonisation across all sectors, including transport. Cities and regions compete for central support to meet energy needs which is tailored to local preferences and resources. Over time central government integrates the patchwork of local networks.

Turning to network scenarios, in 2009, Ofgem published the results of a Long Term Electricity Scenarios study (LENS)[11], which looked at the future for electricity networks. It was authored for Ofgem by academic partners with wide engagement across industry. The study considered a range of scenarios from the emergence of local microgrids and supply companies to extensive transmission grids for large remote generation, such as offshore windfarms. The key scenarios were:

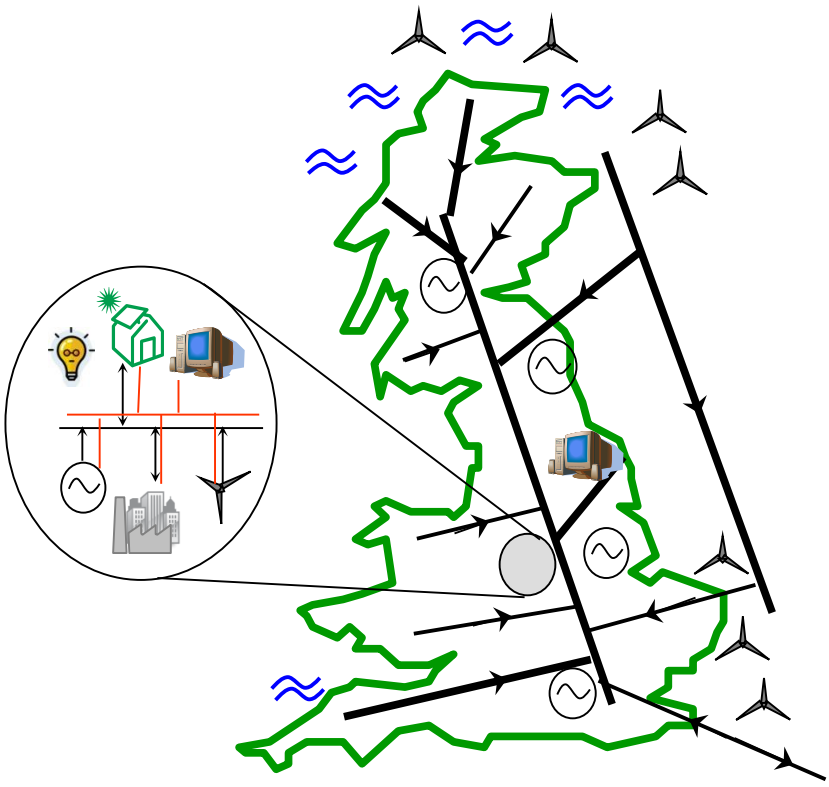
- Big Transmission and Distribution, in which transmission system operators (TSOs) are at the centre of networks activity. Network infrastructure development and management continues as expected from today's patterns, while expanding to meet growing demand and the deployment of renewable generation.
- Energy Service Companies, in which energy service companies (ESCOs) are at the centre of developments in networks, doing all of the work at the customer side. Networks contract with such companies to supply network services.
- Distribution System Operators (DSOs) take on a central role in managing the electricity system. Compared to today, distribution companies take much more responsibility for system management including generation and demand management, quality and security of supply, and system reliability, with much more distributed generation.

[10] Source: ETI

[11] https://www.ofgem.gov.uk/sites/default/files/docs/2009/03/20081107final-report.pdf.

- Microgrids, in which customers are at the centre of activity in electricity networks. Electricity consumers take much more responsibility for managing their own energy supplies and demands. Microgrid system operators (MSOs) emerge to provide the system management capability to enable customers to achieve this with the new technologies.
- Multi-Purpose Networks, which assume network companies at all levels respond to emerging policy and market requirements. TSOs still retain the central role in developing and managing networks but distribution companies also have a more significant role to play. This multi-purpose scenario is probably closest to the energy network environment that exists in 2015.

Diagram 6 – Multi-purpose networks



6.2.2 Whole Energy system – Key uncertainties for 2030

The above scenarios provide a rich picture of different potential outcomes for 2050 and demonstrate a wide range of major uncertainties. However, the industry landscape expected for 2030 is likely to be much closer to that which exists today and will be determined by decisions and events in the much shorter term. By 2030, the direction of the following key components of the whole energy system will have a significant overall influence on the sector:

6.2.2.1 Electricity

The UK electricity transmission and distribution network that exists today will still play a major role in 2030. There will be considerable sunk investment in legacy networks. More renewables (mostly inflexible and intermittent) will bring a significant balancing requirement to energy system operation, with implications for networks as well. Alongside a major increase in interconnection, the development of distributed energy systems incorporating renewables, storage, and demand response seems set to grow. Growing penetration of electric vehicles is expected to reverse the currently declining demand profile.

The development of more large scale generation nuclear, CCS, offshore wind, gas, etc., under a mixture of market forces and government control is uncertain. Also, important from a networks perspective is the uncertain timing and location of generation plant that is closing.

6.2.2.2 Gas

Similar to electricity, there are major legacy transmission and distribution networks. For 2050, gas is widely expected to be transitional fuel with substitutes including electricity, heat networks, and new gas solutions that may exploit substitute or alternative gases such as bio-methane, shale gas, hydrogen, etc. However, for 2030 key uncertainties also concern whether new CCGT installations are constructed, and the potential pace at which gas demand declines.

6.2.2.3 Heat

Ambitions are high for decarbonisation of heat but limited progress has been made. There are few legacy heat networks and new ones are costly to install. Electric heating as a substitute increases electricity demand and potentially also system balancing requirements. While there is potential for local heat storage solutions, these are costly and investment decisions may require government policy and financial support.

6.2.2.4 Transport

Traffic volumes are expected to increase and decarbonisation route might be electric or gas using hydrogen fuel cells. Given the relatively short timescale for vehicle development in the highly competitive automotive sector, transport has rapid deployment potential impacting on either gas or electricity networks or both.

6.2.2.5 Demand and storage

Storage could play a pivotal role in reducing the need for back-up non-renewable generation capacity. Without storage, there is a very high reliance placed upon CCS and nuclear to provide non-intermittent capacity in the long term. A potential growth in energy storage is forecast due to the increased intermittency of renewable energy, which creates a need for more flexible generation capacity. There are various storage technologies which may be needed to address intra-day and inter-seasonal variations in other energy production technologies. The scale of future deployment is uncertain.

Demand response may be considered in two ways, namely the permanent energy efficiency investments that may be made by consumers or businesses, or the ability to reduce demand for short periods in response to price signals (either payments or charges). Technology and communications improvements are expected to enhance both these capabilities over coming years but the impact is uncertain. Demand response may be driven by community/consumer decisions, leading to a more devolved energy system, which may create additional uncertainty.

6.2.3 Whole energy system – Impact on networks

In summary, the future development of networks to address decarbonisation challenges must recognise that there is a significant range of potential future for energy networks, encompassing electricity, gas and heat. These range from:

- The emergence of locally planned energy microgrids, including heat networks, where communities are in control of their energy use and deployment.
- The growth of large national energy networks connecting large remote electricity and gas generation/production resources (including natural gas substitutes such as hydrogen).

It is possible that both of these futures will co-exist and will need to be accommodated within future network planning, regulation and governance. This was the experience when Ofgem considered the

electricity network scenarios in its LENS study. Heat and transport energy use must also be addressed alongside gas and electricity and not considered separately.

As well as decarbonisation, security of supply and affordability objectives being key drivers for future network development strategies, there are several other factors that are particularly relevant for network planning.

- The need to ensure appropriate **reliability** of networks. For example, electricity transmission networks are currently generally to a N-2 standard. i.e. two separate failures have to occur before loss of supply. However, if more local energy is deployed then this loss of supply risk may not be as high, then either network investment savings or stranded assets may result.
- The need to ensure that **peak demands** can be met. Generally, networks are planned to meet peak demands which may only occur for short periods in the year. Reliable mechanisms for reducing peak demand may make a significant difference to network investment requirements.
- The need for **flexibility and balancing services**. The increased use of intermittent renewable generation means that intra-day and inter-seasonal energy use may vary significantly, making energy peaks and troughs more pronounced. These variations have an impact on network flows and capacity requirements in certain geographic locations, and network congestion may result.

Among the measures that are available to address these network issues are local generation, energy storage and demand response. If suitable market platforms are established, these services have the opportunity to participate in energy markets and in balancing services, including those needed to mitigate network constraints. These services are not new, but are becoming increasingly important in a decarbonised energy market with more variable sources of supply and demand.

7 What governance and regulation framework is needed in 2030?

The previous sections indicate a wide range of influences impacting on the energy sector both now and in the future. It has focused in particular on developments in electricity, and to a lesser extent in gas, as this is where the key decarbonisation decisions have been taken to date.

While significant progress has been made towards decarbonisation, major challenges lie ahead, particularly in terms of considering the whole energy system. Given the long life of energy sector investments, policy decisions taken over the next few years will still be in effect by 2050. The governance and regulatory framework will need to adapt accordingly, especially if investor confidence (and associated competitive financing costs) are to be retained. At the same time, it will be necessary to address affordability, decarbonisation and security of supply agendas.

7.1 What are the future governance and regulatory challenges?

At present, while there is a Government Department for Energy and Climate Change (DECC), there are many other departments with responsibilities in this area. DECC's ability to deliver decarbonisation measures is primarily targeted on the areas of subsidy that it controls i.e. renewable energy investment decisions. Its policies in other areas e.g. energy efficiency, rely on incentives to gain support from other public or private bodies such as energy suppliers, local government, etc. DECC has the responsibility to address heat savings but few policy tools to as yet make a significant impact. It does not have responsibility for transport, business, or environmental energy policies.

As the sector economic regulator, Ofgem's main objective is to protect gas and electricity consumers, alongside objectives to address decarbonisation and security of supply. It sets price controls for monopoly electricity and gas networks and oversees the effective operation of electricity and gas markets, but has no whole energy system responsibilities.

The next Ofgem decisions for network investment plans are due to take place in 2021 and 2023, with the next round of 8 year RIIO price controls. Due to the long term nature of network investments, funding commitments made at this time are likely to be critical for the network investments needed for 2050. The next RIIO price controls (which will run to around 2030 if 8 year periods are maintained) are likely to have to take whole energy system solutions into account.

While the current governance and regulatory regime has worked effectively to drive major new investment in renewables and associated networks in pursuit of 2020 targets, there are a number of challenges if 2050 whole energy decarbonisation solutions are to be attained. In particular:

- Clarifying within government who is responsible for a) designing and b) delivering a 2050 'whole energy system' solution for decarbonisation and where accountabilities sit.
- Clarifying the regulatory responsibilities for whole energy systems, including transport and heat.

7.2 What change may be needed?

The current industry governance and regulatory framework has attracted criticism for being too complex and costly, presenting barriers to new entrants and innovation. It also does not fully consider whole energy system solutions, often because conflicting responsibilities lie within different institutions and companies. For example, regulatory regimes that separate gas, electricity and heat networks may reduce the potential for realising benefits from whole energy solutions.

However, this has to be balanced against the policy and regulatory certainty that has attracted billions of new investment into the sector and has overseen significant industry changes. A new framework needs to evolve from existing arrangements but at the same time to be responsive to change and the new industry drivers. Future incentives for investors and companies should seek to realise patterns of investment in new infrastructure that are efficient from a whole sector perspective.

Key decisions for the future governance and regulation of the whole energy system are whether key decisions should be centrally controlled or devolved, and the extent to which market forces should be involved in deployment. Given the major challenge and cost involved in re-nationalisation of the energy supply industry, it is assumed that competitive market forces and private sector investment will continue to be deployed wherever possible, and regulatory price setting used only when competition is not possible. So, what might this look like?

7.2.1 Evolution of governance and regulation for 2030

Over the history of the industry, changes in governance and regulation are not new, and have been essential to meet new priorities. However, changes take time to put into effect and institutional reforms will be needed well in advance to impact on future policy and investment decision making for 2030. This section offers some suggestions about potential institutional reforms that may be beneficial. The aims of such institutional reform would be expected to include:

- Clearer accountability, in particular for managing decarbonisation and security of supply.
- Greater responsiveness and flexibility to technology, business and market developments.
- Less administrative and regulatory complexity, reducing cost and barriers to entry, and lower administrative costs as duplication and overheads are reduced.

As decarbonisation targets are mandated by Parliament, central government would be expected to maintain a leading role in strategic policy decisions about decarbonisation pathways and incentives, although policy implementation and delivery could be performed by others. The alternative to central government policy incentives could be a carbon tax on carbon emitters to deter emissions, but this would be difficult to administer and enforce, and may not deliver the desired outcomes.

While Government is advised on future carbon budgets by the CCC, there is no equivalent body to advise Government on such major energy deployment options. While the National Infrastructure Commission has recently been established with a partial energy remit, it does not have a responsibility for advising on 2050 whole energy solutions. Given the significance of future energy decisions, it would appear appropriate for a senior advisory body, perhaps similar in nature to the National Infrastructure Commission or Labour's proposed 'Energy Security Board'[12] to be established to guide long term government thinking in this area. Such a body, perhaps an 'Energy Commission', might be established to provide advice and then be disbanded. A variant on this approach would be to expand the role of the CCC to more explicitly and directly advise on major energy deployment options. The function would remain advisory and relatively high-level: detailed operational strategy and planning would be beyond the body's remit and performed by other industry institutions.

In a scenario where central government retains control over key energy policy decisions within a market structure, private capital and innovation should be incentivised to deliver cost effective decarbonisation; decisions that are devolved are taken within centrally defined frameworks to ensure efficient co-ordination; Electricity, Gas, Heat, Transport, and consumer energy policies are considered in a holistic way, including their respective network implications.

Policy incentives should be targeted more at whole energy solutions, encouraging community energy investment and management where this is more efficient that centrally planned solutions; encouraging the development of heat networks, energy efficiency and other decarbonisation measures as needed. As far as devolution is concerned, it seems that decarbonisation and energy

[12] Source: Labour party 2015 manifesto.

choices that would benefit from local decisions e.g. consumer preferences for heat networks, demand response, transport provision, could be devolved to a greater degree as long as such an approach enabled faster, more effective, and more efficient decisions.

Central regulation of markets and energy networks by Ofgem should be maintained, but extended to include a cross sector approach i.e. including heat and transport, when evaluating impacts and trade-offs for regulatory decisions to benefit existing and future consumers. This is a significant change that is likely to require careful evaluation and potential legislative amendments to redefine Ofgem's responsibilities. For example, as part of any reforms, it will be important that policies to deal with issues such as asset stranding are defined to reassure investors.

Responsibility for managing energy system operation and security of supply is currently split between several different bodies. A key role is performed by National Grid's System Operator function on behalf of the government and industry. While in the past this role has sat well with a company that owns electricity and gas transmission networks, it is less likely to suit the needs of whole system planning and operation, involving more distributed energy and heat networks.

An option that could offer significant advantages is the creation of an Independent System Operator (ISO). This could combine the current system operation and planning functions of National Grid, with whole energy system planning and technical issues being considered by Government and Ofgem. This would create clearer accountability for security of supply, industry operational processes, decarbonisation decisions, and remove potential conflicts of interest. An ISO potentially also could encompass electricity and gas market settlement activities performed by Elexon and XoServe. However, such a broad remit may be difficult for a single organisation to perform, so careful analysis would be needed to identify where such responsibilities may best be managed.

Industry rules and codes should be simplified and made more responsive to engage new entrants and new business models, perhaps by creation of a new single 'Energy Code Administrator' to replace or co-ordinate the six institutions that perform these roles at present.

Clean energy incentive administration should be the responsibility of a new single delivery body, rather than the ten or so that currently exist. These incentives currently total over £5 billion a year and will exceed £10 billion pa by 2020. Such a body, perhaps a 'Clean Energy Delivery Agency', would be able engage across power, heat and gas policies, ensuring a co-ordinated approach to policy and incentive delivery. A particular area of focus of this body could be decarbonisation of heat energy and associated networks. This approach would allow the consolidation of several legacy bodies all carrying out similar functions.

7.2.2 Summary

The current industry governance and institutional framework has changed significantly from that of a decade ago, and a new framework will almost certainly be needed for 2030. In summary, this paper suggests there are benefits in terms of accountability, effectiveness, and cost in moving to an institutional and governance framework that includes:

- Central Government policy oversight of whole energy systems, supported by a new advisory 'Energy Commission'.
- Maintenance of market based industry frameworks, with oversight by a national Regulator.
- Creation of an 'Independent System Operator' that fulfils technical advisory and delivery roles for Government, Regulator and the Industry.
- Simplification of energy system administration and regulation by consolidation of existing bodies into a 'Clean Energy Delivery Agency' and an 'Industry Code Administrator'.

Significant institutional and governance change will almost certainly need legislative change particularly if investor and public confidence is to be maintained, and will take time to implement.

8 Where and how investment decisions should be taken?

The previous section has set out some assumptions and proposals for whole energy system governance and regulation in 2030. However, some key policy decisions are needed well before 2030 as future decarbonisation pathways are chosen. It is difficult to assess the most effective and efficient long term pathway, and decisions are being taken now that will have an impact in 2030 and 2050. For example, decisions are currently being made to support nuclear and offshore wind generation investment, rather than alternatives such as solar or CCS. These decisions will be 'locked-in' for the future energy system.

Difficult decisions lie ahead. One of which is the future of natural gas in the energy supply mix. While decarbonisation to date has focused on electricity, if 2050 targets are to be met then gas will need to be decarbonised or replaced. Gas supplies are currently used for space and water heating and cooking, as well as industrial processes including large scale power generation. Direct alternatives for natural gas include the use of hydrogen as a fuel, and electricity as a replacement for heating applications. Gas is seen by many as a transitional fuel that can be expanded to replace coal fired power stations and consumption may rise for a number of years before emission limits require closure of natural gas installations. Investment decisions for new gas-fired power stations and associated networks will be difficult without a clear pathway.

There is emerging evidence that with sufficiently large volumes of interconnection, greater energy efficiency and growth in distributed energy then the demand on the transmission network and the need for new large-scale generation could be lower than previously forecast by DECC[13]. Decisions on the future regulation of the network will need to carefully consider the demand profile on the network and its key drivers.

Another difficult and potentially conflicting decision concerns the deployment of heat networks and associated energy saving measures. The cost and inconvenience of deployment means that incentives or obligations are likely to be required to realise the benefits of a large scale roll-out. It is unclear where this funding will come from and who should be responsible for deployment. Again investment decisions will be difficult without a clear investment and regulatory regime in place.

The above examples indicate that major national policy decisions may be required, for example, to mandate the replacement of natural gas with hydrogen, or to mandate the replacement of gas networks with decarbonised heat networks, or electric heating. Such decisions will require examination of costs and benefits on a whole system basis.

8.1.1 Decision making for networks

Ofgem currently sets price controls for monopoly gas and electricity networks and also faces difficult decisions about future network requirements, as government policies will significantly affect both the supply and demand that networks connect.

First of all, looking at the demand perspective, many scenarios see significant electrification of heat. Under the existing market structure, energy supply and demand investment decisions should not be impeded by the availability of network access, and this is expected to continue. However, network cost, scope and timing decisions will become more complex due to increased trade-offs between local and central network solutions and between power, gas and heating technology decisions.

[13] Forthcoming research, KPMG (2016).

Network scope and designs are likely to become more complex, especially if solutions turn more and more to those involving avoided network investment in gas or electricity. While it will be important that individual network companies are incentivised to reach their most efficient solution, many planning and investment decisions will need a more joined up approach. Ofgem will face the challenge of setting price controls and incentives for individual electricity and gas network companies while seeking to optimise value for money from efficient cross-sectoral whole energy investment solutions.

Ofgem may need expert advice to determine network solutions in a whole energy system. In this context, the concept of an independent 'System Architect[14]' proposed by the Institution of Engineering & Technology (IET) may be useful. The IET proposition is that the power grid is starting to migrate from traditional centrally managed and largely passive operation, to a highly distributed and more complex architecture. They concluded that whole-system integration needed a System Architect function to ensure effective design interfaces across multiple parties so as to maintain supply security while ensuring that innovations deliver real benefits to consumers.

Such a technical industry body could also advise on system planning alternatives such that appropriate regulatory and policy decisions may be taken. However, if extended across the energy sector, an 'Energy System Architect' could consider the many different ways of determining the appropriate network solution, involving trade-offs between energy sectors, network reliability and consumer participation in energy management. If an Independent System Operator (as described in the previous section) is established, then it might also take on this role.

More access connections will incur additional gas and electricity network costs, in terms of connection and deeper network reinforcement, and will need to be paid by network users. While charging methodologies will need to appropriately reflect existing and future network investment costs, there are many different ways of determining these, and a cross-sectoral perspective may also be required. Ofgem would retain a central role in this decision making but reform, and simplification, of charging methodologies and industry regulations will be required.

The RIIO regulatory framework has been designed to address changing network outputs as the energy system changes. However, change will continue to be uncertain and the right balance between flexibility and efficiency will be needed. The RIIO framework and output measures should continue to be used, potentially with outcomes adjusted to support enhanced decarbonisation targets. For example, network companies might need to be incentivised to enable local heat networks, decentralised whole energy solutions, and switches to alternative gases.

Once a RIIO investment framework is set, individual network companies or other commissioning organisations could proceed with investment decisions within this approval framework, as established by Government and Ofgem. Flexibility could be retained for individual company action within their price controls. Similar arrangements could potentially be established for the development of heat networks in due course.

8.1.2 Development of heat networks

Heat networks are expected to play an important role in realising future decarbonisation targets. There are approximately 2,000 heat networks in the UK currently, supplying heat to 21,000 dwellings and 1,700 commercial and public buildings. DECC estimates that approximately 14% of UK heat demand could be met by heat networks by 2030 and around 43% by 2050, making a cost effective contribution to the UK's decarbonisation targets.[15] Since September 2013, DECC has awarded £9.7 million development support funding to 180 unique heat networks projects across 115 local

[14] http://www.theiet.org/factfiles/energy/brit-power-page.cfm.

[15] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466130/HNDU_Round_5_-_Overview__Oct_2015.pdf.

authorities in England and Wales. This funding is mainly targeted at helping local authority/private network projects through their development stages.

DECC estimates the capital investment in heat networks resulting from these initiatives to be £400 million to £800 million over the next ten years.[16] A major challenge lies ahead for heat network development and investment if future demand objectives are to be achieved. Progress may need to be realised through incentives or obligations placed upon local authorities or other institutions.

Assuming extensive development of municipal heat networks takes place by 2030, they will be monopoly utility infrastructure assets similar to those for gas and electricity, and the necessary protections for consumers will need to be in place. It is likely that large scale heat networks would need to be licenced and regulated, particularly if they are delivering mandatory service and decarbonisation obligations. If heat networks are established as regional or local monopolies, then potentially Ofgem, if it also had heat responsibilities, could potentially also approve their charges, determining efficient costs of investment, operation, and financing.

Heat networks may be developed in tandem with other heat options, for example the development of heat networks in urban areas coupled with more decentralised renewable heat (such as heat pumps and biogas) in more rural areas. Existing gas and electricity distribution network licensees are likely to have an important role to play in the growth of heat networks. With great experience in local utility delivery services, they may be able to take on new licence obligations or offer services to new local heat network owners.

8.1.3 Summary

Many billions of investments have already been made in energy networks and investors will seek certainty about their existing investments as well as the future investment plans. Future regulatory regimes will face challenges in addressing the regulatory changes to networks as they are impacted in different ways by decarbonisation. For example, electricity networks may face major demand increases while gas networks face issues of stranded assets. This paper suggests the following approach for future network investment decisions:

- Network price controls will increasingly need to consider whole energy system solutions, and Ofgem may increasingly require technical support from an 'Energy System Architect' or equivalent.
- Existing RIIO regulatory frameworks appear appropriate for future whole energy system changes but output measures will need to evolve accordingly.
- The potential growth of heat networks may lead to a new requirement for network regulation and decision making alongside deployment incentives. This could include determining efficient costs of investment, operation, and financing

[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf.

9 Increasing the use of competition

Government and Ofgem have sought to use markets and competition wherever possible to protect consumers. This is primarily applied in energy markets but has also been applied to some networks. This section describes the current competitive arrangements for network infrastructure and sets out potential for future development.

An important enabler for innovation and cost savings is competition. New entrants to an industry can often bring new ideas, experience and technology that can drive performance improvement and efficiency benefits. Network regulation to date has sought to exploit this in a number of ways:

- The introduction of some competition into RIIO price control reviews, where monopoly network companies are able to offer high performing business plans into the price control setting process to gain financial benefits from fast track status.
- The introduction of competition for assets, such as the offshore transmission (OFTO) regime, where new entrants are encouraged to bid their innovative approaches to minimise the revenues they need to bid. Ofgem is currently planning a similar regime for new and separable onshore transmission assets. Such assets are rewarded for availability rather than utilisation.

Competition has also been used for network innovation incentives and funding, where existing companies are invited to improve their investment in R&D and ultimately improve industry performance. This is the arrangement put in place under RIIO.

9.1.1 Offshore and onshore transmission

The offshore transmission tendering regime designed by Ofgem and DECC, has successfully attracted £3 billion of investment from new network investors, resulting in significant innovation and savings to consumers compared to existing price controls (Ofgem estimate around 15% on Tender Round 1, with higher savings expected on later tender rounds).[17]

Successful Offshore Transmission Owners (OFTOs) are granted licences requiring them to meet availability targets for the asset, and in return they receive their revenue bid for this service. They do not trade electricity or take generation risk, as for onshore networks. Ofgem does not calculate cost of capital or cost allowances for the assets.

The tendering process, which invites bidders to offer a revenue stream for 20 years has proven attractive to investors and operators because it offers a firm revenue stream for an extended period against the backcloth of an established regulatory regime. Regulatory oversight and price resetting activity is reduced for Ofgem as well. Future tenders for onshore and offshore networks are expected to attract several billions of new investment.

9.1.2 Distribution network connections

The value of the electricity and gas distribution connections market is in excess of £500 million a year with hundreds of thousands of connections completed each year. The installation of new connections assets has been opened to competition by Ofgem, allowing new entrants to compete for this work against incumbent distribution companies. Independent Connection Providers (ICPs) and licensed Independent Distribution Network Operators (IDNOs) can compete with Distribution Network Operators (DNOs) to complete some connection activities.

Ofgem has recently tested the distribution connections market and found that, while competition had developed in some sections of the market, there were areas (especially in electricity distribution) where competition was limited. It had often not taken hold because these competitive services were

[17] Source: Ofgem

partly reliant on activities performed by the DNOs themselves. Ofgem has taken steps to address this barrier by reducing the extent to which competitors depend on DNOs for essential services. Where the DNO is required to provide these services, it will need to do so on same basis to both its competitors and own connections business.

In the future, distribution network connection will connect new energy storage and new forms of energy demand, such as electric vehicle charging points. In this case, there is the opportunity for new connection (and associated) assets to be opened to competition in a number of ways, including running competitions for zones of network connection, where more significant infrastructure is required – this may include an electric vehicle charging network for a town or city for example, where a planned approach to deployment may be more efficient. It might also include the provision of electric vehicles in a similar way to bicycles are currently provided in some UK cities. Local authorities may seek to run such competitions, perhaps even opting to own the infrastructure.

9.1.3 Heat network competitions

Currently there are around 2000 heat networks in the UK and central Government funding is being provided to Councils and local authorities to explore the potential for further heat network infrastructure. Government scenarios show that as much as 43% of heat demand for buildings could be supplied via heat networks by 2050. While there is vast potential for decarbonisation through the development of heat networks, practical issues remain including how heat loss can be effectively managed. Alongside the need for investment in new heat networks, renewable energy sources will need to substitute for the heat produced by Combined Heat and Power plants using gas or biomass which are going to be less attractive fuels to meet long term decarbonisation targets.

If heat networks become a key part of a decarbonisation strategy, then they may be opened up to competition through the development of individual heat zones or networks, perhaps on a city or community basis. Such zones might also include the provision of insulation and alternative heat sources such that a whole system solution is found. The development of such infrastructure would probably need to be funded by subsidy to incentivise deployment, as the benefits for savings are likely to be incurred over a long timescale, likely to be unattractive to most investors (including customers being asked to invest).

Similar to Local Authority tendering of waste to energy projects, competitive tenders of long term heat network contracts or licences could take place for individual cities or regions, placing obligations on the contract/licence holder to build, own and operate heat networks. Revenues could be realised from consumers, and Local Authority/central Government support could be provided in terms of subsidies, guarantees or direct financing. Such tenders could be performed by local or central Government as appropriate, including commercial mechanisms similar to those used in RIIO regulatory regimes to incentivise delivery.

9.1.4 Future development of network competitions

Future infrastructure solutions may increasingly involve the local delivery of electricity, gas and heat energy as well as infrastructure to a particular community. Such a community energy solution could offer opportunities for existing network companies and suppliers, and new entrants, to invest and collaborate together under their respective regulatory regimes. However, optimum solutions may require closer integration of investment decisions and risks, requiring changes to regulations to allow local reintegration of generation, network and supply services. If integrated community energy solutions become attractive from an economic and delivery perspective, then creation of a new utility asset class, and tendering for, cross-sectoral local solution providers may be needed.

9.1.5 Summary

As described above, there are a number of opportunities for investments in energy network assets (including some using design, build, finance and maintain models) to be pursued through competitive processes. Implementation of such competition will require the definition of assets, obligations,

revenues and risks, together with clearly defined tender processes if benefits from competition are to be realised. This paper has highlighted the following approaches for increasing competition:

- Some competitive processes are already established such as offshore transmission and competition in network connections, and their market share will grow over time
- A competitive regimes for onshore transmission is currently being introduced, offering the potential for competition for ownership of new major network assets
- Looking forward, other energy infrastructure such as local heat or local integrated energy networks offers potential for the future

Appendix 1 Qualitative ranking of key regulatory issues

Issue heading	Brief summary of the nature/relevance of the issue	Brief summary of potential resolution	Priority (score 1-5 low to high priority)
Administrative complexity	■ Administrative complexity adds cost and time burdens to the system. ■ There are now more than thirty bodies involved in the administration of the energy industry – centred around DECC, Ofgem and National Grid. ■ Further change is expected as the transformation towards a low carbon energy system gathers pace.	■ There is potential to simplify the landscape, for example by creating bodies with wider responsibilities such as an ISO, Clean Energy Delivery Agency, and an Energy Code Administrator.	5
Heat delivery and regulation	■ There is scope for the regulatory framework to be made clearer for growing methods of heat delivery ■ Heat networks (especially in urban areas) and other delivery mechanisms such as heat pumps will become increasing important.	■ A regulatory regime for heat may be required. ■ More joined-up system planning in new investment explicitly including heat delivery.	4
Whole system planning	■ There is an ever-increasing need for designing and implementing a 2050 'whole energy system' policy solution. ■ There is currently no specialist independent body whose sole remit is technical expertise and advice on major deployment options for long-term planning.	■ A senior advisory body (e.g. an "Energy Commission") could be established to perform this function. This could be time-limited and staffed by technical experts. ■ An alternative option would be to widen the CCCs role to explicitly focus on deployment.	4
Changing needs of the Gas Network	■ The future of gas networks retains some uncertainty. Gas is seen by many as a transitional fuel towards decarbonisation. Equally, some see it playing a long-term role in lower population density, taking advance of legacy networks	■ A joined-up approach to regulatory regimes (especially heat) by Ofgem and other bodies.	3

	■ For 2030, the key uncertainty may be the role of new CCGT installations in driving gas network demand.		
New supply: Growth of Distributed Energy (DE)	■ Distributed Energy is growing as part of the network and is presenting new challenges for DNOs.	■ This could be addressed as part of the approach outlined for whole system planning (i.e. a senior advisory body) ■ Additionally, establishing an Independent System Operator (ISO) could be beneficial.	3
New demand: Transport sector	■ Traffic volumes are expected to increase and decarbonisation route might be and decarbonisation route might be electric or gas using hydrogen fuel cells ■ Relatively rapid vehicle development in this highly competitive sector suggests rapid deployment is possible. This would put additional strain on the network.	■ This could be addressed as part of the approach outlined for whole system planning (i.e. a senior advisory body)	2

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Profile

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At Ofgem, he was a Managing Director, leading Ofgem E-Serve, the offshore transmission (OFTO) tendering regime, and gas and electricity network price controls. At National Grid, he led new network investments worldwide. He is a Chartered Engineer.

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