

# Country study - United Kingdom

## 1 The United Kingdom in numbers

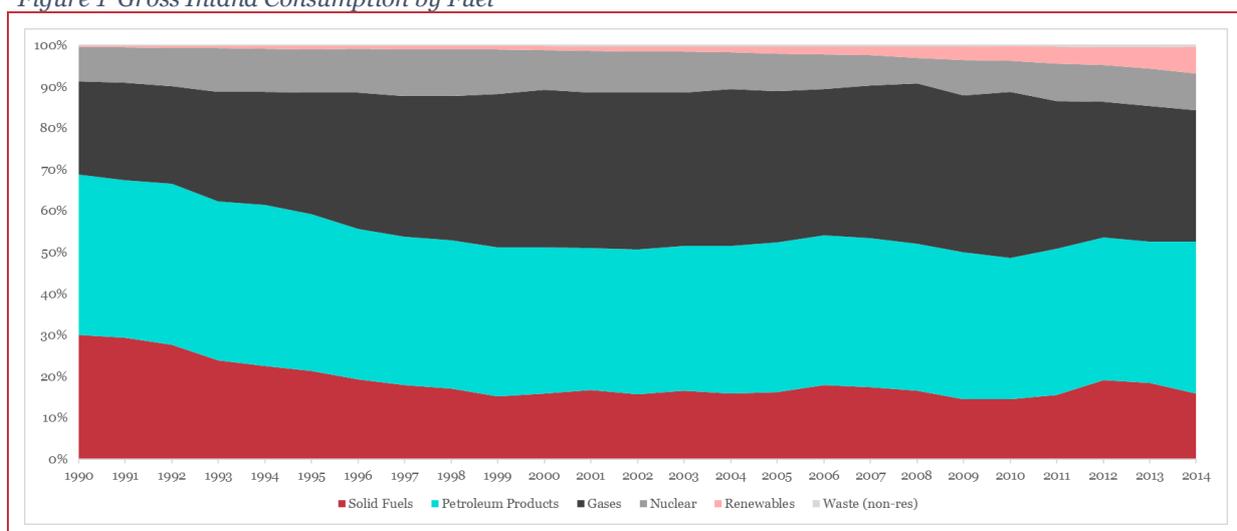
### 1.1 Economic and industrial structure

The United Kingdom is the fifth largest economy in the world in terms of GDP, the single largest producer of oil in the EU, and the second producer of natural gas. It has also one of the lowest energy intensities in the world in terms of energy per unit of economic output (GDP) owing to the large share of high-value and financial services in the economy.

The UK energy market is dominated by the ‘Big Six’ utility companies (EDF, E.ON, SSE, British Gas, Scottish Power, N-Power). Their guiding principles are price competition, sweating assets and fuel flexibility (Pearson & Watson, 2012). A ‘liberal market economy’ ideology, particularly confidence in the market to secure diverse and sustainable energy supplies, has meant that the UK government has traditionally adopted non-technology specific policy instruments, which has created barriers for new entrants. Although this policy of ‘not picking winners’ is changing, especially in relation to renewables research and technology, an emphasis on cost efficiency and market dominance of the ‘Big Six’ has resulted in a preference for close-to-market technologies, thus affecting the nature and the pace of energy transition in the UK. Thus, in the 1990s, many power plants switched from coal to gas, and since 2002, co-firing of biomass in coal-fired power stations has grown rapidly because it was easy and cheap for utilities (Geels, et al., 2016).

At the same time, the UK has lost many manufacturing industries, which has made it more difficult to develop a credible green industrial strategy (Geels, et al., 2016) that will be acceptable to this still powerful lobby. In addition, the UK’s national electricity grid, which has been privatised, needs upgrading at a considerable cost to make it more flexible to integrate renewable energy (European Environment Agency, 2014). Although the government is addressing this challenge with other stakeholders, the Grid remains another systemic barrier to changes in the UK’s energy system and is an important consideration for policy makers.

Figure 1 Gross Inland Consumption by Fuel



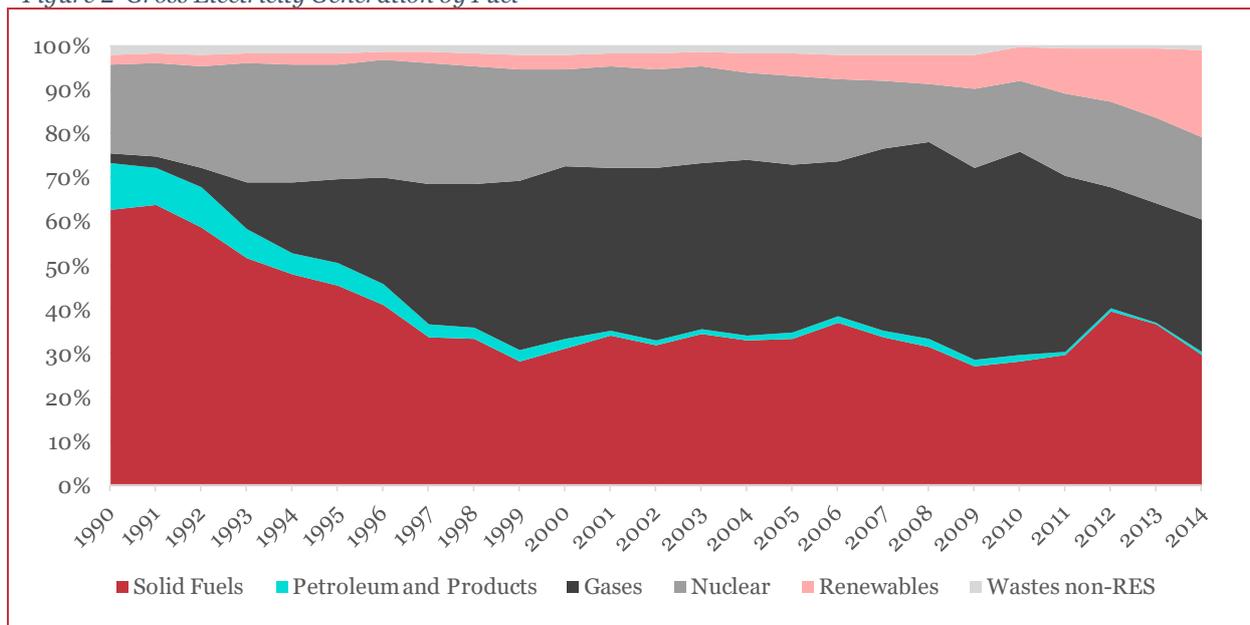
Source: Eurostat

## 1.2 Main indicators on energy generation and usage

Production of fossil fuels in the UK peaked in the late 90s, and has generally declined, with a small increase in 2015 as a result of investments made during the years of high oil prices. After being a net exporter of crude oil and natural gas since the early 80s, the United Kingdom became a net importer of both fuels in 2004 and 2005 respectively. In 2013, the UK became a net importer of all fossil fuels. The Government has since focused on managing the domestic declines in production and the country's reliance on imported fuels. To that end, the UK government has been involved in securing the supply of energy, enhancing recovery from maturing oil and gas fields, promoting energy efficiency and decarbonising the UK economy through new investments in renewable energy (U.S. Energy Information Administration, 2016).

Gross electricity generation in the UK was of 338.9 TWh in 2014. Figure 2 shows the evolution of the electricity mix from 1990 to 2014. In 2015, the UK electricity mix consisted mainly of natural gas (30%), coal (23%), nuclear (22%) and renewable energies (25%). Between 2005 and 2014, total primary energy consumption decreased by nearly 20%, mainly as a result of a smaller contribution from energy-intensive industries in the economy and due to improvements in the energy efficiency of industrial processes. Renewable energy use has more than doubled over the same period with a focus primarily on power generation. On the other hand, oil and natural gas still accounted for 36 and 33% of total energy consumption respectively in 2014, with coal accounting for around 16%.

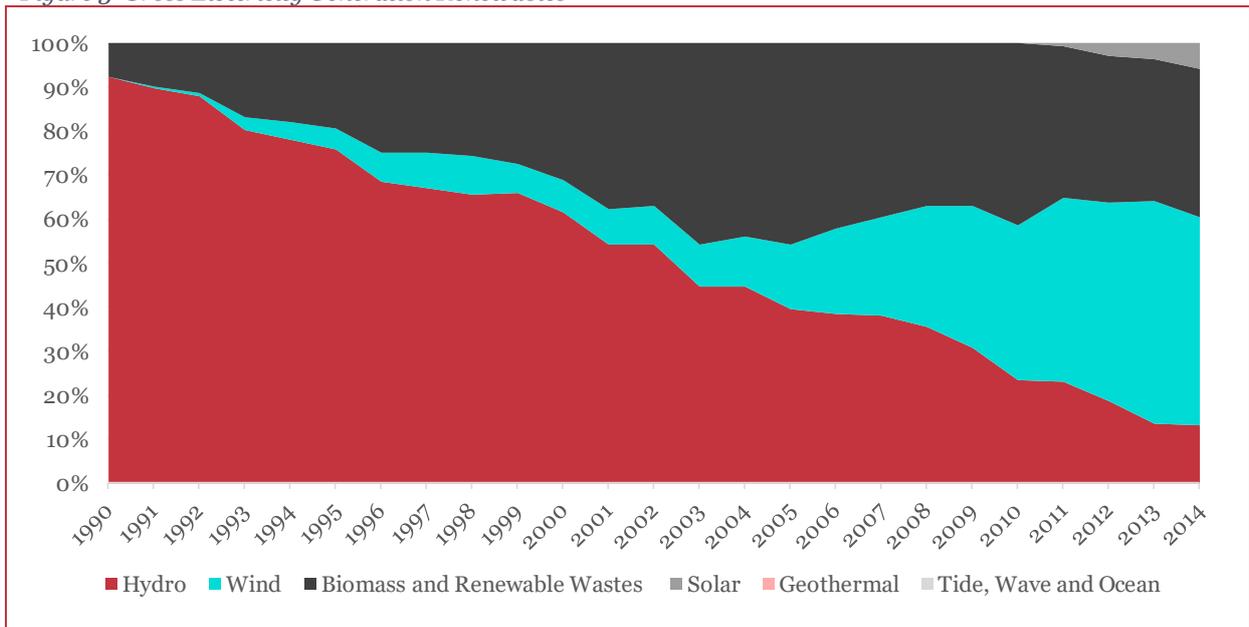
Figure 2 Gross Electricity Generation by Fuel



Source: Eurostat

In recent years, the UK has achieved a remarkable reduction in GHG emissions from energy production, thanks in part to the replacement of coal-fired plants with renewable energy technology, such as offshore wind farms and solar panels, and an increased use of nuclear energy. In 2015, CO<sub>2</sub> emissions were 38% lower than in 1990. Almost half of this reduction was achieved only in the last three years as a result of the change in the energy mix (Bell, Gault, & Thompson, 2016). In 2015, the country obtained 16% of its primary energy from low-carbon sources with nuclear energy (48%) and bioenergy (34%) being the two largest contributors (UK BEIS, 2016). In terms of tonnes of oil equivalent, Bioenergy (predominantly biomass) accounted for more than 70% of renewable energy use in 2015 followed by wind energy (20%).

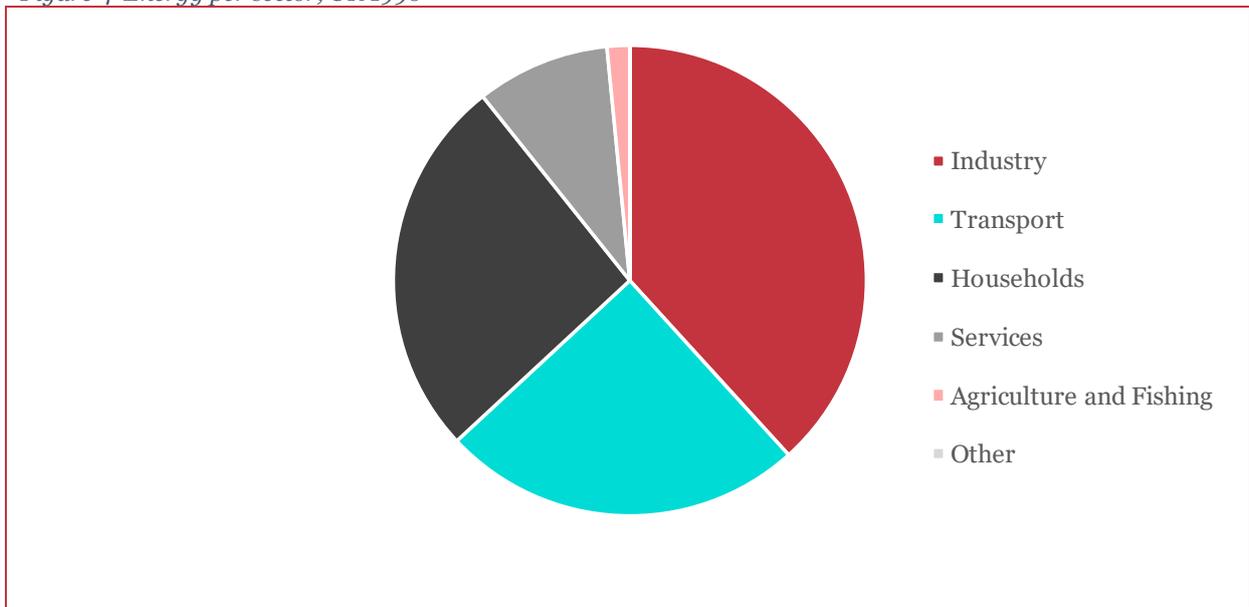
Figure 3 Gross Electricity Generation Renewables



Source: Eurostat

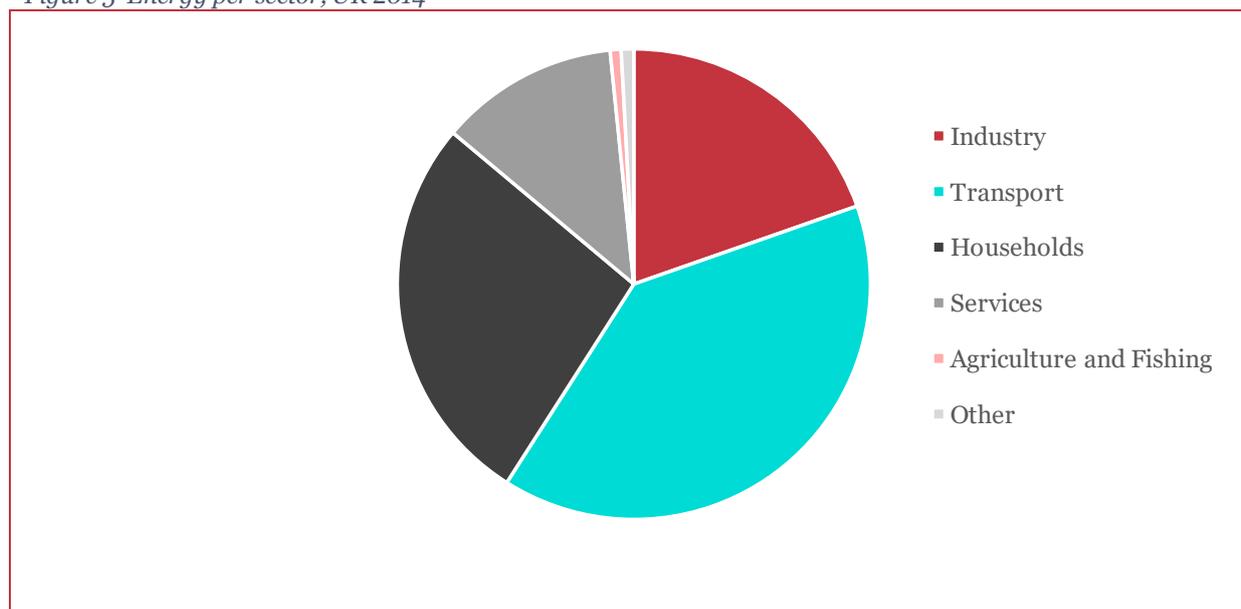
Figure 5 shows the latest figures in energy usage per sector in the UK. Transport remains the single largest sector for energy consumption in the UK (~40% in 2015) followed by the domestic sector (29%), industry (17%) and services (14%). This has been the case since 1988. Earlier, industry used to consume the largest share (1970 to 1984), before being briefly overtaken by the domestic sector (1985 to 1987). This shift in consumption was due to the decline in heavy industries and the rise of personal mobility and car ownership (UK BEIS, 2016). In 2014, 23% of total GHG emissions were due to the transport sector, an increase from 15% in 1990.

Figure 4 Energy per sector, UK 1990



Source: Eurostat

Figure 5 Energy per sector, UK 2014



Source: Eurostat

Among the other sectors, services have a relatively stable energy consumption but domestic consumption is more volatile due to fluctuating heating needs (Department for Business, Energy & Industrial Strategy, 2016). Space and water heating accounts for around 80% of domestic energy consumption and the majority of this heating is done by gas. The UK housing stock is old relative to most other European countries with a large proportion of houses dating from the Victorian era and having poor insulation, resulting in more susceptibility to temperature fluctuations. In 2014, 16% of housing in the UK was built before 1919. This is not the case for buildings used by the service sector. In 2014, GHG emissions from the residential sector accounted for around 12% of total emissions, a decrease of 20% from 1990 levels (UK BEIS, 2016). This is due to the progressive replacement of the housing stock and more importantly the introduction of energy-efficient boilers, double glazing, cavity wall insulation, and more efficient appliances in existing homes. However, the UK Committee on Climate Change recently pointed out that there is still a very slow uptake of low-carbon technologies and behaviours in the buildings sector (UK Committee on Climate Change, 2016).

## 2 Culture and history around energy policy

### 2.1 Policy history, informal rules and structures, events that shaped the country's energy transition

The UK energy and climate change policy has come a long way since 1997, when the then Labour government was trying to balance the interests of its Union supporters, notably coal miners, with a strong commitment to the Kyoto agreement (Fabra, et al., 2015). They introduced a fuel price escalator that raised the price of road fuel and a climate change levy rather than a carbon tax. They also imposed a moratorium on gas-fired generation to protect coal even though the switch from coal to gas in the 1990s (since privatisation) had been responsible for the UK's rapid fall in CO<sub>2</sub> emissions.

In 2008, under Prime Minister Gordon Brown, the Department of Energy and Climate Change (DECC) was created with the aim of ensuring security, affordability and low carbon in the energy supply, collectively known as the 'energy trilemma'. The same year saw the establishment of the Climate Change Act laying out the UK's commitments to tackle climate change. This remains the foundation of current energy policy in the UK.

Over the years, the energy policy paradigm has undergone a shift with changes in interpretation of the role of energy and energy markets, policy objectives and instruments, as well as governance institutions. The change between 2001 and 2011 is shown in Table 1 below.

*Table 1 The energy policy paradigm in 2000 and 2011*

<b>Level</b>	<b>2000</b>	<b>2011</b>
<b>Interpretive framework</b>	<ul style="list-style-type: none"> <li>energy as tradable commodity</li> <li>markets as most efficient vehicle for energy trade and supply</li> <li>government should not supply energy, nor decide energy mix</li> <li>energy to be traded and supplied in an economically efficient manner through competitive, freely trading markets</li> <li>free markets understood as delivering energy security</li> </ul>	<ul style="list-style-type: none"> <li>energy is understood to have a central socio-economic role to play rather than understood as a normal commodity</li> <li>markets to supply energy but within tighter government specifications</li> <li>market failure in climate and energy requires a relative change in the role of the state</li> <li>more energy should be 'home grown' and should come from clean sources</li> </ul>
<b>Objectives of policy</b>	<ul style="list-style-type: none"> <li>the provision of secure, diverse and sustainable supplies of energy at competitive prices as an outcome of freely trading, competitive markets</li> </ul>	<ul style="list-style-type: none"> <li>energy security, including affordability, one of two primary objectives</li> <li>climate change mitigation goals now legally binding through Climate Change Act (and specific to include precise level of emissions reductions)</li> <li>increasing share of renewable energy now formal objective of policy</li> <li>Affordability objectives somewhat sidelined</li> </ul>
<b>Instruments</b>	<ul style="list-style-type: none"> <li>Regulatory framework designed to enhance ability of markets to supply energy at lowest cost</li> <li>Formula-based electricity pricing</li> <li>renewables obligation being developed to support renewable energy</li> </ul>	<ul style="list-style-type: none"> <li>variety of instruments put in place to facilitate more domestic energy production</li> <li>Feed-in tariff introduced for small-scale generation of renewable electricity</li> <li>introduction and banding of renewables obligation</li> <li>electricity market reform</li> </ul>
<b>Governance institutions</b>	<ul style="list-style-type: none"> <li>Department of Energy had been disbanded in 1992</li> <li>Responsibility for energy policy at subdivision of Department of Trade and Industry (DTI)</li> <li>Ofgem key player: regulator to oversee markets to ensure low prices for consumers</li> </ul>	<ul style="list-style-type: none"> <li>Creation of DECC with specific energy security and climate mandates</li> <li>Other new institutions including the Climate Change Committee and the Office for Renewable Energy Deployment</li> <li>Ofgem mandate changed to include sustainability</li> </ul>

Source: (Kern, Kuzemko, & Mitchell, Measuring and explaining policy paradigm change: the case of UK energy policy, 2014)

UK energy policy is also seen to be influenced by various stakeholder opinions (Table 2). However, the relative influence of different stakeholder groups is variable and can depend on the issue in question.

In general, the UK public accept that climate change exists and show support for measures to mitigate it. Therefore, support for renewables is generally high. In turn, people’s concerns about climate change are being institutionalised. The Climate Change Act and watchdog “Climate Change Committee” are an institutionalised response to climate change such that if governments change policy will not drastically change.

However, public opinion has its ups and downs. Particularly at times of economic crises and job losses, climate change and energy are not the top priority for many people. Energy is often correlated with consumer bills by the public and the connection between energy use and climate change is not always made. There is no urgency to address these issues on a personal level. Thus, despite broad support for tackling climate change, a public push for behaviour change and investment in energy transition has not been forthcoming.

Table 2 Stakeholder type mapping

	High power	Low power
High interest	<p><b>Government</b>  <b>Energy Regulator</b>  <b>‘Big Six’ Utilities</b>  <b>Trade associations</b></p>	<p><b>NGOs</b>  <b>Cooperatives</b></p>
Low interest	<p><b>Labour organisations</b></p>	<p><b>General Public</b></p>

In the wider community, climate change and energy is hardly discussed at all outside of perhaps schools, academia and think tanks. Since a myriad of complicated issues are involved, most people feel ill-equipped to engage in an informed debate. Moreover, people are sceptical of the role of experts in these debates. When debates do occur, they are often on issues that receive media attention and once that goes, public attention wanes and it is business as usual. Examples include the Russia-Ukraine standoff in the mid-2000s that led to debates on the UK’s energy security and the recent investment in a new nuclear reactor at Hinkley Point which led to discussions about the relative costs and benefits of different low-carbon technologies.

When it comes to policy action, the British population has been largely passive and reliant on the government for answers. There is a view that the withdrawing of low-carbon subsidies and cancelling of carbon capture and storage projects after the 2015 election is because people were more concerned about health and jobs, and the Treasury decided to focus on these priorities rather than energy transition. However, it seems that in the new government, energy policy is not seen as at odds with industrial strategy, and hence the formation of the new Department for Business, Energy and Industrial Strategy (BEIS).

Within government, the UK civil service culture which prefers generalists over specialists means that civil servants move around a lot. One of our interviews felt that this reduces competences and capabilities of civil servants and the institutional memory is low, which impacts on how and what policy decisions are made. In addition, the same interviewee reported that the strong role of the government economic service that is trained to apply tools such as cost-benefit analysis to different

scenarios in the same way also impacts on policy. In their opinion, there is a need to have a wider and deeper understanding of energy issues e.g. social challenges and public acceptability.

The energy sector and sometimes foreign policy interests are also intertwined with decision making, as most recently evidenced by the dialogue between the UK, France (EDF) and China over the Hinkley Point nuclear reactor. For some commentators, there is a lack of transparency regarding the influence of big energy market players on government policy. According to one of our interviewees, there is a 'revolving door' between government departments and the energy industry with executives from the big energy companies going to work for government and then going back to industry.

Yet, the energy sector undoubtedly remains of great significance to the UK economy. The security and affordability of energy supply is important so that industry and businesses can access energy and costs allow for competitiveness. With the restructuring of BEIS, having an industrial strategy and a low-carbon industrial strategy could be an important driver of the economy. This might see importance of energy industry increasing further. For example, the government is promoting shale gas as a way to stimulate the economy and grow jobs in the UK. Similarly, there is a jobs argument for subsidising renewable energies to allow the development of new renewables technologies in the UK, thus creating new jobs, as opposed to importing technology whereby those jobs will be created elsewhere. Similarly, there is another argument for promoting more local energy capabilities so that the huge revenues from energy consumption are distributed more locally. Currently, many of the big utility providers (such as EDF and N-Power) are owned by foreign companies and the profits from the industry are not all being retained in the UK.

Within industry, corporate social responsibility has the potential to make a big impact on energy transition. It is increasingly the case that companies need to position themselves on the issues of climate change and decarbonising energy system. This is partly about savings and costs through becoming more sustainable but also about conveying to the public that they are socially responsible as a business. Hence, there is more demand for services like the Carbon Trust is providing such as looking at a company's carbon footprint along the production chain and certification to show that a business is taking action on environmental sustainability.

Regulations also help to drive the energy transition, both at the industry and community levels. Regulations help to improve standards and make efficiency gains. For example, efficiency and decarbonising target help to meet climate goals. Once regulations are in place, there is definitely a culture of law abidement. However, not all policy decisions are popular. For instance, the decisions on building nuclear power stations and drilling for shale gas have been unpopular with the general public. Similarly, it is unpopular in some quarters to subsidise renewable energy. In addition, there is some distrust of utility and energy companies among the UK public that they are not playing by rules. That is, they are following the letter but not the spirit of the rules. Examples include misgivings about the competitive behaviour of the 'Big Six' and the energy market. In the 2015 general election, the Labour Party put a spotlight on these issues with a promise to fix the energy market.

Poor housing stock continues to be a problem for energy efficiency. Most people can afford their energy costs, but the hassle and expense of putting in better insulation for their homes is not economically feasible for most households. Even newly built homes do not always meet standards. The government relies on the construction industry to conduct its own quality assurance and consumer codes are often voluntary and regulated by the industry itself (Tims, 2015), thus magnifying the problem.

Geography also is a factor. Renewable energy generation and demand are not in line with each other. A lot of wind energy is produced in Scotland but most of the demand is in London and the South East. Thus, it is a challenge to convey electricity to fill demand in the most efficient way. This shapes the physical structure of the system as well as many of the rules that govern it.

Looking forward, the relative balance between gas and electricity in the UK will depend on the type of heating technology that will be embraced by public in the next decade and more. If people continue to use gas then gas infrastructure will be needed, but if they move to electric heating, the UK will need a

much bigger electricity system. So the energy transition will be partly driven by technology but largely by human preference and behavioural norms.

## 3 Formal rules and instruments

### 3.1 Laws and regulations

The United Kingdom was the first country in the world to set a national long-term and legally-binding emissions target (European Environment Agency, 2014). In 2008, the UK Climate Change Act (2008) established ‘a framework to develop an economically credible emissions reduction path’, which contributed to increasing the UK’s international standing under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (UK Committee on Climate Change, 2016).

The Climate Change Act set out a statutory target for the UK of an 80% reduction in GHG by 2050 against a 1990 baseline. This target was set out on the basis of an appropriate contribution to global emission reductions, consistent with limiting global temperature rise to 2°C. It requires the UK Government to set out a series of 5-year Carbon Budgets, as a set of stepping stones towards achieving the 2050 target and to ensure that regular progress was made (Table 3 UK Carbon Budgets). The first four carbon budgets have been set in law and the Government has agreed to the fifth budget, with new measures and draft legislation for the fifth budget to be further defined in late 2016.

Table 3 UK Carbon Budgets

Budget	Carbon budget level	% reduction below base year
1 <sup>st</sup> Carbon budget (2008-12)	3,018 MtCO <sub>2e</sub>	23%
2 <sup>nd</sup> Carbon budget (2013-17)	2,782 MtCO <sub>2e</sub>	29%
3 <sup>rd</sup> Carbon budget (2018-22)	2,544 MtCO <sub>2e</sub>	35% by 2020
4 <sup>th</sup> Carbon budget (2023-27)	1,950 MtCO <sub>2e</sub>	50% by 2025

Source: UK Committee on Climate Change, 2016

The Energy White Paper (2007), the Low Carbon Transition Plan (2009) and the UK Carbon Plan (2011) set out different measures to meet the first three carbon budgets. The first carbon budget has currently been met and the UK is on track to outperform the second and the third carbon budgets, but the Committee on Climate Change states that the UK is not on track to meet the fourth, which would require that are reduced by 50% from 1990 levels in the 2023-27 period.

In addition to national targets, the UK is also bound by the EU emissions targets part of the Emissions Trading System (ETS) and the 20:20:20 package, which aims to achieve a 20% reduction in emissions, 20% energy efficiency improvement and a 20% share of renewables by 2020. In late 2015, the UN adopted the Paris Agreement, which has been signed by the UK but not yet ratified. The Paris Agreement will not come into force until it has been ratified by sufficient countries. In July 2016, the BEIS Minister of State for Energy and Intellectual Property confirmed that the UK Government intends to ratify the agreement as soon as possible (UK National Audit Office, 2016).

The main independent body in charge of monitoring the achievement of the main emissions targets and energy reduction goals of the UK is the Committee on Climate Change (CCC). The CCC is a statutory body that was established under the 2008 Climate Change Act with the aim of acting as an advisory group for the UK Government and Devolved Administrations. The CCC reports to the Parliament on the progress made on the UK energy transition, mainly focusing on the areas of greenhouse gas emissions and climate change mitigation. The CCC also advises Government on setting and meeting the Government Carbon Budgets, with this advice directly reflected in UK legislation. In

addition to the monitoring and advice functions, the CCC also undertakes independent sectoral analysis, with recommendations that are sometimes then reflected in UK energy and climate policy, and has an outreach programme to disseminate information and influence public debate (UK Committee on Climate Change, 2016).

In terms of low-carbon technologies, the Low Carbon Innovation Co-ordination Group (LCICG) brings together the UK Ministries, the main representative bodies for trade and industry in the UK Home Countries, the Energy Technologies Institute (ETI) and the Engineering and Physical Sciences Research Council (EPSRC). The goal of the LCICG is to monitor the UK's capability in low-carbon technologies and to decide how and where to prioritise innovation support. A very important part of LCICG's work is the Technology Innovation Needs Assessment (TINA) project, which produces monitoring information and analysis on the potential role of each technology in the UK's energy system and estimates its value to the UK economy from the point of view of using the technology, cutting its costs through innovation, and increasing exports. TINA reports are consensus views and analysis that play an important role in the energy transition roadmap of the UK (LCICG, 2016). Current topics include all renewable energy production technologies as well as carbon capture and storage, electricity storage and networks, and energy efficiency in buildings.

The current policy targets for the UK Government's plan to meet the fourth and fifth carbon budgets are summarised below (Table 4). In addition to the four main energy functions (buildings, transport, industry and power generation), the carbon budgets also contain additional provisions for the following areas:

- Agriculture, land use, land-use change and forestry (8% of 2014 emissions): GHG emissions to fall by around 15% between 2014 and 2030, and afforestation rate to increase to 15,000 hectares per year
- Waste (3% of 2014 emissions): GHG emissions to fall by around 50% between 2014 and 2030
- Fluorinated gases (3% of 2014 emissions): GHG emissions to fall by at least 70% between 2014 and 2030

Table 4 Overview of targets and regulations per energy function

<b>Targets and regulations</b>	<i>Buildings (18% of 2015 emissions)</i>	<i>Power (21% of 2015 emissions)</i>	<i>Industry (23% of 2015 emissions)</i>	<i>Transport (24% of 2015 emissions)</i>
Target 2030	Emissions to fall by around 22% between 2015 and 2030	Emissions intensity to fall by around 75% (to below 100 gCO <sub>2</sub> /kWh) between 2015 and 2030	Emissions to fall by around 20% between 2015 and 2030	Emissions to fall by around 43% between 2015 and 2030
Target 2050	options developed to allow near-zero emissions by 2050	options developed to allow near-zero emissions by 2050	--	options developed to allow near-zero emissions by 2050
Special/additional regulations or targets	--	See additional targets above for waste	See additional targets above for waste, F-gases and agricultural industry	--

Source: (UK Committee on Climate Change, 2016)

### 3.2 Energy policy and instruments

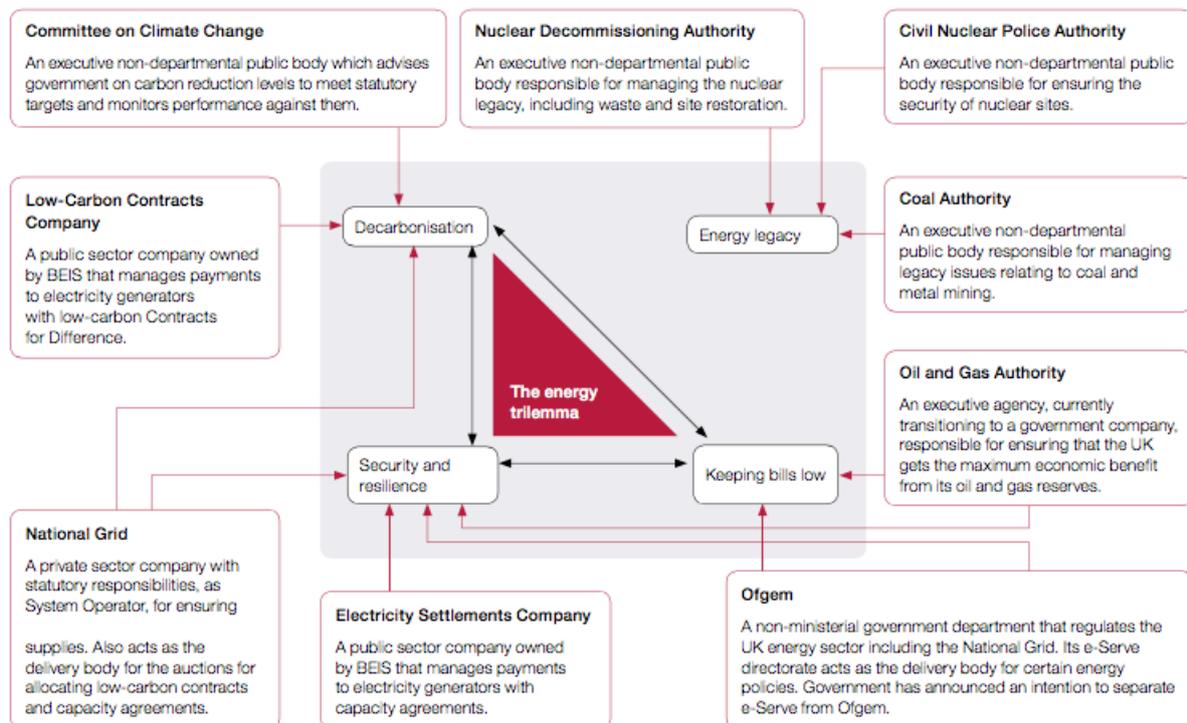
UK Ministries were reorganised after the outcome of the Brexit referendum in July 2016. The Department of Energy & Climate Change (DECC) was merged with the remaining activities of the Department of Business, Innovation and Skills (BIS), forming the new Department for Business,

Energy & Industrial Strategy (BEIS). Although there are changes undergoing which also affect energy policy, as it currently stands BEIS is still in charge of rolling out DECC's Single Departmental Plan 2015-2020. The following main responsibilities which are now part of BEIS, which includes the energy legacy objective to the objectives previously in DECC's remit (UK DECC, 2015; UK National Audit Office, 2016):

- **Decarbonisation:** to work with international partners and to meet the national carbon target of 80% reduction by 2050
- **Energy security and resilience:** to work with the oil, gas and electricity sectors to ensure a well-functioning, competitive and resilient energy system and sufficient capacity
- **Energy bills:** to keep bills as low as possible for hard-working families and businesses
- **Energy legacy:** to discharge legal liabilities and manage the security risks from the legacies of nuclear and coal industries

Apart from the legacy objective, the other three policy areas were often referred to as the energy 'trilemma' because actions in one area of the cost-security-sustainability equation could easily have a negative impact in the others. Energy policy in the UK is largely 'reserved', with BEIS having responsibility for overseeing policy and legislation for the entire UK. However, there are also some areas such as energy poverty which are devolved (with different degrees) to Scotland, Wales and Northern Ireland. DECC managed these tensions through a network of delivery partners tasked with delivering on policy priorities, and it is expected that this overall arrangement will continue under BEIS (Figure 6). Delivery partners further develop the policy priorities in a series of themes and focus areas, which are addressed with a mix of support measures.

Figure 6 Delivery partners of UK energy policy



Source: National Audit Office, 2016

The **energy security and resilience** policy priority focuses mainly on the supply side. For electricity, which cannot be yet stored in large quantities, a complex regulatory framework is in place to balance supply and demand in real time. This regulatory framework strongly influences the decisions of private actors in the investment of new equipment for power generation. On the other hand, the provision of oil and gas is left largely to the private sector, apart from the regulated gas distribution network operated by National Grid on behalf of BEIS. Several instruments are in place:

- **Balancing services** managed by National Grid, which are funded through energy generators and suppliers at-rate tariffs and the ‘Balancing Services Use of System’ charge
- **Balancing services penalties** issued by Ofgem for suppliers and generators that are out of balance, and which are used to support Citizens Advice services and the Carbon Trust.
- The **Capacity Market**, introduced by the Government’s Electricity Market Reform Programme to ensure future availability of energy by providing energy generators with a steady, predictable income stream to support investment.
- **Interconnectors with Europe**, maintaining existing interconnection infrastructure (which has a capacity of 4GW, ~6% of total electricity demand) and increasing harmonisation with the EU energy infrastructure, providing additional resilience through imports of energy and gas when necessary.

In terms of the **energy legacy**, the activity focuses mainly on managing the impacts of decommissioning nuclear facilities and retired nuclear power plants, geological disposal of higher-level waste, and of managing legacy impacts of the fossil fuel industry (including mining and energy generation infrastructures). For nuclear, responsibility is mainly within the **Nuclear Decommissioning Authority (NDA)**. The NDA is responsible for managing and decommissioning sites and storages on nuclear waste and it initially used private contractors to do that, although some have now been transferred as subsidiaries of the NDA in order to improve on the delivery of these services. These are for example Sellafield and the Radioactive Waste Management Ltd. For the coal industry, responsibility of managing the legacies is carried out through the **Coal Authority (CA)**. Even though the last deep coal mine in the UK (Kellingley) closed in late 2015, there are still a few open mines operating and past activities have left significant environmental impacts that need to be managed. For example, waste water treatment will be necessary for 100 years, and further subsidence claims for another 50 years. The exact timeframes and costs of these legacies are difficult to assess and heavily dependent on the discount rates applied by HM Treasury to estimate them.

The largest activities to incentivise **decarbonisation** of the UK economy are the **Electricity Market Reform (EMR)**, the **Contracts for Difference (CFDs)**, the **Emissions Performance Standard (EPS)** and the **EU Emissions Trading Scheme (ETS)**. The Electricity Market Reform (EMR) was launched in 2013 and introduced minimum prices for CO<sub>2</sub> emissions, while the Contracts-for-Difference provide a guaranteed income for suppliers, who also have to pay back if the market offers more than the agreed price. The Emissions Performance Standard (EPS) imposes a limit for emissions in power plants, effectively making coal fired plants non-compliant unless they employ carbon capture and storage (CCS) technologies. Other measures in support of decarbonisation are the **Renewables Obligation**, which supports renewable generation but it is progressively being replaced by CFDs, the **Renewable Heat Incentive (RHI)**, which supports renewable energy heating for domestic and non-domestic buildings, and the small-scale **Feed-in Tariff scheme**, supporting renewable generation using solar panels and biomass.

Lastly, the Energy bills or **fuel poverty** objective focuses mainly on the domestic sector, and aims to solve a problem that is related both to economic hardship and the poor quality of the housing stock. Fuel poverty is significant in the UK, compared to other European economies, and this is an issue that has been devolved to the Home Countries. Both Scotland and Wales have set their own targets for fuel poverty reduction, with “fuel poverty” calculated differently by the different administrations – a household living in a home which cannot be kept warm "at reasonable cost" in Scotland and 10% or more of household income spent on energy costs in Wales. According to DECC, in 2014 2.4m households (more than 10% of the total) were in fuel poverty in England, with similar levels projected

for 2015 and 2016. The Government's position is that the retail energy market is not fully competitive, with prices not reflecting drops in the price of energy generation, particularly at the wholesale level. Therefore, the Government is using a **Levy Control Framework (LCF)** to cap and control the costs of government energy policies that are funded by consumers through their energy bills. A new package of measures to improve competition and remedy these price imbalances is to be presented in or before December 2016.

These and other support measures and instruments dealing with information, education, networks and R&D are further summarised in the table below for the main energy functions and types of intervention (Table 5).

Table 5 Overview of policy instruments per function

<b>Instrument</b>	<i>Buildings (18% of 2015 emissions)</i>	<i>Power (21% of 2015 emissions)</i>	<i>Industry (23% of 2015 emissions)</i>	<i>Transport (24% of 2015 emissions)</i>
Economic	<ul style="list-style-type: none"> <li>• Climate Change Levy</li> <li>• Enhanced Capital Allowances</li> <li>• CRC Energy Efficiency Scheme</li> </ul>	<ul style="list-style-type: none"> <li>• EU ETS</li> <li>• Carbon Price Floor</li> </ul>	<ul style="list-style-type: none"> <li>• EU ETS</li> <li>• Climate Change Levy</li> <li>• Climate Change Agreements</li> <li>• Enhanced Capital Allowances</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicle Excise Duty</li> <li>• Fuel Excise Duty</li> <li>• Air Passenger Duty</li> <li>• Renewable Transport Fuel Obligation</li> </ul>
Information, education, networks	<ul style="list-style-type: none"> <li>• Non-Domestic Energy Efficiency Training Fund</li> <li>• ‘Catapult’ Centres</li> <li>• Knowledge Transfer Partnerships</li> </ul>	<ul style="list-style-type: none"> <li>• ‘Catapult’ Centres</li> <li>• Knowledge Transfer Partnerships</li> </ul>	<ul style="list-style-type: none"> <li>• ‘Catapult’ Centres</li> <li>• Knowledge Transfer Partnerships</li> </ul>	<ul style="list-style-type: none"> <li>• ‘Go Ultra-Low’ Campaign</li> <li>• Plugged-in Places</li> <li>• Local Sustainable Transport Fund</li> <li>• Green Bus Fund</li> <li>• Ultra-low Emission Taxis</li> <li>• National Rapid Charge Point Network</li> <li>• HGV Gas Refuelling Network</li> <li>• Polymer Fuel Cell Challenge</li> <li>• ‘Catapult’ Centres</li> <li>• Knowledge Transfer Partnerships</li> </ul>
Policy / regulations/ standards	<ul style="list-style-type: none"> <li>• CHP Focus</li> <li>• LSX Reporting Requirements</li> <li>• Ecodesign Requirements</li> <li>• Labelling for Energy-Related Products</li> <li>• Energy Company Obligation</li> <li>• Smart Meter Roll-Out</li> <li>• Code for Sustainable Homes</li> <li>• Energy Performance Certificates</li> <li>• Energy Saving Trust</li> <li>• Government Buying Standards</li> </ul>	<ul style="list-style-type: none"> <li>• Emissions Performance Standard</li> <li>• CHP Focus</li> <li>• LSX Reporting Requirements</li> </ul>	<ul style="list-style-type: none"> <li>• CHP Focus</li> <li>• LSX Reporting Requirements</li> <li>• Agriculture Greenhouse Gas Action Plan</li> </ul>	<ul style="list-style-type: none"> <li>• LSX Reporting Requirements</li> <li>• Energy Saving Trust</li> <li>• CO2 intensity standards for Passenger Cars &amp; LGVs</li> <li>• Passenger Car Labelling</li> <li>• Government Buying Standards</li> </ul>
Research and development	<ul style="list-style-type: none"> <li>• Electricity Demand Reduction Pilot</li> <li>• Energy Entrepreneurs Fund</li> </ul>	<ul style="list-style-type: none"> <li>• Energy for Growth Project</li> <li>• CCS Commercialisation Competition</li> </ul>	<ul style="list-style-type: none"> <li>• Electricity Demand Reduction Pilot</li> <li>• Industrial Energy Efficiency</li> </ul>	<ul style="list-style-type: none"> <li>• Bioenergy Sustaining the Future Programme</li> </ul>

	<ul style="list-style-type: none"> <li>• Bioenergy Sustaining the Future Programme</li> <li>• Invest in Innovative Refurb Programme</li> <li>• Renewable Heat Incentive</li> <li>• Green Deal</li> <li>• Green Investment Bank</li> <li>• Salix Finance Public Energy Efficiency Loans</li> <li>• ‘Catapult’ Centres</li> <li>• The Energy Catalyst Fund</li> <li>• Energy Technologies Institute</li> </ul>	<ul style="list-style-type: none"> <li>• Cross-Government CCS R&amp;D Programme</li> <li>• Offshore Wind Component Technologies Development and Demonstration Scheme</li> <li>• Carbon Trust Offshore Wind Accelerator</li> <li>• Marine Energy Array Demonstration Scheme</li> <li>• Nuclear Innovation Funding Schemes</li> <li>• Energy Storage Innovation Competitions</li> <li>• Low Carbon Networks Fund</li> <li>• Sustainable Power Generation and Supply Programme (SUPERGEN)</li> <li>• Energy Entrepreneurs Fund</li> <li>• Bioenergy Sustaining the Future Programme</li> <li>• Green Investment Bank</li> <li>• Salix Finance Public Energy Efficiency Loans</li> <li>• ‘Catapult’ Centres</li> <li>• The Energy Catalyst Fund</li> <li>• Energy Technologies Institute</li> </ul>	<p>Accelerator</p> <ul style="list-style-type: none"> <li>• Energy Entrepreneurs Fund</li> <li>• Bioenergy Sustaining the Future Programme</li> <li>• ‘Catapult’ Centres</li> <li>• The Energy Catalyst Fund</li> <li>• Energy Technologies Institute</li> </ul>	<ul style="list-style-type: none"> <li>• Low Carbon Vehicle Innovation Platform</li> <li>• ‘Catapult’ Centres</li> <li>• Energy Technologies Institute</li> </ul>
Voluntary instruments	<ul style="list-style-type: none"> <li>• Energy Savings Opportunity Scheme</li> <li>• Microgeneration Certification Scheme</li> <li>• Building Minimum Energy Performance Standards (inc. Zero Carbon Homes Policy)</li> </ul>	<ul style="list-style-type: none"> <li>• Microgeneration Certification Scheme</li> </ul>	<ul style="list-style-type: none"> <li>• Energy Savings Opportunity Scheme</li> </ul>	<ul style="list-style-type: none"> <li>• Energy Savings Opportunity Scheme</li> <li>• Logistics Carbon Reduction Scheme</li> <li>• Plug-in Car and Van Grants</li> </ul>

Source: Based on (Drummond & Ekins, 2016)

## 4 Interaction and governance

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### 4.1 Stakeholders in the UK energy system and how they interact with each other

The UK energy system is very vertically integrated and centralised with the government and energy sector incumbents wielding the most power. This includes government departments, the regulator (Ofgem), the system operator (National Grid), the regional transmission and distribution system operators, and the 'Big Six' energy companies. Although energy is a national competence, the devolved administrations are also seen to have a key interest in this area and are included as stakeholder in policy decisions. Much traction is also given to building cross-party consensus in parliament so that a change in government does not detract from long-term energy and climate change goals. The situation now is that only the relative mix between nuclear, renewables and gas could change with government but the decarbonisation and emissions targets remain the same.

Within government, different departments such as BEIS, the Department for Communities and Local Government and the Treasury all have a stake in the energy agenda. Disagreements between these departments can affect policy decisions and the Treasury usually has the casting vote. For example, when the Conservative-Liberal Democrat government came into power in 2010, public attention towards climate change had diminished and the 2008 financial crisis had enhanced concerns about jobs, competitiveness and energy prices. The Treasury used these concerns to influence policy by issuing warnings that green policies should not hinder the economy. In 2013, concerns over rising energy bills led the government to scrap, delay or water down various green policies. The government also refused to commit to long-term renewable electricity targets beyond 2020, despite repeated recommendations from the Committee on Climate Change (Geels, et al., 2016).

Other less influential stakeholders include think tanks, consumer groups, industry umbrella groups, green organizations and new entrants such as small energy suppliers, renewable energy companies and smart technology companies e.g. energy storage companies and aggregators who bring retail energy customers together to manage their demand, costs and services more effectively. Industry associations, think tanks and green organizations such as the Renewable Energy Association, Energy UK, Energy Saving Trust, Energy Technology Institute, Carbon Trust, Green Alliance, Green Peace and Friends of the Earth are instrumental in lobbying government and furthering the sustainability agenda as well as in conducting research and providing consultancy services to government and industry at times. During the last parliament, the Green Alliance helped to broker a cross-party deal to phase out coal unless less polluting technology is used. The Renewable Energy Association has been trying to protect the interests of solar trade organisations by trying to influence government but such associations are usually less influential than big utilities.

Public groups typically do not play a major role, although there is an emerging constituency behind community energy schemes that has increasing visibility and political power. Some NGOs such as Shelter support people who are energy poor and try to voice the energy-related concerns of less influential groups within society. Other entities with an involvement in energy issues are the Green Investment Bank, Crown Estate and Climate Change Committee.

In trying to influence policy, some of these stakeholders adopt a clear position in terms of their desired trajectory to energy transition. Within industry, this often depends on existing technology assets or their intention to develop assets in a particular technological area. Thus, incompatible positions are sometimes adopted by different sections of the industry based on what the energy transition entails. Green organisations and consumer groups also often adopt a particular position on energy transition issues such as renewables targets, subsidies for renewables and support or objection to particular technologies such as shale gas or nuclear energy.

Over and above the efforts of stakeholder groups to engage with government, the government tries to keep in contact with all of the stakeholders too. It works very closely with Ofgem and the National Grid. Ministerial and official level contact as well as bilateral or group meetings with stakeholders are actively pursued. Moreover, public consultations or calls for evidence are undertaken before major

decisions or policy changes. Parliamentary select committees are another mechanism to gather evidence and opinion on policy from businesses, sector experts and academics. However, the impact of these various types of engagement on policy is not always clear.

## 4.2 Governance

As already highlighted, the UK energy system is very centralized with little autonomy for regions. Hence, there is no incentive for local government to engage independently with energy-related issues. Three of our interviewees raised the point that more autonomy to regional structures – big cities like Manchester – would result in more engagement with energy transition through local strategies. In addition, more power to local authorities needs to be combined with local capacity building in energy-related areas. The lack of delegation to local authorities may also be a legacy of the UK's political structure where local government is highly dependent on central government for funding and is less powerful compared to countries like Germany which has a federal structure and powerful municipalities.

An interesting case in point in the UK energy system is the system operator (National Grid) which has a variety of technical roles within the system. In other countries, the amount of discretion given to the system operator varies a lot. In the US, the system operator is independent whereas in many European countries, the system operator is an integrated part of the main transmission owner. Britain is part way between those two extremes and discussions about giving the system operator more independence are ongoing whether to allow it to take greater responsibility or contribute more to the direction of the energy system. Currently, the system operator falls under the Ofgem regulatory regime and is licensed by Ofgem. The hope is that the licence provides enough incentives to the system operator to allow it to be high performing and drive the system in an efficient direction. Whether this actually works is a matter of debate.

An interesting case in governance is the proactive and entrepreneurial role of the Crown Estate in offshore wind generation where the UK is a world leader. The Crown Estate saw an opportunity to make more revenue from licenses but also realised that they need to help people to invest in order to make that revenue. So they started co-investing and co-developing opportunities, adopted a business-friendly approach and tried to build a UK supply chain. They have effectively acted as a 'system builder' and can be credited with the UK's relative success in this area (Kern, Verhees, Raven, & Smith, 2015). This kind of approach has a potential impact not only on governing the energy transition but also on economic growth.

Not enough incentives are given to individuals to steer the transition in the desired direction. Those that have been put in place are too complicated. For example, the Conservative-Liberal Democrat Coalition Government's Green Deal failed for this reason. To have someone provide advice on making changes to one's home to make it more energy efficient, then take out a government loan at a high interest rate and pay it back via energy bills was too complicated for many consumers. Many households were worried about what would happen if the house was sold – would somebody else pay? The terms for that were unclear.

Other main incentives come from policy instruments e.g. feed-in tariffs, renewables obligation and the EU emissions trading system. Incentives that have worked well include the electric car incentive – this incentive has now been cut – and solar panel installation, which worked well because people got good value for money. In terms of incentives, another issue is that all the costs of renewables and efficiency measures has gone on to the electricity price. This is a problem because to get decarbonisation people need to use more electricity. Thus, there is a problem if gas prices are lower, which drives people to use more gas. Besides, gas is subsidised in the UK with only 5% VAT compared to 20% VAT for most other commodities.

The nature and trajectory of the energy transition is also potentially influenced by the nature of the UK electoral system. Since it has a 'first past the post system' rather than a proportional representation type of system, the representation in parliament of small parties such as the Green Party is low. The Green Party which has a clear position on the manner in which energy transition should be undertaken has limited influence as a result. In turn, the people who are elected are likely to have a more

pragmatic or economy-led view which will impact on how the UK goes about energy transition now and in the future.

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## 6 Interviewees

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<b>Name</b>	<b>Organisation</b>	<b>Interview date</b>
Jo Coleman	Strategy Development Director, Energy Technologies Institute	Tuesday 18 October
Benedict Eyre-White	Senior Policy Advisor, Electricity System, UK Department for Business, Energy and Industrial Strategy	Tuesday 25 October
Florian Kern	Senior Lecturer at Science Policy Research Unit, <sup>[[1]]</sup> Co-Director of the Sussex Energy Group, <sup>[[1]]</sup> University of Sussex	Tuesday 25 October
Catherine Mitchell	Professor of Energy Policy, Energy Policy Group, University of Exeter	Friday 28 October