Programme Area: Smart Systems and Heat

Project: Value Management

Title: Characterisation of the Current Energy Value Chain

Abstract:

Work Area 4 (Value Management and Delivery) addresses the key issue of how value can be delivered across the entire smart systems value chain (in the context of the UK). The premise here is to understand how smart systems can deliver consumer value along with commercial value to all market participants. The scope of work in relation to this deliverable comprises of an assessment of the current energy value chain and value delivery and considers current value chains for mains gas, electricity, district heating, heating oil and heating enabling technologies. This has been completed in order to identify the current drivers of business models and value delivery mechanisms such that we can then identify where any opportunities, or barriers to change, exist. This will then inform our consideration of future business models and their applicability to SSH moving forward.

Context:

This project studied how value can be delivered across a smart energy value chain - in the context of the UK. It built a clear understanding of how smart energy systems can deliver combined consumer value alongside commercial value for market participants - producers, suppliers, distributors. The analysis will help to make the commercial deployment of smart energy systems more likely. This £600,000 project was delivered by Frontier Economics, a leading economic consultancy.

Characterisation of the current energy value chain v1.1

VALUE MANAGEMENT D1 (WA4 SSH)

24 JULY 2013

Characterisation of the current energy value chain v1.1

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Executive Summary

Frontier Economics and Total Flow have been commissioned to deliver Work Area 4 (WA4) of the ETI's Smart Systems and Heat (SSH) project. This report considers the current value chains for mains gas, electricity, district heating and heating oil, and heating enabling technologies[1].

The purpose of this report is to identify the current drivers of business models and value delivery mechanisms so we can identify where opportunities, or barriers to change, may exist. This will inform our consideration of future business models, the focus of the WA4 project.

Key insights and learning

The basic characteristics of the energy value chains have led to deep policy and regulatory interventions that largely shape energy sector business models. This will not change and policy needs to be recognised as a primary driver of future business models.

Understanding the basic characteristics of the energy value chain provides insight about the business models that emerge. For example, the different options for transport and storage of alternative energy types have meant that there are local markets in district heat and oil, but national markets in gas and electricity. It is the policy response to these basic characteristics that largely determines the nature of the industry and the business models that can exist within it.

This is particularly the case for the electricity and gas value chains. The response of business models to policy may be explicit (for example in the case of the regulated monopoly network companies) or be the result of a complex interaction of policies (such as the move to vertically integrate in the electricity sector to manage imbalance risks). Policy also drives the profitability of the value propositions that businesses are able to offer. This may be direct (where the number and complexity of energy tariffs are limited through regulation) and indirect (for example, through settlement rules that reduce the benefit to offering time of day tariffs).

As a consequence, policy and regulatory change is a primary facilitator of business model change.

Ensuring that existing policy does not act as a barrier to efficient change is one of the main sector challenges. Fundamental changes are possible, as shown by the

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1 Current enabling technologies include technologies that convert energy to heat or cooling (such as boilers, air conditioners, electric resistive heating, heat pumps and other low-carbon heating technologies) and technologies that increase heating or cooling efficiency (such as insulation, double glazing and thermostats).

whole-scale shake-up of the sector following its privatisation in the 1990s. And there are no signs of policy intervention diminishing, with major reforms underway across the sector to meet climate change goals. This, in turn, means that risk of policy change becomes an important consideration for businesses. A recent example of this is the current stalling of investment in the generation sector as investors await the outcome of Government's electricity market reform.

Management of fuel price risk drives both business models and value propositions.

The management of fuel price volatility has had a big impact on customer-facing business model design and value propositions. The main cause of retail business failure since liberalisation has been failure to manage fuel price risk. Management of fuel price risk has also been seen as a barrier to entry, as the most effective way of mitigating this risk in the electricity sector under the current market rules has been through vertical integration into the generation sector.

The need to manage fuel price risk is also one of the main limitations to creating innovative retail offerings. To offer long term stable prices to consumers requires a supplier to hedge this risk over comparable timescales. However, this can be prohibitively expensive, particularly if there are regulatory restrictions associated with tying customers in to long term contracts.

Access to finance as a driver of business models is likely to become increasingly important.

Investment rates are currently high across the sector, and will need to rise further. Infrastructure finance is a global business. Further, many of the energy companies that operate in the UK are part of larger global utilities and therefore the competition for finance between countries is also driven by internal factors. Ensuring that the UK energy sector remains competitive in its ability to secure finance is one of the main challenges facing the sector and policy makers.

Securing finance for projects with a significant new technology or novel process element has become increasingly difficult, although there are government schemes to help (such as the UK Guarantees Scheme and the Green Investment Bank). The ability to take advantage of investment by pension funds and insurance companies has also been driving business model structures. For example, it has contributed to a number of the network companies divesting themselves of all other interests to focus on the more stable long-term inflation protected income streams attractive to these investors.

What does this mean for future business models?

There are significant barriers to change in the energy sector on the supply and demand sides.

Long asset lifetimes, and investment lead times, mean that changes in energy infrastructure can be slow. A large amount of capital has been sunk into the energy value chains. These technologies only need to cover their marginal /operating costs to remain viable, which may reduce the pace at which new alternatives can penetrate the market. In addition, consumers generally display low levels of responsiveness on energy contracts and technologies. Many consumers are not interested in switching energy retailer, even when they could potentially make savings, and some are only willing to install new enabling technologies at trigger points that may be many years apart (e.g. moving house, renovating).

Despite these barriers, substantial new opportunities for new businesses will arise in response the challenges associated with a move to the low-carbon economy.

In particular, the move to a low-carbon economy is likely to create opportunities for business models that help add flexibility to the system (for example by harnessing customer demand side response through new retail offerings, or by investing in storage), and businesses that manage the increasing levels of supply side complexity associated with a low-carbon economy for consumers (for example by providing bundled retail offerings, based around comfort rather than energy).

The need to install smart systems in homes will also present opportunities. There is less regulation of the business models and value propositions that sit on the customer side of the meter in the "smart home" market. This may provide more opportunities for innovative business models to emerge in these areas, potentially driven by new entrants to the energy sector.

1 Introduction

Frontier Economics and Total Flow have been commissioned to deliver Work Area 4 (WA4) of the ETI's Smart Systems and Heat (SSH) project. This Work Area addresses how value can be delivered across the smart systems energy value chains (in the context of domestic and small business consumers in GB) and how future systems might be configured and operated.

To understand which business models are likely to be successful in the future, it is important to understand the present. In this report, covering the first part of the WA4 analysis, we undertake the following:

- we look at the current value chains for mains gas, electricity, district heating, heating oil, and heating enabling technologies[2];
- we describe how value is delivered across each value chain through an assessment of the ownership structures, business models market shares and profitability; and
- based on this analysis, we develop an understanding of the implications of the current market structure for change to the sector, and pull out the key tensions and issues relevant to a move to new business models in a low-carbon economy.

The report is structured as follows:

- this section describes the context and objectives of the report;
- Section 2 outlines the methodology;
- Section 3 presents an overview of the outputs of our work;
- Section 4 summarises key insights from the analysis; and
- Section 5 sets out our conclusions and recommendations.

1.1 Context

The UK has signed up to legally binding targets to reduce greenhouse gas emissions by 80% over 1990 levels by 2050. To achieve this target, analysis suggests that major reductions in emissions from the heating sector will be

2 Enabling technologies include technologies that convert energy to heat or cooling (such as boilers, air conditioners, electric resistive heating, heat pumps and other low-carbon heating technologies) and technologies that increase heating or cooling efficiency (such as insulation, double glazing and thermostats).

required by 2050[3]. At the same time, the smart meter rollout and the development of smart technologies are presenting new opportunities to reduce carbon emissions in a cost-effective way.

In this context, the ETI's SSH programme aims to design a first of its kind Smart Energy System in the UK. The programme is focussing on domestic consumer requirements for space and water heating, in the context of other energy service needs in buildings, and taking account of the evolution of the whole energy system out to 2050.

This project (WA4) is part of the first phase of the SSH programme, which aims to develop the toolkit and capacity to deliver a prototype Smart Energy System to the mass market. Phase I comprises six work areas focussing on technological and commercial aspects of the development of a smart energy system. The second phase will validate the research carried out in the first phase with a significant system level demonstration.

1.2 Objectives

The overall objective of WA4 is to address how value can be delivered across the smart systems energy value chains to domestic and small business consumers in Great Britain, and how future systems might be configured and operated.

This report presents the outputs of the first phase of WA4. To understand which business models are likely to be successful in the future, it is important to understand the present. The first phase of the WA4 project is therefore to characterise the current energy value chains for domestic and small business heating.

In this report, we examine the current value chains for mains gas, electricity, district heating and heating oil, and heating enabling technologies[4].

Specifically, this report has the following objectives:

- to analyse each value chain from supply of input fuel and degeneration through transmission/distribution to retail, metering and consumer offerings;
- to describe how value is currently delivered across each value chain through an assessment of the ownership structures, business models market shares and profitability;

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3 DECC and CCC analysis suggests that the heating sector will need to be almost completely decarbonised by 2050.

4 Throughout this report we focus on drawing out the points that shed light on the opportunities and barriers in the current energy sector. Detailed analysis and data are presented in the annexes to this report, along with a description of our analytical framework.

- to assess the implications of this for change to the sector, and to identify potential barriers to change; and
- to identify issues that should be considered by other work areas.

This analysis allows us to understand the drivers of business models and value delivery mechanisms, and to identify key tensions and issues within the current market place which may be important in the move to new business models.

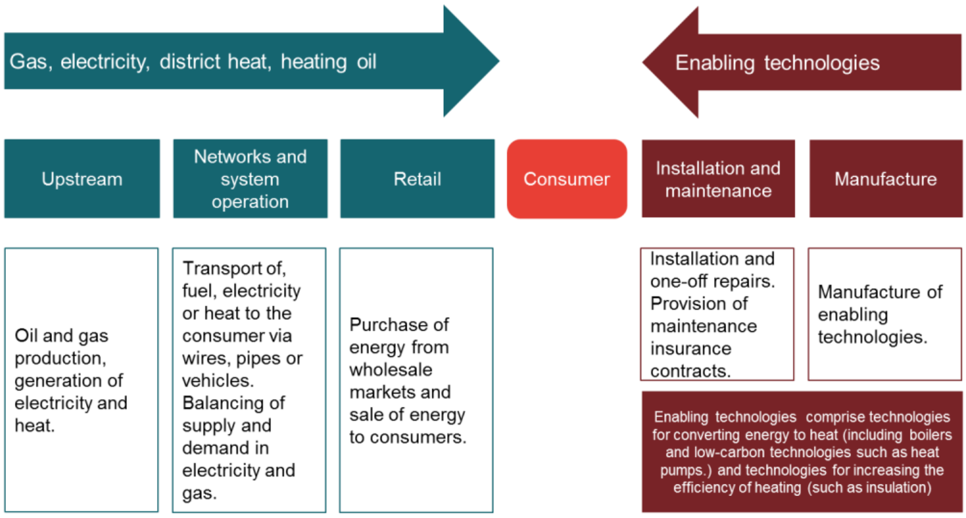
The second part of WA4 involves the development and evaluation of business models and value delivery mechanisms which will help. The outcomes of this piece of work will be set out in a separate report.

2 Methodology

This section describes our methodology[5]. We undertook the work in five stages.

- **High level characterisation of value chains.** We first developed a framework for the analysis. We divided each energy value chain into three parts: upstream, networks and system operation, and retail. We divided current enabling technologies into two parts: installation and maintenance, and manufacture. This is illustrated in Figure 1.

Figure 1. Overview of current value chains



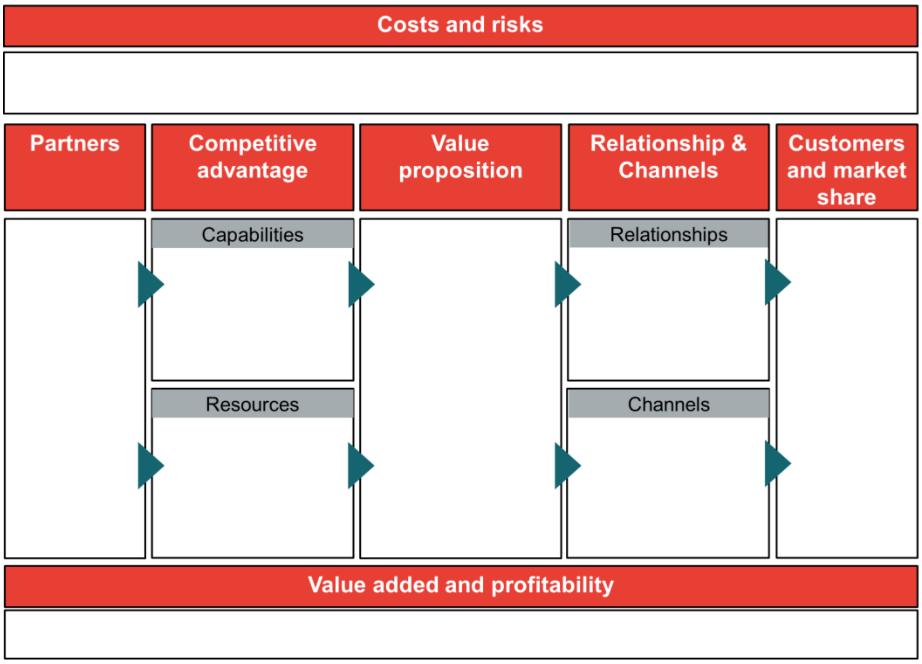
Source: Frontier Economics

- **Framework for the characterisation of business models.** We then developed a framework that allowed us to systematically analyse each part of the sector[6]. We used a business model canvas (Figure 3) to structure our analysis. This allowed us to develop and present an understanding of the key factors that define business models and the environment in which they operate.

5 Further detail on the Methodology is given in Annexe 1.

6 Adapted from the Business Model Canvas from BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.

Figure 2. Business model canvas



Source: Adapted from the Business Model Canvas from BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.

- **Data collection and analysis.** We undertook a detailed analysis of each of the value chains, drawing on published data from a range of sources, including DECC and Ofgem published statistics, company Annual Reports, UK Government and EU policy publications, White Papers and Directives, industry and consumer association websites and consultancy and academic reports. The output of this phase of the work was a detailed characterisation of each value chain, and of the policy and legislative context in which they sit[7].

- **Expert review.** The next stage of the work involved expert review of our characterisation of business models. This took the form of a workshop, held on February 19th 2013. Attendees included representatives from ETI member organisations, Ofgem and ETI itself. A high level endorsement of the approach and initial results was gained.

7 A detailed characterisation of each business model is presented in Annexes 3-7. We have also included annexes covering policy (Annexe 3), contractual arrangements (Annexe 9) and finance (Annexe 10).

- **Interpretation of analysis.** The final stage involved the synthesis and interpretation of the analysis. We took the following approach to developing key messages.
  - We began by outlining the fundamental characteristics that ultimately drive the shape of today's value chains and describe the policy interventions that have been made in response to these characteristics. Drawing these two elements together allows us to characterise the business environment using the **PESTLE** framework[8].
  - We then described the consequences of these factors for business models including identifying the value added and market share for each of the main components of each value chain.
  - Finally, we synthesised the insights from this analysis, to identify the most important characteristics of the current value chains which may affect how business models develop in the future.

8 PESTLE analysis provides a framework for thinking about businesses in relation to their external environment. PESTLE analysis is relevant in this context as it is policy that largely dictates industry structure in the energy sector, but policy itself is shaped by a set of fundamental drivers. The methodology for our PESTLE analysis is described in Annexe 1 and the detailed results are presented in Annexe 2.

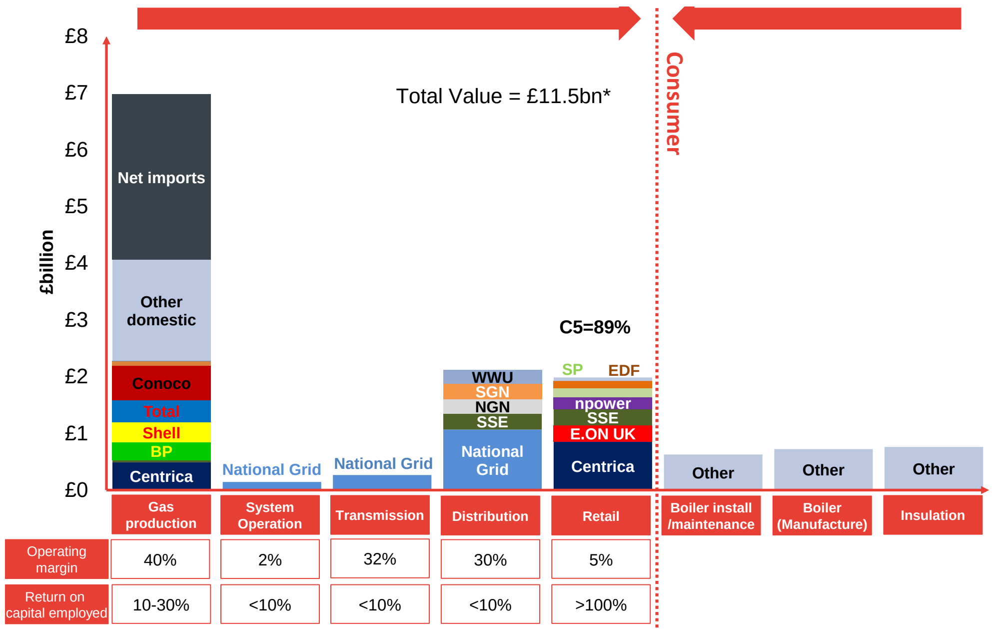
3 Work completed

This section summarises the results of our analysis for each value chain. We first present the high level results of our data analysis and we then summarise the key points from the business model canvas analysis. The detailed results from our work are presented in Annexes 4-8.

3.1 Headline figures

Figure 3 and Figure 4 provide summaries of the value added[9], profitability and market shares for the gas and electricity value chains[10].

Figure 3. The distribution of value added and profitability in the gas value chain (domestic and small business)[11]



* This value does not include the market value of current enabling technologies.

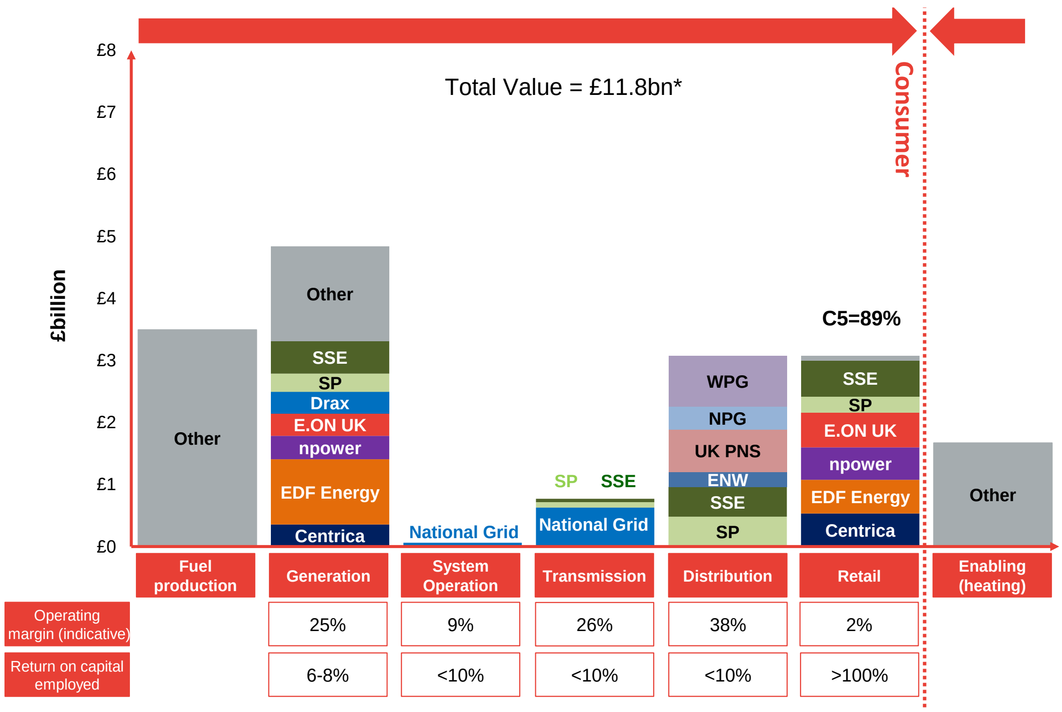
9 For a given part of a value chain, value added is the revenues less outside purchases of materials and services (e.g. for gas retail this would entail revenues minus fuel costs and network charges).

10 The results of our analysis of the oil, district heating and current enabling technologies value chains are presented in the annexe.

11 Note: The ranges of return on capital employed in production and retail are based upon Centrica's reported segmental financial accounts 2011-2007. The returns in gas production are given as post-tax due to the high tax rates on UKCS (UK continental shelf) production. The retail returns are pre-tax. The returns on revenue for retailers are based on the average return in 2011 across the big six retailers. This therefore obscures occasional negative returns for individual retailers, occurring due to wholesales price fluctuations. Returns on revenue for regulated networks are taken from the latest OFGEM price control, using allowed revenues.

Source: Frontier Economics based on OFGEM Supply Market Indicators, OFGEM Household Bills Explained, Company Annual Reports and DECC Digest of UK Energy Statistics.

Figure 4. Indicative value added in the electricity value chain[12]



* This does not include the value of the current heat enabling technologies market, as a proportion of this relate to the other energy sources

Source: Frontier Economics based on Ofgem Supply Market indicators, Ofgem Household Bills Explained, Company Annual Reports and DUKES.

These figures show that the value chains for the sectors providing heat to consumers are all significant. The total value added of the market for domestic consumers and small business is around £12bn/year for each of electricity and gas. The market for current enabling technologies is worth 2.5bn/year[13] and the total value added of the domestic heating oil market is currently around £2bn/year. Even the relatively small market for district heating in the UK is

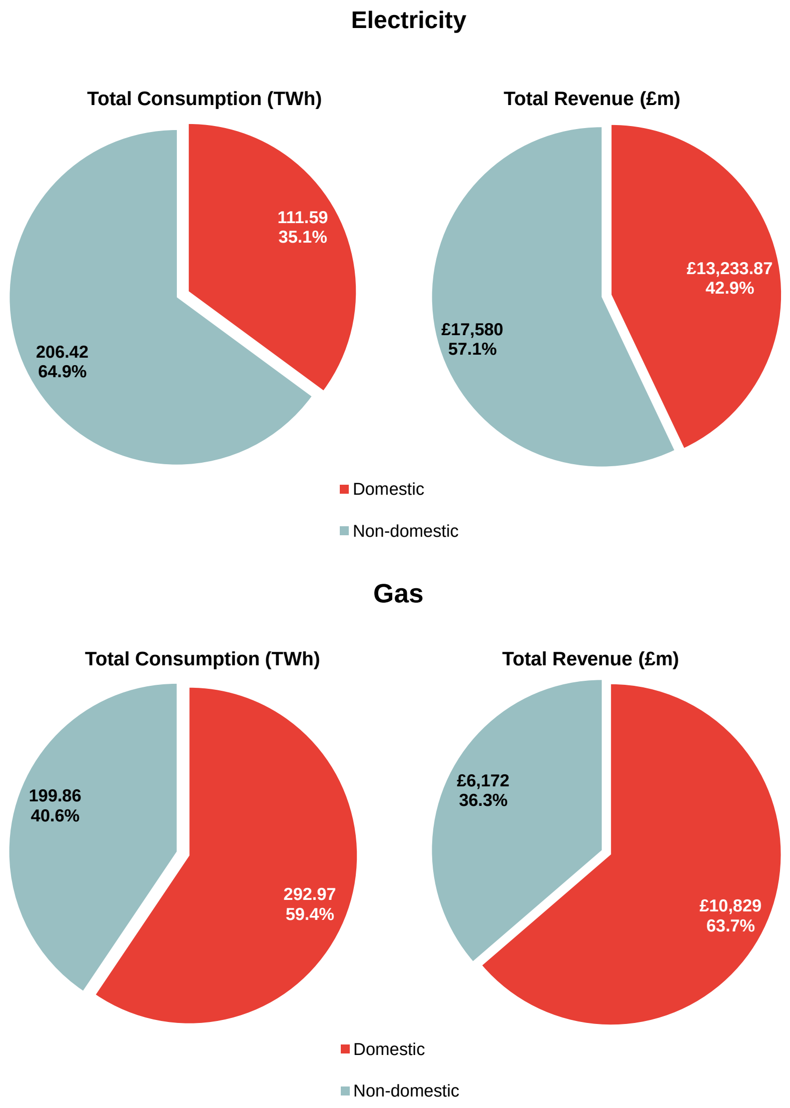
12 Note: The ranges of return on capital employed in generation are based upon Centrica's reported segmental financial accounts 2011-2009, over which period Centrica had an established and representative fleet of power stations. The returns on retail capital employed are based on Centrica financial statements for 2011-2007 and incorporate both the gas and electricity retail business. The retail returns on revenue are based on the average return in 2011 across the big six retailers. This therefore obscures occasional negative returns for individual retailers, occurring due to wholesale price fluctuations. For return on revenue for generators, the return is calculated for four of the big six which report fuel costs in their segmental statements (Centrica, EDF Energy, Scottish Power and E-on) and independent power producer Drax. Returns on revenue for regulated networks are taken from the latest OFGEM price control, using allowed revenues.

13 Covering heat pumps, insulation, boiler purchase, boiler maintenance and boiler installation.

currently worth around £200m to £400m per year. And although a significant proportion of value sits in the upstream parts of the value chain (particularly associated with the primary fuel), there is material value spread throughout the chains, including at the retail and current enabling technologies end.

Figure 5 splits consumption and revenue by domestic and non-domestic customers, and illustrates that domestic customers are a major source of revenue.

Figure 5. Electricity and gas consumption and revenue by domestic and non-domestic consumers



Source: Frontier Economics based on Ofgem Segmental Statements 2011 and Digest of UK Energy Statsitics 2012

3.2 Summary results of business canvas analysis

We now present the most important outputs of our business canvas analysis[14]. The purpose of this section is to set out the key features of the business models in each area. The implications for change are discussed in the following section.

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14 The business model canvases are presented in Annexes 4-8.

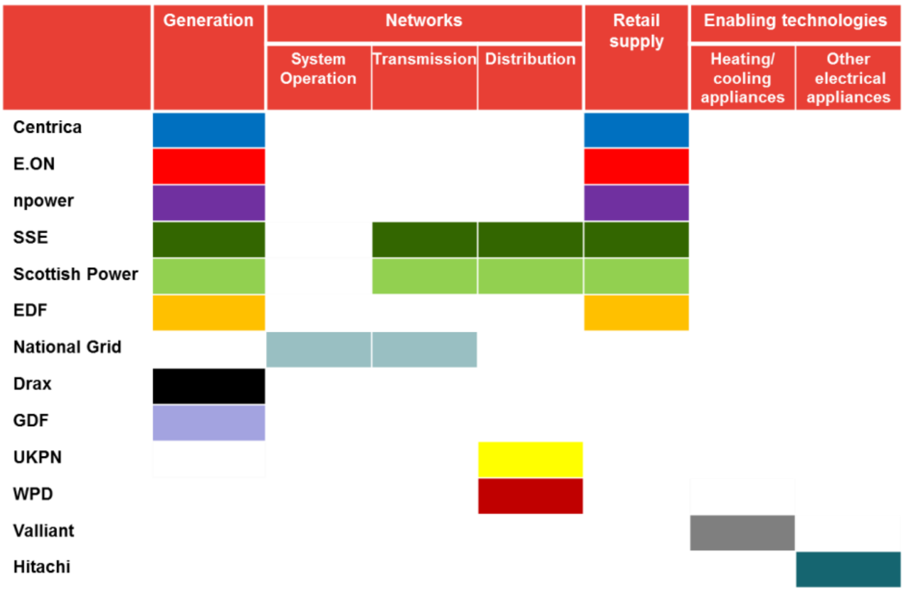
3.2.1 Upstream canvases

Upstream businesses (fuel production, electricity generation) are mostly represented by large firms who typically "build, operate and own" the gas production platforms, power stations, storage assets and refineries.

Differences in means of transport and ability to provide security of supply mean there are local markets in district heat and oil, but national markets in gas and electricity. In gas and electricity competitive wholesale markets have developed at a GB-scale (and beyond) for fuel producers and generators to sell to retailers. In contrast, wholesale markets for refineries to sell heating oil to distributors are more localised due to the required physical connection. Meanwhile competitive wholesale markets for district heat do not yet exist as heat and power plants are tied to specific and localised projects[15].

Vertical integration between upstream and retail is a major feature of the current electricity industry (Figure 6). All of the six major electricity retailers have large generation businesses.

Figure 6. Major players and vertical integration in the electricity value chain



Vertical integration is also a feature of the district heat value chains. Heat losses in transport mean that district heat networks are limited to serving higher density populations, and drawing heat from a source that is relatively close by. It makes sense for the retailer integrate with these sources, rather than face market power. In contrast, there is less vertical integration in oil and gas. Oil and gas are more easily stored and/or hedged on a contractual, rather than physical, basis.

15 In principle if heat networks become large enough, a market for heat generation would be possible where a number of generators are connected to the networks and compete to supply heat.

Nevertheless, in gas, many owners of storage are vertically integrated with retail, with Centrica owning around 70% of total UK storage capacity.

There is a high degree of policy intervention in upstream businesses, aiming to reduce emissions and to protect security of supply. Major changes are currently underway as part of DECC's Electricity Market Reform programme.[16]

3.2.2 Network canvases

The regulatory framework largely determines business models for delivery networks and system operation. In gas and electricity, transmission and distribution are subject to revenue regulation. This means they are run as low risk, regulated monopoly businesses and their success is largely dependent on their operational efficiency and managing regulatory risk.

In both the gas and electricity sectors, most networks are now owned by companies who do not operate in other parts of the value chain. Over the past few years many of the vertically integrated retailers have sold their network business, with only SSE, Scottish Power and National Grid retaining theirs[17]. The rest of the market is represented by independent networks, including firms who run multiple networks. This ownership pattern may reflect the 'low-risk' nature of network businesses which mean they provide stable returns and are attractive to be owned independently (including by pension infrastructure funds).

3.2.3 Retail canvases

Retail business models differ across the value chains, according to the variations in the drivers faced by each one. They provide the direct link to the end consumer and are therefore of particular interest to this study.Six large retailers dominate in electricity and gas retailing (Figure 3 and Figure 4). The six largest firms cover around 99% of the domestic market and 70% of the small business market. These companies have largely competed on price and customer service, since this is what the majority of customers have been most interested in, with little material differentiation in offerings between them[18]. There has been particular competition to get "high value" customers, which tend to be the high consumption customers and also to retain "sticky" customers (those less likely to switch retailer), given margins for these customers tend to be higher.

16 Further discussion of Electricity Market Reform is included in Annexe 3.

18 British Gas could be seen as an exception to this with its early roll-out of smart meters and its proposition Remote Heating Control.

There has been some new entry into the gas and electricity retail markets from companies offering distinctive brands and products. This has largely been based around four propositions.

- **Green energy:** For example companies like Good Energy, Ecotricity and LoCO2 Energy market tariffs based on the supply of energy from low-carbon or renewables sources[19].
- **Ethical providers:** Cooperative Energy[20] and EBICO (backed by SSE) have entered the market branded as ethical providers.
- **New technology:** Companies like First Utility offer smart tariff packages, including a smart meter[21].
- **Bundling:** Utility Warehouse entered the market on the basis of offering discounts associated with using it to provide multiple utility services including fixed and mobile telecoms services.

However, the number of consumers supplied by these entrants remains small and all of the six big retailers also market similar offerings to these new entrants.

Charging is generally based on consumption of energy, reflecting retailers cost structures. Gas and electricity are sold to consumers largely on a consumption basis (i.e. based on units of energy consumed) with a standing charge representing between 10% and 20% of the average bill[22]. This dominance of the consumption charge matches the costs to the retailer of serving consumers, which are largely related to consumption (e.g. purchasing electricity generation or gas). Oil is also sold based on the volume of input fuel. In contrast district heat charging is based on the output (heat) rather than the input (fuel).[23] Domestic heat contracts also usually include a standing charge (often reflecting maintenance costs of the heat network and heat exchangers).

Bundling of gas and electricity contracts is common, largely driven as a means of incumbent gas and electricity retailers entering each other's markets following liberalisation. The number of 'dual-fuel' consumers (i.e. purchasing electricity and gas together) is currently around 75% of the domestic market. Given the number of households without a gas connection, this is around 85-90% of the potential

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19 http://www.goodenergy.co.uk/

20 http://www.cooperativeenergy.coop/why-us/why-we-are-different/

21 http://www.first-utility.com/home-energy/smart-tariff

22 Calculation based on DECC (2012) *Domestic Price Statistics*

23 25% of households metered and thus charged according to their actual heat consumption whereas the remainder are charged according to their deemed consumption For example, deemed usage may be based on the total building consumption and/or on a points system based number of rooms in the property. DECC (2012), *District heating – heat metering cost benefit analysis.*

market[24]. However, outside of dual fuel offerings, there have been few examples of other services being added into the narrow commodity offering (with the exception of boiler and central heating maintenance).

Consumers often face fuel price risk and there is limited long-term contracting. Around three-quarters of domestic gas and electricity consumers pay on a variable price basis, where the retailer may change price periodically[25]. This means retailers are often able to pass on long-term wholesale price risks such consumers. The uptake of fixed price contracts by consumers is influenced by their outlook on fuel prices and the take-up of fixed price contracts tends to increase when fuel prices increase. In contrast to the domestic market, over 65% of contracts for small businesses are fixed price, typically for a period of 1-2 years[26]. For heating oil, only around 1% of consumers are under contract with a distributor. Instead most consumers purchase periodically from a distributor of their choice (sometimes buying in groups to improve their bargaining power). In contrast, district heat is typically sold under long-term contracts linked to the property which is connected to the heat network. However, consumers still take fuel price risk as prices within these contracts typically vary over time in relation to fuel prices (e.g. according to a price index of the fuel used in the heat plant).

3.2.4 Current enabling technology canvases

The value chains for current enabling technologies are diverse. However, a number of points can be made about this part of the sector.

There is typically a separation between installers and maintenance, and manufacturers. Consumers generally contract directly with installers and providers of maintenance. The manufacturers of current enabling technologies typically do not install them, instead marketing to installers via builder and plumbing merchants.

The market for the installation of current energy efficient enabling technologies has been strongly driven by policies and obligations on the large energy retailers. Under CERT[27], which ran until the end of 2012, enabling technologies worth £1.5bn/year have been delivered. Under the replacement policy, ECO[28], expenditure to deliver ECO is expected to be around £1.3bn/year.

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24 Cornwall Energy (2013), *Energy Spectrum: Issue 361*

25 Over 55% of direct debit customers and 85% of standard credit customers are on fixed price tariffs. DECC, 2012, Tariff type variation in the domestic energy market.

26 Ofgem (2012), *Retail Market Review: updated proposals for businesses.*

27 The Carbon Emissions Reduction Target (CERT) was designed to reduce household carbon emissions through uptake of cost-effective energy efficiency measures such as insulation, heating and lighting

28 Since the start of 2013, the Energy Companies Obligation (ECO) has been in place. which entails three separate obligations on the large energy retailers: Carbon Emissions Reduction Obligation

Boiler and heating maintenance are often sold as insurance contracts. Both installers and manufacturers of boilers and other enabling technologies offer insurance contracts to transfer risks around reliability away from consumers (e.g. product guarantees, maintenance contracts). These are typically structured like an insurance contract with an annual or monthly fixed-fee. All six of the major energy retailers operate in the maintenance insurance market, along with larger independents such as HomeServe. There is a significant advantage to being able to bundle boiler maintenance cover with other related products, such as gas and electricity retail contracts. In the case of HomeServe, a considerable focus is placed on maintaining relationships with "affinity partners" providing complementary products which can then be bundled with HomeServe insurance at the point of sale.

Social landlords are a very important channel for delivering enabling technologies. Bulk installation of low-carbon enabling technologies can be effectively delivered by social landlords, such as Peabody Trust. For example, 25% of energy efficiency measures under CERT were delivered by social landlords.

There is a high integration between the oil, gas and electric space and water heating technologies market, with traditional gas boiler manufacturers investing in launching heat pump technologies. This may be driven by competitive advantages through synergies in manufacturing and branding.

High transport costs for some current enabling technologies mean that the markets are dominated by firms located in the UK, but international markets are important for others. Only 10% of insulation is imported[29]. In contrast, around 70% of boilers sold in the UK are manufactured outside the UK.

where companies must deliver 20.9 million lifetime tonnes of carbon dioxide savings by 2015; Carbon Saving Community Obligation where companies must deliver 6.8 million lifetime tonnes of carbon dioxide savings in low-income areas by 2015; and A Home Heating Cost Reduction Obligation. This requires energy companies to provide measures which improve the ability of low income households to heat their homes.

29 In this case insulation covers domestic and commercial uses.

4 Key insights

Drawing on the business model canvas analysis, this section presents key insights into the issues, tensions, and opportunities, which may be associated with a move to new business models.

- **The management of energy price risk will play a large part in the customer-facing business models that emerge.**
  - **Issue:** The management of fuel price volatility has a big impact on customer-facing business model design and value propositions.
  - **Tensions:** The main cause of retail business failure since liberalisation has been failure to manage fuel price risk. The need to manage risk has also been seen as a barrier to entry, as the most effective way of mitigating this risk in the electricity sector under the current market rules has been through vertical integration into the generation sector. It is also one of the main limitations to creating innovative retail offerings. To offer long term stable prices to consumers requires a supplier to hedge this risk over comparable timescales. However, this can be prohibitively expensive, particularly if there are regulatory restrictions associated with tying customers in to long term contracts.
  - **Opportunities:** Business models that involve new ways of managing wholesale price risk would provide new opportunities for energy retailers.

- **Electricity Market Reform (EMR) is likely to enable new business models, based around lower risk investments in low-carbon generation plant.**
  - **Issue:** EMR, (including Contracts for difference and the carbon price floor[30]) is likely to reduce the risks associated with low-carbon investment.
  - **Tensions:** Waiting for this policy to emerge has shown the potential for uncertainty in Government policy to stall investment. Policy risk acts as a major barrier to the emergence of business models that require sunk investments to be made.

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30 Carbon price support helps strengthen, and provide long term credibility to the price signal provided by the EU Emissions Trading Scheme. However, carbon price support alone may not overcome all of the barriers associated with the move to a low-carbon economy. EMR therefore contains a package of measures. Further detail is provided in Annexe 3.

  - **Opportunities:** As EMR progresses, it will create new opportunities for businesses interested in lower risk investments.

- **Firms who have large sunk investments may also have lower incentives to introduce new technologies and business models that destroy their value[31].**

  - **Issue:** A large amount of capital has been sunk into the energy value chains (e.g. power stations, networks and boilers).

  - **Tensions:** These technologies only need to cover their marginal operating costs to remain viable, which may reduce the pace at which new alternatives can penetrate the market.

  - **Opportunities:** Despite this barrier, experience from metering (see Annexe 12) shows that policy can drive the introduction of new business models, providing: there is sufficient value at stake; a set of arrangements that is attractive to financers; at least one party of sufficient size to want to change; and sufficient regulatory oversight to ensure that legacy interests (often involving the protection of sunk costs) are not able to stall change.

- **Network regulation sets boundaries on the types of business models that can emerge in the electricity and gas network sectors.**

  - **Issues:** Regulation effectively dictates the level of service to customers. Targets and incentives for the performance of networks and system operation (in particular the reliability and availability of supply) are set as part of the regulatory price control processes. Overall revenues for gas and electricity networks are fixed for a price control period by Ofgem. The revenues are collected through charges on network users (e.g. retailers, generators, shippers).

  - **Tensions:**

    - There is little scope to offer new business models based on different customer preferences given the nature of a fixed network infrastructure.

    - The level and structure of network charges affects the viability of alternative network businesses emerging.

    - Although distribution networks have a physical link with end consumers, regulation largely prevents them having any commercial

31 See Annexe 10.

link, which creates barriers for some options (e.g. DNO-led time-of-use tariffs).[32]

- **Opportunities:**
  - Discussions about changes to the structure of charges (including debate about the extent of locational charging) and whether connection charges should be deep (including network reinforcement costs) or shallow are on-going. The outcome of both will influence future sector change as they affect the costs and benefits associated with introducing alternative networks as an addition to the existing national systems.
  - Gas, electricity and district heat networks are built to meet peak demand. This means a lot of capacity sits unused. Reducing the extent of the redundant capacity by smoothing demand or using storage solutions could reduce network cost. There are opportunities for new business models in this area.

- **Innovation in gas and electricity networks has to be led by regulatory intervention, which may limit its effectiveness in driving fundamental change.**
  - **Issue:** The incentives for innovation in network businesses must come through the regulatory framework.
  - **Tensions:**
    - Licences largely restrict network businesses from changing the product they offer and entering new markets. For example, there is a restriction on electricity networks owning storage[33]. For system operation, the regulatory framework may reduce their incentive to contract for innovative sources of flexibility, since they only keep part of any efficiency gains delivered.
    - Driving innovation through regulation has its limitations, not least that the design of the regulatory mechanism will be what drives the

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32 Instead the commercial link is via the retailer. During planning for the smart meter roll-out it was discussed whether it would be better for the networks to undertake the installation of the new meters, given potential benefits from undertaking the activity on a street by street basis. However, the decision was taken to leave the responsibility with the retailer given a policy preference for it to be a competitively delivered activity, rather than a regulated one.

33 DNOs are able to trade energy from storage, but only if the following conditions hold: The storage provides no more power than 10 MW per installation or has a net capacity of less than 100 MW and provides no more power than 50 MW per installation or the storage investments and turnover do not exceed 'De Minimis' limits specified in the Distribution Licence, or the storage business has GEMA's consent.

"innovative" response, rather than necessarily what customers or the market requires.

  - **Opportunities:** Ofgem has been working to ensure that network regulation does not act as a barrier to the development of the low carbon economy. It has therefore provided new incentives for innovation and consumer engagement through the new price control framework (RIIO) and initiatives such as the Low Carbon Networks Fund (LCNF)[34]. These schemes and incentives provide opportunities for the testing of new business models.

- **District heat networks are currently unregulated, although it is likely that new policies and regulations will emerge as this sector scales up.**

  - **Issue:** In district heating, the local heat network operators are typically integrated into the same company/consortium as the heat retailer.

  - **Tensions:** By their nature district heating scheme are local monopolies. Their revenues are not directly regulated but there is typically significant public sector involvement in projects (or companies are "not-for-profit") which provides some control on prices. However, it is unlikely this they would escape political and policy intervention if they became more prevalent. This new regulation may create constraints on the business models that can be applied.

  - **Opportunities:** DECC have announced their intention to remove barriers to the district heat networks between now and 2020. Once more is known about the shape of this policy action, opportunities for new business models are likely to emerge.

- **Political and regulatory risks in the energy retail markets may make it less attractive to new entrants.**

  - **Issue:** New entry into the energy retail markets has been relatively limited in recent years.

  - **Tensions:** There are a number of potential reasons why new entrants have not been able to penetrate the market at a larger scale.

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34 This is £500m fund for electricity distribution networks to fund new technology, operating and commercial arrangements.

- There are difficulties managing the risks around wholesale trading (including associated trading costs and collateral requirements) and meeting regulatory and policy requirements on retailers[35].
- Energy retail is also a highly political market, and big brands have tended to stay away from entering this market due to concerns about brand damage.

- **Opportunities:** There are exceptions. For example, "White label" or "affinity" deals exist where supermarket brands act as a front for one of the larger suppliers' businesses. The two main players in this market are Sainsburys (British Gas) and M&S Energy (SSE). There is no information on the market share of these products[36]. However, they were deemed to be important enough for Ofgem to change its RMR proposals to put in place measures to allow the schemes to continue[37]. These exceptions suggest that there may be future opportunities for new business models and entry in this area.

- **The rollout of smart meters will create opportunities for new business models.**
  - **Issue:** Infrequent measurement of consumption means flat tariffs are the most common in gas, electricity and district heat. In addition, the market share of Energy service companies (ESCos) remains small. ESCos, where the fuel and enabling technologies are purchased as part of a services package, are yet to be commercialised at scale partly because of difficulties accurately measuring energy services delivered with current metering systems.
  - **Tensions:** Energy charges do not usually vary by time-of-day, reflecting the fact that most meters are 'dumb' and are not able to monitor and communicate usage on this basis. The major exception to this is Economy 7 tariffs where consumers are charged a "day" and a lower "night" rate and are metered on this basis[38]. Since there will be losers, as well as winners, should existing cross-subsidies be unwound through

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35 For example, once retailers meet certain thresholds of consumer numbers they must meet energy efficiency obligations (CERT, CESP and now ECO).

36 Customer numbers are attributed in Ofgem's published data to the licensed supplier rather than the white label retailer.

37 The original proposals for limiting the number of tariffs that retailers could offer would have essentially ended these white label offerings.

38 There are also variants to Economy 7 such as Economy 10 and Teleswitching tariffs in Scotland. Around 3-3.5 million households (around 10% to 15%) are on Economy 7 tariffs Around 2 million of these consumers have electric storage heating to help them manage their demand. Sustainability First (2012), *GB Electricity Demand, Paper 3*

the introduction of cost reflective time of day pricing, it is not yet clear what the policy response to this issue will be.

- **Opportunities:**
  - The rollout of smart meters to domestic and small business customers will facilitate the introduction new customer offerings, based around more complex tariffs.
  - The roll out of smart meters may also facilitate a greater expansion of ESCos by allowing them to offer a greater range of services.

- **Policy developments are driving new business models in enabling technologies.**
  - **Issue:** In the past, consumers have purchased enabling technologies such as boilers up front.
  - **Tensions:** Low-carbon technologies often entail higher up-front costs (and lower running costs) than the incumbent technologies.
  - **Opportunities:** The high upfront costs of low-carbon enabling technologies and policy interventions to overcome these have led to an increasing number of schemes where consumers pay for the technology over its lifetime. These new business models are expected to become more important under the Green Deal where retailers are obligated to provide upfront financing with repayments made via the energy bill.

- **There are a range of opportunities for innovative business models in the installation of enabling technologies**.
  - **Issue:** The market for installation and one-off repairs is characterised by many small, independent providers. Brands do not seem to be important in this market, with consumers preferring to use information gained from positive word of mouth and respected messengers to try and establish relationships of trust.
  - **Tensions:** Relationships with installers and providers of repairs are often characterised by low levels of trust**.**
  - **Opportunities:** There are opportunities for business models which can help overcome barriers related to lack of trust.

5 Conclusions and recommendations

The market for delivery of heat to customers is of a significant size. The value of the sector, and the returns being earned, would be expected to be sufficient to generate interest from even the biggest of players. Given international synergies for such services, the global size of the market could be expected to be an order of magnitude bigger.

In this section we present our conclusions and recommendations.

5.1 Conclusions

Policy is a major driver of business models in the energy sector.

The basic characteristics of the energy value chains have led to deep policy and regulatory interventions that largely shape energy sector business models. This will not change and policy needs to be recognised as a primary driver of future business models. As a consequence, policy and regulatory change is a primary facilitator of business model change.

Policy-driven change and innovation have to be, by their nature, quite directional and prescriptive, which may have some limitations. However, the vast range of policies that have arisen in the sector over the last five years show that there is no shortage of policy push to generate opportunities across these value chains. It is too early to evaluate the outcome of the Green Deal and ECO schemes, but this will be particularly instructive for understanding how the policy-led market for customer installation and renovation will work once the up-front barrier to raising finance is removed.

Ensuring that existing policy does not act as a barrier to efficient change is one of the main sector challenges. Fundamental changes are possible, as shown by the whole-scale shake-up of the sector following its privatisation in the 1990s. And there are no signs of policy intervention diminishing, with major reforms underway across the sector to meet climate change goals. This, in turn, means that risk of policy change becomes an important consideration for businesses.

There are barriers to the emergence of new business models.

Long asset lifetimes, and investment lead times, mean that changes in energy infrastructure can be slow. A large amount of capital has been sunk into the energy value chains. These technologies only need to cover their marginal /operating costs to remain viable, which may reduce the pace at which new alternatives can penetrate the market. In addition, consumers generally display low levels of responsiveness on energy contracts and technologies. Many consumers are not interested in switching energy retailer, even when they could potentially make savings, and some are only willing to install new enabling technologies at trigger points that may be many years apart (e.g. moving house, renovating).

However, there are also major opportunities for new business models.

The move to a low-carbon economy will create new opportunities. Technical change required to meet carbon targets will be an important driver of this. Rising (unit) energy prices will increase customer-pull for further change.

In particular, the move to a low-carbon economy is likely to create opportunities for business models that help add flexibility to the system (for example by harnessing customer demand side response through new retail offerings, or by investing in storage), and businesses that manage the increasing levels of supply side complexity associated with a low-carbon economy for consumers (for example by providing bundled retail offerings, based around comfort rather than energy).

The need to install smart systems in homes will also present opportunities in the enabling technologies sector. There is less regulation of the business models and value propositions that sit on the customer side of the meter in the "smart home" market. This may provide more opportunities for innovative business models to emerge in these areas, potentially driven by new entrants to the energy sector.

5.2 Recommendations

In our final Work Area 4 report, we will make policy recommendations in relation to the evolution of the new business models we are putting forward. We focus here on recommendations for topics that should be considered by other work areas in the SSH programme.

Future technologies

- **Implications of the move to a low-carbon economy in each part of the value chain**. Our analysis shows that the structure of value propositions to consumers is partially driven by upstream and network conditions. For example, the prevalence of variable price tariffs in gas and electricity is driven by upstream wholesale cost risks. To design smart systems and the business models to support them, it is important that we understand the technology changes across the whole value chain.

- **Capital intensity of technologies.** The cost structures of technologies are important drivers of the business models, and of the need for policy interventions. For example, long term contracts with consumers have developed in district heat in response to the capital-intensity associated with the district heat value chain. In contrast, oil distribution operates on short term contracts. To develop future business models, understanding the cost structures of technologies as well as their overall cost is therefore important.

- **Availability of technologies to help manage the volatility of wholesale costs.** The management of wholesale costs risks is an important driver of business models in each energy sector. These are particularly important, and more challenging to manage, in the electricity sector. Understanding the likely availability of new technologies (e.g. new bulk, local or domestic-level storage technologies) that could help manage these risks will be very important.

Future consumers

- **The willingness of consumers to accept novel value propositions.** The set of tariffs faced by consumers in each of the value chains are relatively narrow and Ofgem is seeking to further restrict the choice through its proposed reforms to the retail market. For example, most involve consumption-based charges and long-term contracts (greater than two years in duration) are rare. It would be useful to understand more about consumers' appetites to accept novel value propositions.

- **How to increase consumer engagement with the energy sector.** A number of consumers are relatively disengaged with the energy sector. It would be helpful to understand from the consumer research how this disengagement could be overcome, for example through the use of novel value propositions or if the service was offered by a particular type of provider.

- **Consumer attitudes to less flexibility in heating supply.** Most enabling technologies (e.g. gas boilers) currently allow consumers a high degree of flexibility in their heating needs. However, electric storage heating gives us an example of a heating technology that provides limited flexibility to consumers. It would be useful understand how this is perceived by consumers, by both those that have the technology and those that do not.

6 Annexe 1: Methodology

This annexe briefly describes the overall methodology we have used in the report, in three sections:

- PESTLE framework;
- value chains and components; and
- business canvas.

6.1 PESTLE analysis

PESTLE analysis provides a framework for thinking about businesses in relation to their external environment. PESTLE analysis is relevant in this context as it is policy that largely dictates industry structure in the energy sector, but policy itself is shaped by a set of fundamental drivers.

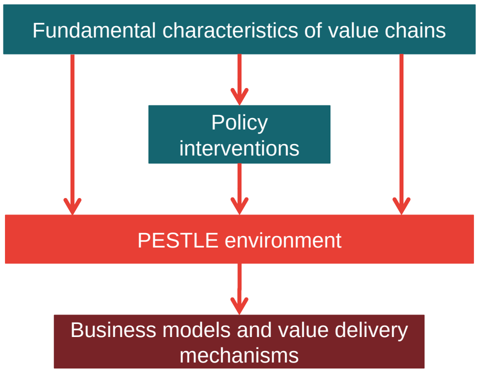
PESTLE covers **p**olitical, **e**conomic, **s**ocial, **t**echnological, **l**egal and **e**nvironmental factors.

In our use of the framework, we group these factors as follows:

- **Fundamental characteristics of the value chain**. Economic, social, technological and environmental factors fall into this category.
- **Policy interventions.** Political and legal factors fall into this category.

As illustrated in **Figure 7**, some of the fundamental characteristics impact directly on the business environment and therefor on businesses. Others impact on the business environment as drivers for policy.

Figure 7. Framework for PESTLE analysis



Source: Frontier Economics

6.2 Value chains and components

The sector providing heat to domestic and SME consumers is made up of a very diverse set of activities and business models. To explore these business models we have divided the sector into five areas:

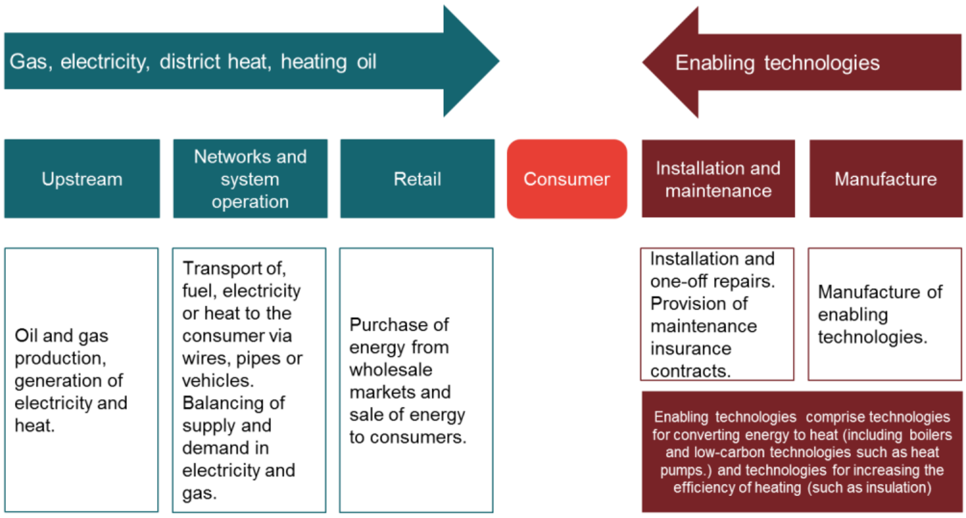
- four energy value chains, each with different characteristics – gas, electricity, district heat and oil; and
- the value chain for enabling technologies.

We have also broken down each value chain into a number of broad stages, each of which contains similar activities and business models:

- for the energy business models, we have divided each value chain into upstream, system operation, networks and retail; and
- we have divided the enabling technologies into manufacture, maintenance and installation.

This is illustrated in **Figure 8**.

Figure 8. Value chains and components



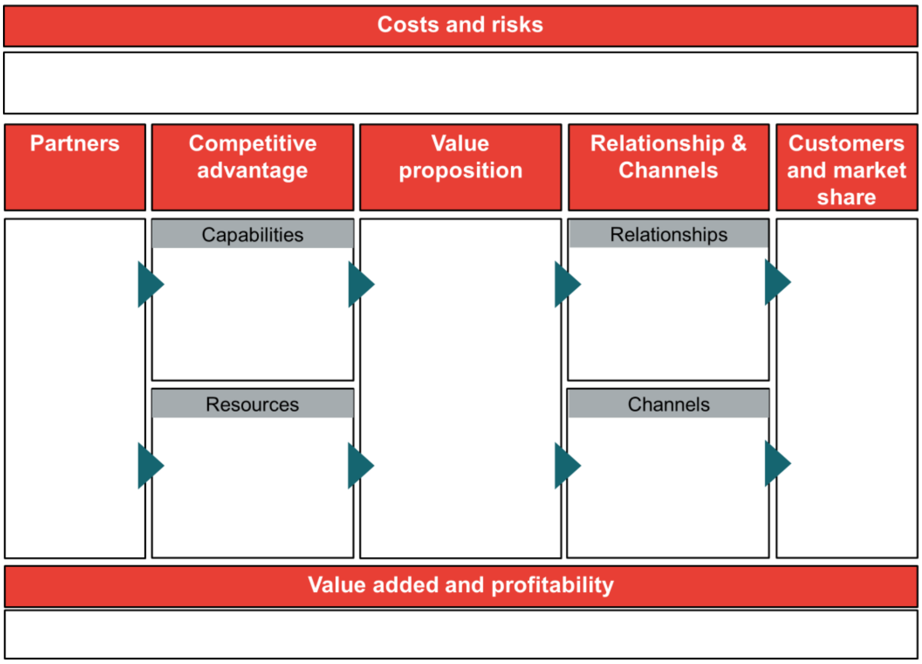
Source: Frontier Economics

This approach has a number of advantages. It provides a structure to the analysis, allows us to see clearly the interdependencies between value chains and allows us to draw insights from understanding the differences between the value chains. Annexes 4-8 contain detailed analysis on each of these.

6.3 Business canvas

This section describes the business model canvas, which we use as a framework for analysing each part of the value chain.

Figure 9. Business model canvas



Source: Adapted from the Business Model Canvas from BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.

The business model canvas allows us to systematically describe business models in each part of the value chain using the following categories.

- **Costs and risks.** We start by characterising the cost structures and lead times for new investments. This can differ across the value chain, for example in terms of the mix of upfront and on-going costs. The characteristics of the costs in each sector, along with other technical characteristics and the regulatory landscape, are a key determinant of the risks faced by each sector. In turn, these risks determine the business models adopted by the firms.

- **Customers and market share.** It is important to understand which customers are served by the business model. We identify the customers served and draw out how each part of the sector has evolved to its current split of market shares.

- **Relationship and channels.** It is important to understand how the business engages with its customers, and what the nature of the relationship is.

- **Value proposition.** We describe the value proposition to consumers. For example, this might be a set of tariffs offered to consumers, or a contractual relationship between wholesalers, retailers or networks.

- **Competitive advantage.** To understand how businesses gain competitive advantage and what drives their performance, it is necessary to first understand the capabilities and resources that they employ.

- **Partners.** We need to understand which other businesses work with each part of the value chain, and in particular, where horizontal and vertical integration occurs.

- **Valued added and profitability.** Finally, consider value added and profitability in each sector.

7 Annexe 2: PESTLE analysis

The energy sector is one of the most heavily regulated sectors in the economy. To understand the value chains, business models and value propositions, it is necessary to understand how policy has shaped them. In order to do this, it is first necessary to understand the drivers of policy intervention.

In this annexe we set out some of the fundamental characteristics of the sector that drive current policy interventions. By identifying these, we can see what is likely to change, how policy might respond and then how the future energy sector might develop.

We then look at how policy has responded to these fundamental factors.

Together these factors make up the PESTLE[39] environment in which business models must operate. This provides a framework for understanding the current structure of the value chains and the opportunities and limitations for future change.

7.1 Fundamental characteristics

Energy and enabling technology value chains have a set of fundamental social, economic, technical and environmental characteristics that drive policy interventions and determine the business environment.

Social factors

The social characteristics of the energy value chains are critical drivers of the business environment.

- **Energy and appliances from each value chain are used to meet consumers' basic needs.** Gas, electricity, district heat and heating oil are used to meet basic needs for space heating and hot water. Electricity and gas are also used for cooking and electricity is used for lighting. This is a major driver for policy intervention in this sector. It is also a driver for the significant reputational risk associated with operating in this sector.

- **For some households, expenditure on fuel is a large part of total expenditure.** Figure 10 shows 16% of households need to spend more than 10% of their income in to heat their homes adequately. Without mitigating measures (such as investment in efficiency), bills as a proportion of income

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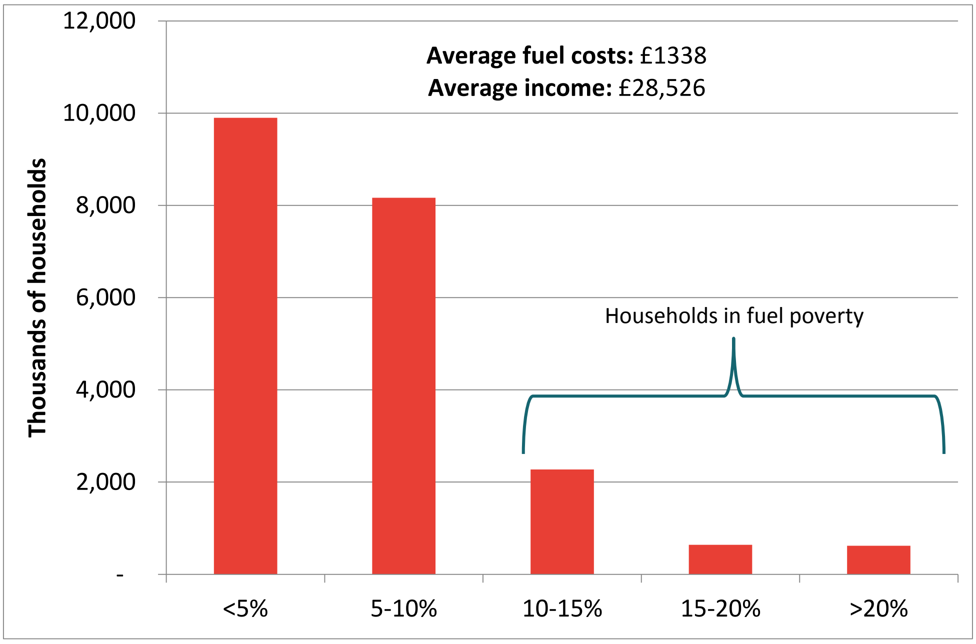
39 The PESTLE framework allows systematic identification of the **p**olitical, **e**conomic, **s**ocial, **t**echnological, **l**egal and **e**nvironmental context in which businesses operate. It is often used as a tool to describe the environment in which businesses operate (see Annexe 1).

may rise even further, due to rising fossil fuel prices and rising costs of climate change mitigation[40]. Political interest in the level of bills is therefore high. It also means that the energy sector can end up being used as a way of delivering social policy.

Figure 10. Domestic expenditure on fuel as a proportion of income, 2010



Source: DECC (2013), *Fuel poverty 2010: detailed tables*

Economic factors

Economic characteristics feed directly into the risks faced by businesses and drive a policy and regulatory response.

- **A secure and reliable energy system is considered to be fundamental to a strong economy.** Gas and electricity are used across the economy, not just by domestic and small business consumers. This drives policy intervention to ensure there is sufficient reliable capacity in place to meet demand. It is also an important driver of the scale of gas and electricity networks: it is easier to reduce the risks of outages by creating networks connected to multiple sources of gas and electricity.

- **High fixed sunk costs in the transport of gas, electricity and district heat mean that networks are natural monopolies.** Fixed costs in these

40 Committee on Climate Change (2010), *Energy prices and bills – impacts of meeting carbon budgets*

parts of the sectors are so high that it is most cost-effective to only have one network in a given area. In addition, the costs of much gas, electricity, district heat (and to a lesser extent oil) infrastructure are sunk. This means that the full costs of new technologies may have to compete with only the marginal costs of established technologies.

- **Where there are natural monopolies in transport, products are sold as a homogenous product**. All the energy must come from the same network which makes it much harder for customers to be offered a differential service.

Technical factors

The technical characteristics of energy and heat are important determinants of the business models that have developed for their delivery.

- **Supply and demand must be matched at each point in time.** Electricity, and to a lesser extent gas[41], is difficult and expensive to store. Consumer demand for heat fluctuates within the day and across the year. There is currently little flexibility on the demand side as few enabling technologies (with the exception of Economy 7 storage heaters) include the ability to store energy or delay use. To ensure that demand can be met at all times, enough generation and network capacity must therefore be available to meet expected peak demand, with a margin to take account of the risk of plant or network failures. In the future, there may be a greater role for storage as its costs come down. The role for technologies which can predict demand or generation output, may also increase.

- **Energy is more easily transported in the form of gas, electricity and oil, than as heat.** Electricity and gas are most easily transported in national networks of wires and pipes, although losses increase with distance travelled. Transporting heat across long distance is more difficult, which means only dense developments are suited to district heat networks. Oil is in liquid form and is most easily transported by vehicle.

- **There are safety issues associated with the production, transport and use of energy for heating and with the enabling technologies (such as boilers).** For example, natural gas is a flammable and toxic substance in high concentrations. This means all along the gas value chain, it must be handled and transported safely.

41 Some gas can be stored in the pipeline networks to help manage volatility in demand as well as through dedicated storage sites.

- **Domestic and SME consumption of gas, electricity and heat are currently only measured periodically**[42]**.** Most existing metering technology for gas and electricity is 'dumb' meaning household consumption cannot be monitored in real-time and meter reading requires a site visit. Further, only 25% of households with district heating have heat meters[43]. This limits the granularity with which retailers can charge for gas, heat and electricity.

Environmental factors

Finally, the environmental characteristics of energy businesses are a major driver of policy interventions and therefore of business models.

- **Temperature has a big influence on demand for energy and associated enabling technologies.** The ambient temperature is a big driver of demand for energy, particularly for heat and cooling. The UK climate has meant that there is a big domestic demand for heating technologies, whereas cooling demand has typically been met through natural ventilation.

- **The availability of domestic natural resources can dictate policy.** Access to fuel resources becomes a security issue and can therefore have a big impact on UK energy policy. The availability of North Sea gas has therefore had a big impact on the structure of the UK energy sector. Indeed, the availability of North Sea gas together with a climate of cold winters and mild summers resulted in the UK becoming one of the biggest markets for gas boilers.

- **There are environmental externalities from energy production and use**. Each energy sector produces emissions of greenhouse gases and other pollutants. There are differences between the level of environmental externalities between and within sectors. For example, district heat can be less emissions-intense than gas supplied to homes and within electricity, nuclear and renewables produce fewer emissions than coal and gas-fired plant. Enabling technologies can have a significant impact on the efficiency in which energy is transformed into heat.

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42 Further information on metering is provided in Annexe 10.

43 For example the points system used by the London Borough of Lambeth is based on the number of rooms and whether they have direct or indirect heating. Building Research Establishment for DECC (2012) *District heating – heat metering cost benefit analysis*. DECC has commissioned Databuild and BRE to undertake a project to gather evidence to assess the costs and benefits of retrofitting heat meters to domestic and non-domestic buildings connected to heat networks –see BRE (2012), *District Heating – Heat Metering Cost Benefit Analysis*

7.2 Policy and legislative framework

Because of these fundamental factors, the value chains for heating in homes and small businesses are characterised by a high degree of policy intervention and regulation. Policy interventions are made largely at the EU and UK level, driven by the social, economic, technical and environmental characteristics of the sectors. They are a major determinant of the business environment and of the risks faced by companies in each sector, and in some cases it is policy that directly determines the outcome business models.

We provide further background on the legislative landscape and how it impacts on energy value chains in Annexe 3.

7.2.1 International dimension

The UK energy value chains need to be viewed in a global context. This has a number of consequences.

- **Global markets for primary fuels.** Primary fuel markets tend to be international. Although domestic policy can influence the use of different fuels (e.g. by determining the generation mix), it has little scope for influencing the markets themselves. However, the prices set in these markets have a big impact on consumer bills. Indeed, the increases in gas bills seen over the last 10 years have largely been driven by global energy market developments and the rising international price of oil. This is because the UK market is physically connected to continental European gas markets, where gas contracts are indexed to the price of oil products. The oil price link may now be weakening with the expansion of markets in Liquefied Natural Gas (LNG) and the rapid increase in US production of unconventional gas. However, this will not diminish the fact that prices will be set outside of the UK market. Indeed Centrica recently announced signing a £10 billion contract for importing LNG from the US with the price indexed to the "Henry Hub" natural gas price[44].

- **Global players in the UK energy market.** The primary fuel market is dominated by large, multinational firms. However, even when looking at the network and retail parts of the UK value chain, international firms dominate. Following privatisation of the sector in the 1990s, there was an influx of investment into the UK from US based energy companies. However, over the last decade it is the European energy companies that have dominated, such as E.ON, RWE, Iberdrola and EdF. This has important implications for the UK both in terms of being influenced by developments in Europe,

44 The "Henry Hub" price is the primary price set for the North American natural gas market.

but also in terms of access to capital for expansion given the need to compete for limited funds from the parent company.

- **Increase in physical interconnection:** Despite being an island, there is often a physical, as well as financial, connection with international markets. In the case of the electricity sector this comes through three interconnectors (with France, Ireland and the Netherlands). In the gas sector, the increase in importance of LNG has resulted in the development of a number of new import terminals that can receive delivery from international LNG shipments. The infrastructure to receive imported oil has been in place for many years. The level of interconnection, particularly in the electricity sector, is expected to increase further in future. This is likely to increase the influence of international policy on the domestic UK energy sector.

- **Growing influence of EU policy.** The European Commission aims to create an integrated European energy market which provides a secure, competitive and sustainable supply of energy to the economy and society. There have been a number of Directives that have had a material impact on the UK energy sector[45]. This is set to increase. For example, in 2012, draft legislation setting out the functioning of the single electricity market (the European Target Model) was published. It is expected to enter into force in 2014. Ofgem expects the Target Model to have a significant impact on the GB electricity sector[46].

7.2.2 Domestic policy

Domestic policy has to respond to the fundamental characteristics of the sector while being limited in its ability to act by international constraints.

Certain policy choices are then largely dictated by the fundamental characteristics they seek to address. For example, there are a set of characteristics that currently determine that electricity and gas networks are best undertaken as natural monopolies. This requires a policy intervention to prevent abuse of a monopoly position. However, this could be achieved through state ownership and management of the assets or through a model of private ownership and independent regulation. The choices policy makers take to meet these challenges therefore also depend on political ideology and these can have an important influence on the sector. This influence should not be under-estimated, as

45 The most important of these Directives are: The First, Second and Third Electricity and Gas Directives (1996-2009), the Large Combustion Plant Directive (2001), the EU Emissions Trading Scheme (2003), the Directive on Renewable Energy (2009), the Industrial Emissions Directive (2011), the Energy Efficiency Directive (2012). These Directives are discussed in Annexe 3.

46 For example, it may require that liquidity in day-ahead market is developed to lead to a robust reference price for GB, and that price zones to manage internal constraints are considered.

witnessed by the whole-scale shake-up of the sector following its privatisation in the 1990s.

As well as these macro policy decisions that shape the sector, there is a vast range of more micro decisions that also have a major impact. For example, policy decisions determine the data used for settlement, the degree of socialised charging and the level of differentiation of tariffs. These have a big influence on the value propositions that customers see. Further, since the sector is so heavily regulated, policy has taken the lead in trying to drive sector change and innovation through policies such as ECO, the Green Deal and the Low Carbon Networks Fund, among many more examples.

The social, economic, technical and environmental factors described in Section 7.1 have helped determine the current focus of policymakers. We now describe the impact this has on the sector.

Social factors

There is strong policy intervention in the energy and enabling technologies value chains to aim to ensure that consumers can meet their basic needs at a cost that is affordable. Such policies are becoming increasingly prevalent and have a big impact on the value propositions that companies can offer to end consumers. If prices are set to rise, this trend is unlikely to diminish in future.

- **Final energy retail prices are subject to strong regulatory, political and public oversight**. There has been increasing distrust from Government and Ofgem that competition is delivering the best prices for consumers. The policy response to this has been to increase regulation of the sector including putting a limit on the number of tariffs retailers can provide.[47] **This will limit innovation in the sector by slowing or halting the development of new value propositions.**

- **Intervention in the energy and enabling technologies sectors is increasingly focussed on delivering social policy**. In particular, the market for installation of energy efficiency enabling technologies has been heavily shaped by obligations on the large energy suppliers, some of which (e.g. ECO) are focussed on the reduction of bills for low-income households. There are also policies, such as Warm Homes Discount scheme, which are solely focussed on delivering reductions in energy bills for vulnerable customer groups. These are administered by the retailers and funded via a cross-subsidy from the wider customer base. **The obligations on retailers to deliver these schemes are becoming increasingly**

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47 Ofgem (2013), Press release, http://www.ofgem.gov.uk/Media/PressRel/Documents1/RMR%2021-02-13.pdf

onerous. Although there is an exemption for retailers with less than 250,000 customers to participate in these schemes, this is acting as a barrier to growth given the administrative costs involved.

Economic factors

Policy and regulation in response to economic factors drives business models. Indeed, with the focus on competition, this has been one of the biggest influences on policy in the sector over the last two decades.

- **There has been a commitment to protecting consumers' interests through the promotion of competition, where this is feasible.** The strong commitment to the competitive market since the early 1990s has had a major impact on the energy sector. The focus has been on enabling competition upstream and in retail supply, while minimising the parts of transmission and distribution networks that are natural monopolies by introducing competition into metering and connections. **The UK now has one of the most liberalised energy markets in Europe due its strong focus in this area. It also has one of the most fragmented.** This has important implications for how sector change will be facilitated. On the one hand such fragmentation makes it more difficult to dictate national change, while on the other it may mean there are a greater variety of agents that have a financial interest in promoting change.

- **Natural monopolies in electricity and gas are regulated to protect consumers' interests.** Regulating the natural monopolies in gas and electricity is a significant area of Government intervention. Ofgem's price controls set the maximum amount of revenue which energy network owners can recover through charges. Further limitations are placed on the structure of those charges. District heat networks are not currently heavily regulated. This may reflect their small size (in terms of customer numbers), the fact that they are a lower carbon option, and the possibility of competing 'for the market when schemes are being set up.[48]

- **There is significant policy intervention to help ensure security of supply in the electricity and gas sectors**. For example, generation is currently an 'energy-only' market with wholesale trading based on generation (MWh). However, as a result of concerns whether this can deliver sufficient incentives for investment in capacity (MW) in a low-carbon system (and the associated reliability of supply), DECC is proposing to introduce a capacity

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48 Once the network is established, it is a natural monopoly. However, many parties may bid to take on the role of natural monopolist and terms and conditions of their operation of the monopoly can therefore be determined competitively in advance.

market where this is rewarded separately to generation according to its contribution to the reliability of the system. In the gas market, the focus is on promoting security of supply through strengthening trading links and infrastructure. Much of this is occurring through the implementation of the EU Third Package[49].

Technical factors

The technical characteristics of the energy value chains are important drivers of policy although this is potentially one of the areas where future change is most likely, driving changes in policy and business models in future.

- **Market rules ensure supply and demand for gas and electricity are balanced at each point in time.** In both the gas and electricity markets participants are given strong incentives to ensure demand and supply balance. For example, retailers are charged for any differences between the energy they sell to consumers and the amount they have contracted from the wholesale market. These charges target the costs incurred by the System Operator (SO) in resolving imbalances in demand and supply to those parties who create the costs (i.e. those parties who do not balance their inputs and outputs within the relevant balancing period). Therefore parties who are not in balance incur charges that reflect the costs incurred by the SO in addressing the imbalance. These are known as cash out prices.[50]

- **Cash out signals are dampened due to the lack of frequent demand metering.** Because of the lack of timely metering, estimated load profiles are used in settlement by the System Operator. This dampens cash-out incentives because imbalance charges paid by suppliers do not reflect the actual amount of electricity that their customers use across time. The roll out of smart meters will help address this issue and create new opportunities for data management companies.

Environmental factors

The environmental agenda also has a big influence on policy design.

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49 This package aims to establish a single market in energy across the EU and help improve EU market integration and increase cross-border trade for both electricity and gas. Source: https://www.gov.uk/government/policies/maintaining-uk-energy-security--2/supporting-pages/working-internationally-to-maintain-uk-energy-security. Accessed: 01/04/13

50 In electricity the strength of these incentives is currently being reviewed. This is due to concerns that they do not fully reflect the costs to customers of supply interruptions and therefore may under incentivise investment in generation and other measures that improve reliability. Ofgem (2011) *Electricity cash out issues paper*

There is major and increasing intervention to reduce environmental externalities, particularly in the electricity sector. Electricity generation is part of the EU emissions trading scheme (and therefore carbon emissions from plants incur a cost) while electricity retailers are obligated to purchase a certain amount of their electricity from renewable sources. Electricity Market Reform (EMR) will introduce three major new policies to support investment and operation of low-carbon plant: contracts for difference to provide predictable revenue streams for low-carbon plant, a carbon price floor to ensure the carbon price does not fall below a certain level and an emissions performance standard to rule out investments in certain plants.

Table 1: PESTLE environment

	Fundamental	Energy value chains				Enabling technologies
		Gas	**Electricity**	**District heat**	**Oil**	
Social	Meets basic needs and can be a large part of consumer bills	Scrutiny of consumer prices and high degree of regulatory intervention in retail.			Promotion of alternatives to oil.	Focus on delivering energy efficiency to low-income consumers.
Economic	Required for economic growth	Intervention to promote investment in back up capacity.				
	High fixed costs	Regulated natural monopolies.		Unregulated local monopoly.		
	Homogenous product	Not possible to differentiate product.				
Technical	Difficult to store	Detailed market rules for balancing Regulated monopoly System Operator.				
	Consumption measured infrequently	Not possible to send granular price signals to consumers. In electricity incentives balancing are also dampened.				
	Inefficient to transport long distances			Local markets.		
	Can be dangerous	Safety regulation.				
Environmental	Temperature is important					Penetration of air conditioning is low
	Natural resources	23m households have gas heating				
	Polluting emissions	Policies in place to reduce demand.	Policies in place to reduce demand and incentivise lower carbon production.	Policies in place to encourage uptake.		Strong policy intervention to encourage uptake of low-carbon and energy efficient technologies.

Source: Frontier Economics

8 Annexe 3: The legislative landscape and its impacts

Policy, regulation and the legislative landscape that results play a major role in shaping the way energy value chains operate. The energy sector has changed radically in the last 25 years – with a policy-driven move to a largely competitive energy system from a largely state run monopoly system. In recent years, the pace of change has increased again, with major reform of energy markets underway to help tackle climate change.

This annexe describes how the legislative landscape is influencing the individual components of each value chain (gas, electricity, district heating and oil). We cover this in the following sections:

- an overview of the legislative framework;
- the most important aspects of EU and UK legislation;
- a detailed discussion of the legislative landscape in each value chain; and
- a summary of the impact of policies on change and innovation in the sector.

8.1 Legislative framework

Figure 11 describes the legislative framework at a high level.

- At a **global** level, legally binding targets have been set for emissions reductions under the Kyoto agreement. Negotiations for the successor agreements to Kyoto are still underway.

- At **EU** level, legislation is introduced for a number of purposes including to set binding energy goals; to specify environmental regulations; and to promote competition and the single energy market. EU legislation transposed into national legislation by the UK Government (and other member states). It is discussed in further detail below.

- At **UK level**, public bodies have a range of levers for delivering policy goals.
  - **Acts or primary legislation** set in place the overall framework. For example, mandatory smart meter rollout required changes to primary legislation. Acts require parliamentary scrutiny and approval, which can be time-consuming. These are supplemented by **secondary legislation** to help deliver the overall policy framework that has been established in primary legislation. For example, secondary legislation

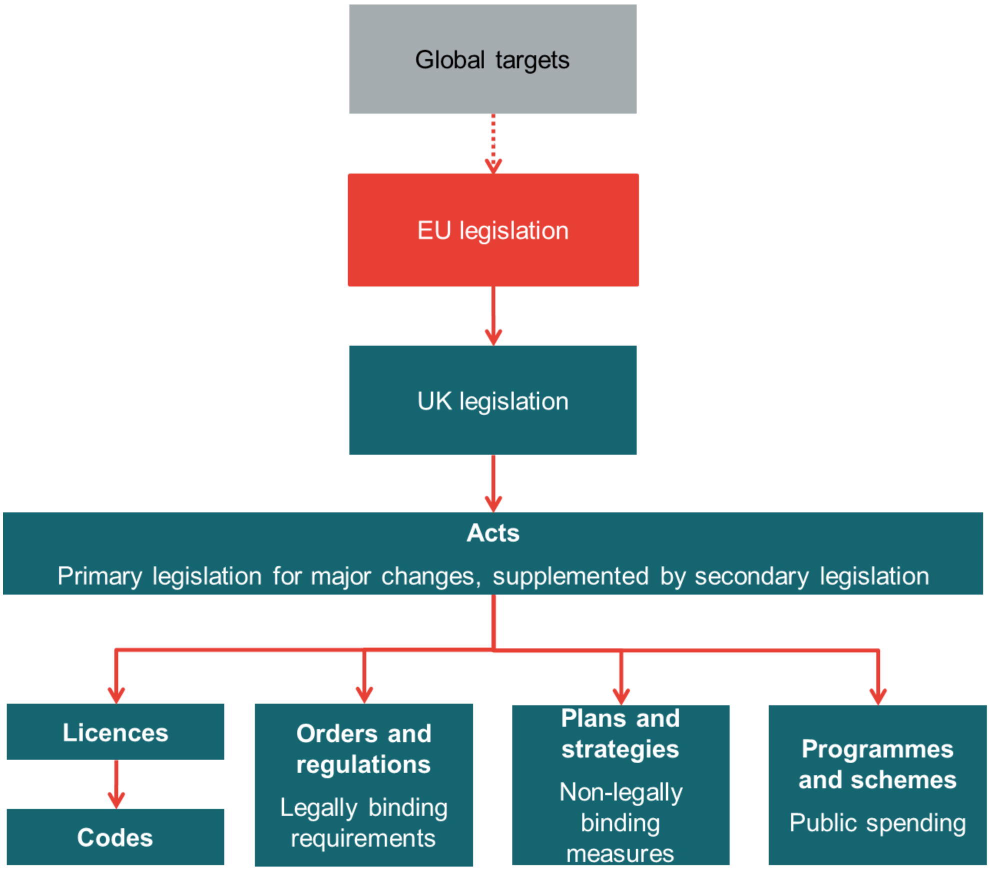
was required to establish the Data Communication Company licence. Secondary legislation also requires parliamentary scrutiny and approval.

- For any given set of structural arrangements set by primary and secondary legislation, **licences** define the obligations of, and relationships between, entities. Licences contain much of the detail about the way in which the individual activities must be undertaken.
- **Industry codes** then set out detailed obligations and, in particular, the ways in which participants are required to interact with each other. The Governance arrangement for each code allow signatories (industry players) to modify it, subject to the approval of the regulator.

Alongside this hierarchy of legislation, Government also has a set of additional levers.

- **Orders and regulations**, such as the Renewables Obligation introduce legally binding requirements on market participants.
- **Plans and strategies**, such as 2009's Low Carbon Transition Plan set out the Government's plans for delivery goals.
- **Programmes and schemes**, such as Feed-in Tariffs for small scale renewable and low-carbon generation provide funding.

Figure 11. Legislative framework



Source: Frontier Economics.

We now discuss EU and UK level legislation in more detail.

8.1.1 The role of EU Legislation

The European Commission (EC) aims to create an integrated European energy market which provides a secure, competitive and sustainable supply of energy to the economy and society.

Integrated, secure and competitive market

Since the 1990s, reform has been carried to meet these aims.

- The **first Electricity Directive**[51] **(1996) and the first Gas Directive (1998)**[52] focused on liberalisation of the generation and retail markets, and

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51 Directive 96/92/EC

52 Directive 98/30/EC

required some separation of the network and retail/generation activities (usually referred to as "unbundling"). Unbundling aims to reduce the risk that integrated companies would use their ownership of the network to unfairly give advantage to their generation and/or retail businesses[53].

- The **second Electricity Directive[54] and Gas Directive[55] (2003)** increased the degree of unbundling by requiring legal and functional unbundling of the networks from other activities. The Electricity Directive also contained provisions to increase security of supply.

- Responding to concerns voiced by consumers and new entrants in the sector about the development of wholesale gas and electricity markets and limited choice for consumers, the EC launched a sector inquiry in 2005. In 2007 the inquiry reported back and identified several shortcomings in electricity and gas markets, including too much market concentration and a lack of liquidity. The EC therefore introduced a third energy package in 2009 aimed at strengthening unbundling, regulation, cross border cooperation and market opening. The third package contains the **third Electricity Directive[56] and the third Gas Directive**[57], which describe the unbundling models for transmission network operators.

- In 2012, draft -legislation setting out the functioning of the single electricity market (the **European Target Model**) was published. It is expected to enter into force in 2014. Ofgem expects the target model to have a significant impact on the GB electricity sector [58] For example, it may require that liquidity in day-ahead market is developed to lead to a robust reference price for GB, and that price zones to manage internal constraints are considered. A vision for a European Target Gas Model has also been published by the Council of European Energy Regulators[59].

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53 Thomas S, (2005) *The European Union Gas and Electricity Directives*

54 Directive 2003/54/EC

55 Directive 2003/55/EC

56 Directive 2009/72/EC

57 Directive 2009/73/EC

58 Ofgem (2012) *Open letter: Implementing the Electricity Target Model in Great Britain*

59 http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/GAS/Gas_Target_Model/CD

Sustainability

EU legislation has also been introduced to reduce emissions and increase sustainability. The four most important of these Directives are as follows.

- **Directive on Renewable Energy (2009)**[60]. This directive sets a target of renewable energy as a proportion of demand for each member state. Under this directive, and its corresponding domestic legislation, the UK is legally committed to delivering 15% of its energy demand from renewable sources by 2020

- **EU Emissions Trading Scheme (EU ETS, 2003)[61].** The EU ETS puts a cap on the greenhouse gas emitted by energy intensive industry and creates a market and price for carbon allowances. Electricity generation, CHP above a certain size, and upstream oil and gas installations are included in the EU ETS, and are subject to the resulting price on emissions (currently €5/tCO_2)[62]. The EU ETS has had a significant impact on the mix of gas and coal generation in the UK.

- **Industrial Emissions Directive (IED, 2011) and the Large Combustion Plant Directive (LCPD, 2001).** The IED and the LCPD specify controls on air pollutants such as sulphur dioxide and nitrogen oxide. Plants which do not meet the LCPD's standards are due to close by 2016. This will affect around 12 GW of older coal and oil-fired generating plant[63]. The IED replaces the LCPD from 2016 and will bring forward the closure of further plants by 2023. The closures resulting from these Directives are a significant driver for security of supply concerns in the UK.

- **The Energy Efficiency Directive (EED, 2012)[64].** The EED establishes a framework of measures for the promotion of energy efficiency in member states, with the aim of ensuring that the target of saving 20% of the EU's energy consumption (relative to projections) by 2020 is met. The Directive also aims to facilitate further energy efficiency improvements beyond 2020. It includes rules designed to remove barriers in the energy market and overcome market failures, and provides for the establishment of indicative national energy efficiency targets for 2020.

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60 Directive 2009/28/EC

61 Directive 2003/87/EC

62 http://www.pointcarbon.com/, accessed 03/04/13

63 National Grid (2011) *Seven Year Statement*

64 Directive 2012/27/EU

As well as introducing legislation, the Commission is also involved in coordinating development of technologies and policy in smart technologies and setting standards.

- **Coordination and research.** For example, in 2009, the Commission established a Smart Grids Task Force to produce policy and regulatory recommendations to ensure consistent and fast implementation of smart grids across the EU. The Commission is also active in research and demonstration across Europe. The most important European research programme is the European Electricity Grid Initiative (EEGI)[65].

- **Standard setting.** The EU also oversees standardisation: a voluntary process of developing technical specifications. For example, the Gas Appliances Directive[66] covers gas-fired appliances used for cooking, heating and hot water production. A separate directive covers Ecodesign and Energy Labelling[67]. While adherence to the standards are generally voluntary for member states, the EU increasingly uses them in legislation.

8.1.2 The role of UK legislation

The UK Government has three policy objectives:

- security of supply;
- decarbonisation and
- affordability[68].

These objectives are delivered by DECC and Ofgem, as described in **Figure 12**.

65 http://www.smartgrids.eu/?q=node/175

66 Directive 2008/142/EC

67 Directive 2009/125/EC and Directive 2010/30/EU

68 DECC (2010) *Electricity market reform: consultation document*

Figure 12. DECC and Ofgem

- Determines energy policy agenda, targets
- Develops and implements policies
- Implementing support policies (e.g. RO, FITs)

- Regulates revenues/service in monopoly sectors
- Promotes competition in retail and wholesale
- Protecting customers (e.g. vulnerable customers)
- Monitors security of supply

Source: Frontier Economics

We now discuss the main policies in each of these areas.

Security of supply

To ensure the UK's energy needs can be met reliably, DECC and Ofgem monitor the security of supply and intervene where they view the market is not working.

- DECC and Ofgem under the terms of the Energy Act (2011) to **report annually** to Parliament on security of supply in GB[69].
- DECC's electricity market reform programme includes measures specifically aimed to increase security of supply – for example the introduction of a **capacity mechanism.** The introduction of a capacity mechanism will allow generators to be rewarded for the provision of capacity on the system as well as for the production of energy.
- DECC are also taking the following actions[70]:
  - reform of the planning system for nationally significant energy infrastructure to speed up the process;
  - working with industry and regulators to prepare for energy emergencies and to increase the resilience of energy networks and assets;
  - undertaking initiatives to reduce risk of security issues by increasing energy efficiency;

69 See: Ofgem and DECC (2012) *Statutory Security of Supply Report*

70 DECC, https://www.gov.uk/government/policies/maintaining-uk-energy-security--2, Accessed 03/04/13

- working to maintain energy networks;
- issuing licences for domestic oil and gas exploration and production; and
- international engagement to promote low-carbon technologies, and to encourage investment in UK energy production.

Decarbonisation

The UK Government has signed up to targets at national and EU level to reduce carbon emissions

At a national level, the UK government has entered a **legally binding target** to reduce greenhouse gas emissions by at least 80% below 1990 levels by 2050. The 2008 Climate Act also requires the Government to set legally binding 'carbon budgets' (or caps on the amount of greenhouse gases emitted in the UK) for each five year period. The first four carbon budgets have been put into legislation and require a 50% cut below 1990 levels by 2025[71].

DECC have introduced a wide range of policies to encourage take up of energy efficient enabling technologies and investment in low-carbon energy infrastructure (including major reform of the electricity market). The specific policies to deliver decarbonisation are discussed in relation to each value chain in the next section.

Affordability

A number of bodies are responsible for ensuring that energy markets are competitive, deliver fair value to consumers and ensure vulnerable consumers are protected. This is at a national level by Ofgem, DECC, the OfT and the Competition Commission.

Actions on affordability by DECC are focussed on delivery decarbonisation and security of supply policy as cost-effectively as possible, increasing energy efficiency and targeting measures at fuel poor consumers.

Ofgem's are focussed on regulating natural monopolies and promoting competition in retail and generation to ensure consumers get the best deal.

We discuss these elements in more detail in relation to each value chain in the next section.

8.2 Legislative framework by value chain

We now describe the legislative framework for each of the value chains.

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[71] Committee on Climate Change (2010), *Fourth Carbon Budget*

8.2.1 Gas and electricity

This section summarises how policy affects the different elements of the gas and electricity value chains.

Industry codes affect the whole of the gas and electricity value chains.

- **The Uniform Network Code (UNC).** As part of having a license for operating in the gas industry, producers, shippers, network firms and retailers must adhere to industry codes which set out rules for operating in the industry. UNC is a common set of legal and contractual frameworks for the supply and transport of gas. It underpins the competitive market arrangements and ensures a level playing field for participants.

- **The Balancing and Settlement code (BSC).** This sets out the arrangements for how electricity trades are settled. This includes penalties for when generator or retailers have not matched their physical delivery of electricity with their contractual positions. For retailers selling to domestic customers without smart meters the amount they physically supply in real-time must be deemed according to estimated demand "profiles". As smart meters are rolled out settlement for domestic retail will be able to take place according to actual consumption.

- **The Connection Use of System Code (CUSC), Grid Code and Distribution Code**. These codes set out the legal and technical requirements for users (i.e. generators and consumers) to connect to and use the transmission and distribution grids.

Retail

Retail supply operates as a competitive market, although as a licensed activity there are a number of restrictions on how retailer can operate. The following policy features are of the most importance to business models.

- **Retail licensing provides some controls on how gas and electricity can be sold to consumers and metering arrangements**. This includes a minimum notice period on price changes (30 days). Under their license retailers are also responsible for ensuring customers are provided with a meter.

- **Prices are not regulated but are subject to strong regulatory, political and public oversight**. While competition is the principle means by which prices are controlled in retail gas and electricity markets, there is strong pressure on retailers to limit prices both formally and informally.

- **Market arrangements determine how retailers purchase gas and electricity**[72].
  - The market arrangements for trade of gas are governed by network codes. Under these, retailers face an incentive to ensure that they balance their customer demand with their gas supply contracts arranged via licensed gas shippers.
  - The market arrangements for trade of electricity are governed by Balancing and Settlement Code. Under this, retailers face an incentive, through the "cash-out" mechanism, to ensure that they balance their customer demand with their generation contracts.
- **Electricity retailers are obligated to purchase a certain proportion of their electricity from renewable sources under the Renewables Obligation.** The costs of this are recovered through consumers' bills. This is described in more detail in the upstream section.
- **Policies obligate retailers to be active in energy efficiency**. Under the Energy Company Obligation (ECO) energy retailers are obliged to deliver a certain amount of carbon emissions savings and heating cost reductions (for vulnerable groups) on behalf of their customers. These can be delivered through a variety of energy efficiency measures. The costs of this obligation are recovered through customer bills. These are discussed in more detail in the enabling technologies section.

Networks

The business models and value propositions associated with the **gas and electricity distribution and transmission** networks are largely defined by the policy and regulatory framework. This is because they are natural monopolies and are therefore regulated by Ofgem to protect consumers from potential abuse of monopoly power. This means that policy change is the biggest driver of industry change for this part of the value chain. The following policy features are of most relevance.

- **Policy largely dictates industry structure:** There are eight principal gas distribution networks (GDNs) given licenses to run as monopolies in a given area and regulated by Ofgem. In addition there are a number of smaller networks, Independent Gas Transporters (IGTs), mostly built to serve new housing. In electricity, 14 distribution networks (DNOs) are given licenses to run as monopolies in a given area and regulated by Ofgem. In addition there

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72 These trading arrangements are discussed in the contractual arrangements annexe.

6 smaller licenses for Independent Distribution Network Operators (IDNOs).

- **Policy dictates the scope of activities.** The activities that networks undertake are defined by policy decisions. Since privatisation, activities where there could be competition have been removed from monopoly regulation on the basis this is expected to lead to a better outcome for customers than regulation. For example, Ofgem has worked to promote competition in the gas and electricity connections markets, as well as in metering. Competition for connection has grown rapidly. For example in gas, more than half of all new connections are now installed by Utility Infrastructure Providers (UIPs) or Independent Gas Transporters (IGTs) rather than the former monopoly incumbent network provider. These have mainly been built to serve new housing developments and approximately one million customers are now connected to these networks in GB. Since they are also monopoly networks, they also require a licence and are subject to regulation. Although this is more 'light-touch' than the regulation applying to the eight principal regional gas networks, it largely restricts the charges that the IGTs can levy and the service they offer.

- **Regulation determines the service being offered:** To be able to distribute gas and electricity networks must hold a licence. The licences contain conditions which largely limit the activities of the companies and the value propositions that they are able to offer. For example, among other requirements, the licences put constraints on the amount of revenue which these companies can recover from customers, the structure of charges by which that revenue can be recovered and the quality of service and outputs that must be offered. Therefore policy essentially drives the service offerings and price levels of these companies. The RIIO (Revenue = Incentives + Innovation + Outputs) is a new regulatory framework that applies to the transmission networks from 2012, the gas distribution networks from 2013 and the electricity distribution networks from 2015. It has increased the length of the price control period and increased the focus on outputs. Both changes are intended by Ofgem to provide a stronger incentive for the networks to meet the investment and innovation challenge to deliver a sustainable energy network at value for money to existing and future consumers.

- **Limitations on relationship with end customers:** Although the gas and electricity distribution networks have a physical link to domestic and small business customers' premises, the commercial relationship between the GDN or DNO and the end customers is limited by regulation. Despite this formal barrier to customer engagement, Ofgem has been trying to encourage network companies to engage with retailers (and others in the value chain) to ensure value is maximised throughout the value chain, in electricity, through initiatives such as the Low Carbon Network fund (see below).

- **The charging structure is determined by regulation.** The revenues are collected through charges on networks users (e.g. retailers, generators, shippers) which are a mixture of commodity and capacity based charges. Discussions about changes to the structure of charges (including debate about the extent of locational charging) and whether connection charges should be deep (including network reinforcement costs) or shallow are on-going. The outcome of both will influence future sector change as they affect the costs and benefits associated with introducing alternative networks as an addition to the existing national systems.

- **Innovation is also driven by regulatory policy.** Since almost all revenues of the networks are controlled by regulation, Ofgem has had to introduce a regulatory incentive mechanism to promote innovation in the sector. This will be focussed on the Network Innovation Competition (a scheme where networks have to bid for project funding to undertake activities that are related to the low carbon agenda and environmental benefits for customers) and the Network Innovation Allowance (a smaller amount of company-specific funding that is available for innovation trialling). These schemes will replace the Low Carbon Networks Fund. This is a £500m fund for projects sponsored by electricity DNOs to trial new technology, operating and commercial arrangements between 2010 and 2015.

- **Safety is an important driver of policy and cost.** The Health and Safety Executive (HSE) has primary enforcement responsibility for gas and electricity safety. This includes a requirement for each gas network owner to prepare a Safety Case, showing how it is safely managing the flow of gas. The Safety Case has to be accepted by HSE before gas can be transported. Safety can also be an important driver of cost. For example it was a requirement of the HSE that the networks undertook an accelerated programme for the replacement of iron pipes with polyethylene pipes because of the risk of a catastrophic incident.

The **gas and electricity system operation** functions are also run as regulated monopolies (one in each sector) with service levels and revenues defined by regulation. The regulatory framework includes incentives for the system operator to ensure efficient balancing of supply and demand, improved demand forecasting and to minimise greenhouse-gas emissions in its activities. In electricity, this also includes managing constraints on the transmission networks.

Upstream gas

Upstream gas is run as a competitive market and is global in scope. The following policies are important for our analysis for UK gas producers:

- **Access to resources is determined by licensing**. Access to the gas fields for exploration and development is determined by licensing rounds. The Petroleum Act 1998 vests all rights to Great Britain's oil and gas resources in the crown, but DECC grants licences that confer exclusive rights to explore for and exploit those resources. These licenses include annual rental charges to ensure licensees have a incentives to exploit the resource or pass the rights on.

- **Much of the value of UK gas production is transferred to the taxpayer**. All UKCS gas fields are subject to a special tax on profits (currently this is between 61% and 82% of profits[73]).

- **The way in which gas can be extracted and stored is subject to regulatory control**. The process for gas extraction is controlled to ensure safety and environmental protection. DECC provides guidance to companies on oil and gas field development plans as well as flaring and venting, and cessation of production and ensure these are followed[74]. The Health and Safety Executive (HSE) is responsible for regulating the risks to health and safety arising from work activities in the offshore industry on the UK continental shelf. Along with general health and safety law, HSE uses a number of specific legislation to regulate the oil and gas industry[75].

- **There are incentives to limit environmental damage.** Gas production installations are part of the EU Emissions Trading Scheme (EU ETS). Carbon allowances must be purchased to cover emissions associated with the production process and flaring.

- **Policy is in place to promote new technologies and investments.** For example in Budget 2013, the Government announced support for investment in shale gas extraction[76].

Upstream electricity

Generation and upstream fuel electricity markets are run as competitive markets. However, there are a number of significant government interventions, including:

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73 Oil and Gas UK, 2012, Economic Report 2012

74 https://www.gov.uk/oil-and-gas-fields-and-field-development

75 http://www.hse.gov.uk/offshore/law.htm

76 The Government will introduce a new field allowance for shale gas and extend the Ring Fence Expenditure Supplement for shale gas projects from 6 to 10 years. HMT (2013), *Budget 2013*

- **Low-carbon generation is encouraged through carbon pricing and renewables subsidies**. There are a range of measures in Europe and the UK to encourage low-carbon and renewable electricity generation.
  - This includes the EU Emissions Trading Scheme (EU ETS) which set a declining cap of carbon emissions from a number of energy-intensive sectors including electricity across the EU. Under the EU ETS generators must purchase carbon allowances for any carbon they emit thus providing incentive to avoid dispatching high-carbon generation and to build low-carbon generation. In the UK the EU ETS price is being supplemented with a price floor on the cost of carbon emissions starting this year.
  - The Renewables Obligation (RO) is also a major driver of renewable generation technologies. Under this policy retailers must purchase an agreed percentage of their electricity from renewable sources, with this percentage growing over time. This creates a market for certificates for renewable generation thus providing a subsidy.
  - There is also a subsidy scheme aimed at a smaller scale (<5 MW), the Feed-in Tariff which is discussed further in the enabling technologies section.
  - From 2014, low-carbon generation will be supported via long-term, fixed price contracts (Contracts for Differences) with prices determined by government. Further support will be provided through an emissions performance standard, which aims to provide a regulatory backstop on the amount of emissions new fossil fuel power stations can emit. Box 1 describes electricity market reform in more detail.
- **There are strong regulations to limit the air quality impacts of generation technologies**. This includes at an EU level, the Large Combustion Plant Directive (LCPD) and the Industrial Emissions Directive (IED), which controls emissions of sulphur dioxide and nitrogen oxides. Both of these are leading to the shutdown of a substantial amount of coal and other fossil plants in the UK at present and over the next 10 years.

In addition, the Health and Safety Executive regulates for safety issues associated with power stations. DECC, Defra and the Environment Agency also regulate to ensure other environment damage associated with generation is limited. For example, DECC works closely with Defra and the Environment Agencyhttp://www.environment-agency.gov.uk/ to regulate management of nuclear substances and waste. DECC also sponsor the Nuclear Decommissioning Authority, which manages the decommissioning of civil nuclear sites. Finally, the Office for Nuclear Regulation regulates some aspects of nuclear industry and provides DECC with advice on developing policies on waste.

Box 1. Electricity Market Reform and new business models

Electricity market reform (EMR) is a package of policy measures which aims to provide stronger incentives for investment in low-carbon electricity generation and to strengthen incentives around the maintenance of security of supply.

Key elements of EMR

There are four main elements to the EMR programme.

Contracts for Difference (CfDs)

CfDs aim to stimulate investment in low-carbon technologies, including renewables, nuclear and carbon capture and storage (CCS) by reducing risks to investors in low-carbon plant, thereby making it easier and cheaper to secure finance. They will provide predictable revenue streams to investors in generation by setting a 'strike price' for each technology. When the electricity market price is below the strike price for a given technology, plants generating electricity using that technology will receive a top-up payment up to the level of the strike price. When the market price is above the strike price, the generator must refund the difference.

By providing stable revenues to investors in low-carbon plant, CfDs will provide opportunities for lower risk business models.

Carbon price floor (CPF)

The energy intensive sector (including electricity generation) has faced a carbon price through the EU ETS since 2005. However, this carbon price has been volatile, and there is a large degree of uncertainty over its future path. By setting a floor below which the carbon price cannot fall, the CPF aims to provide greater support and certainty to investors and thereby increase investment. The floor will start at around £16 per tonne of carbon dioxide and follow a linear path to £30/tCO2 in 2020[77]. It will apply to supplies of coal, gas and liquefied petroleum gas used in most forms of electricity generation, and will take the form of a top up payment to the exchequer.

The CPF will not have a major impact on the revenue for new low-carbon plant, which will largely be determined by the CfD strike price. It is therefore not likely to create major new opportunities for business models. However, since it will increase the wholesale electricity price, it is likely to reduce the cost of CfDs to

[77] In 2009 prices.

the exchequer.

Emissions performance standard (EPS)

The EPS aims to reduce the risk that new, emissions-intensive plant will come on the system. It will act as "regulatory backstop" on the amount of carbon emissions new fossil fuel plants can emit. In the Energy Bill, the limit on emissions is set at 450g/kWh until 2045. This will rule out investment in new coal-fired power stations without CCS. However, the limit has been set high enough to allow new investment in new gas generation.

By providing regulatory certainty for new unabated coal plant, the EPS is likely to create new opportunities for CCS businesses.

Capacity market

The capacity market aims to secure the electricity supply in GB. It will provide financial incentives for the provision of capacity. Under this mechanism, capacity estimated to be required to ensure security of supply will be contracted through a competitive central auction, several years ahead. Successful participants in the auction will enter into an agreement committing to provide electricity in the delivery year, in return for a capacity payment. Generation plant (including CHP) will be eligible to participate in the capacity market, alongside alternative sources of flexibility such as demand side response and storage.

The capacity market is likely to create opportunities for new business models which provide flexibility services for a fee. The nature and extent of these opportunities will depend on the detailed design of the market, which is still being finalised.

Status

The Secretary of State for Energy and Climate Change introduced the Energy Bill into Parliament in November 2012. This Energy Bill implements the main aspects: CfDs, capacity markets and the emissions performance standard (EPS). It is expected to achieve Royal Assent in 2013

As announced in Budget 2011, a CPF has been introduced with effect from 1 April 2013.

8.3.3 District heating and CHP

Several of the characteristics of district heating mean that there are significant policy incentives around the introduction of CHP and district heating.

- **Incentives for CHP**. There are a number of incentives in place for CHP, including:
  - exemption from the Climate Change Levy (CCL);

- enhanced capital allowances offering 100% first year tax relief on CHP investments;
- exemption from business rates;
- subsidies under the Renewables Obligation for biomass and waste-fired CHP plants;
- subsidies under the Renewable Heat Incentive (RHI) if the heat is supplied by an eligible installation (e.g. biomass boiler). This treats networks equivalently to large single consumers of heat;
- "Licence Lite" – Ofgem's proposed arrangements for CHP and other small electricity generators to obtain a better price for their power and improve network access; and
- information on the benefits of CHP and tools for assessing CHP project viability through the CHP Focus programme.

The impact of EMR on CHP is covered in Box 2.

Box 2. Impact of EMR on CHP[78]

It is not yet clear what the impact of EMR on CHP will be.

Contracts for Difference (CfDs)

The current drafting of the Energy Bill could allow for the support for CHP under the CfD regime. However, DECC are still considering whether EMR is the most appropriate system for encouraging CHP deployment.

Carbon price floor (CPF)

The introduction of a CPF has increased costs for CHP plants from April 2013. CHP plants above 2 MWh are required to pay carbon price support the proportion of supplies of solid fuels, natural gas and LPG they use to generate electricity.

Capacity market

The capacity market could provide additional revenue stream to CHP providers as CHP will be eligible to compete in the main capacity market auction alongside other capacity providers. DECC has pointed out that CHP could also aggregate with other capacity providers to help manage risk when providing capacity.

- **Incentives for district heating.** Policy incentives in place for district heating include:
    - eligibility for financial support from ECO in some circumstances (e.g. for vulnerable households);
    - building regulations setting standards for reducing energy demand, of which district heating is one option;
    - local authorities are encouraged to identify opportunities for developing energy supply that is renewable, low-carbon or decentralised as well as co-locating heat supply and demand under the National Planning Policy Framework.
- **Standards ensure the quality of CHP installations**. The Combined Heat and Power Quality Assurance Scheme assesses and monitors the quality and performance of CHP schemes. Scheme which meet the requirements can be defined as 'good quality' CHP allowing them to qualify for incentives such as capital allowances and support under the Renewables Obligation listed above.

78 EMR impacts only on electricity generation and will therefore have no direct impact on other forms of district heat.

Although heat networks have natural monopoly properties, they are not currently subject to explicit revenue regulation like gas and electricity networks. However, the fact that projects typically have a high level of local authority involvement and/or involve 'not-for-profit' sponsors provides some protection on prices for consumers. They are also protected by general trading standards.

Local Authority policies play a key role in promoting and facilitating district heating schemes, including via their planning policies. The EU Cogeneration Directive also sets a framework for Member States to promote the use of CHP.

8.4.1 Heating oil

The following points characterise the policy landscape facing the heating oil market.

- **Alternatives to heating oil are encouraged by policy**. As heating oil is viewed as a high-carbon and relatively expensive option for heating homes, the policies affecting heating oil are typically those focused on promoting alternatives. This includes the Renewable Heat Premium Payment scheme. Under this scheme, homes off the gas grid are able to apply for grants for heat pumps, biomass boilers and solar thermal. The duty on heating oil (5%) also provides a small discouragement to use of heating oil.

  In addition regulations allowing extensions to the gas grid are slowly reducing the size of the heating oil market (including connection funded via Ofgem's Fuel Poverty Network Extension Scheme).

- **Distribution is not subject to revenue regulation**. As the distribution of heating oil is not a natural monopoly (since oil can be delivered by tankers on road) it is not subject to revenue regulation.

The heating oil market is also subject to economy-wide competition law and health, safety and environmental regulations.

8.4.2 Enabling technologies

For **enabling technologies** there are a wide range of policy measures aimed at encouraging the installation of energy efficiency and renewable technologies.

- **The market opportunity for enabling technologies and services is expanded by energy efficiency and vulnerable customer policies**. In particular, the market for installation of energy efficiency enabling technologies has been heavily shaped by obligations on the large energy retailers. These place an obligation on energy companies to meet carbon emission reduction targets by delivering energy efficiency measures to households. More specifically:

- the Carbon Emissions Reduction Target (CERT) was designed to reduce household carbon emissions through uptake of cost-effective energy efficiency measures such as insulation, heating and lighting; and
- the Community Energy Savings Programme (CESP) was designed on an area-basis, with the objectives of reducing carbon emissions and fuel bills specifically for low-income households.

These policies have been replaced by the Energy Companies Obligation (ECO) which entails three separate obligations on the large energy retailers:

- Carbon Emissions Reduction Obligation where companies must deliver 20.9 million lifetime tonnes of carbon dioxide savings by 2015. This focuses on hard to treat homes (e.g. solid wall and cavity wall insulation);
- Carbon Saving Community Obligation where companies must deliver 6.8 million lifetime tonnes of carbon dioxide savings by 2015. This focuses on the provision of insulation measures and connections to district heating systems for consumers in low income areas; and
- a Home Heating Cost Reduction Obligation (£4.2bn of lifetime cost savings). This requires energy companies to provide measures which improve the ability of low income households to heat their homes. This includes the replacement or repair of boilers.

In addition to energy company obligations the Code for Sustainable Homes is also an important driver of energy efficiency by setting minimum energy efficiency standards for new housing developments.

- **Barriers to consumer financing of enabling technologies are starting to be addressed through the Green Deal**. Under the Green Deal, launched this year, private firms offer energy efficiency improvements to their homes with the upfront costs recovered through an increment to consumers' bills. Under the Green Deal customers also receive an assessment of the cost-saving potential energy efficiency options.

- **Domestic-scale renewable electricity generation technologies are encouraged through the Feed-in Tariff (FiT) scheme.** The FiT provides a payment for generation from small-scale renewable technologies (<5 MW) such as solar PV. The tariffs are paid by electricity retailers with costs recovered through consumer bills.

- **Renewable heat generation is encouraged through the Renewable Heat Incentive (RHI) and the Renewable Heat Payment Scheme.** The RHI provides a payment for generation of heat using renewable energy. Eligible technologies are biomass, heat pumps, geothermal, solar, biomethane and biogas. At present it is only open the non-domestic consumers. It is expected to open to domestic consumers in 2014.

Domestic consumers and social landlords can currently obtain support for renewable heat installations under the Renewable Heat Premium Payment voucher scheme. This scheme makes one-off payments to consumers and social landlords who qualify and has a budget of £15m. It focuses on off-gas grid dwellings.

- **Permitted Development Rights have eased to planning barriers to domestic microgeneration**. These allow certain limited developments on home to take place without requiring planning permission.

- **Installers and manufacturers are regulated to ensure safety**. Products such as boilers must meet gas safety standards. This includes British Standards (BS) and European Standards (EN) which govern product manufacturers in relation to safety for technology and appliances. Boiler installers must also be trained and registered as "gas safe". Building control regulations drive the quality and safety of domestic electrical installations ensuring that only competent persons carry out key tasks.

8.5 Policies and the implications for change

Table 2 outlines five main policies that are likely to have an impact on the ability of the sector to change.

Table 2. Summary of five main policy areas influencing the energy value chains

Policy area	Description	Rationale	Implications for change and innovation
Consumer protection and competition policy	• License conditions on retailers to protect consumers • Monitoring of the wholesale and retail markets to identify and act on market abuse	• Energy is an essential need and represents a high proportion of expenditure for low-income households	• Innovations in tariffs and value propositions will need to ensure consumer protection and compatibility with retail license conditions
Obligations on energy retailers to deliver energy efficiency	• Under CERT, CESP and now ECO retailers must deliver specified volumes of energy savings, particularly for low income households	• Although many energy efficiency measures are cost-effective there are some barriers to uptake (e.g. upfront costs, information, hassle)	• A large amount of the energy efficiency market is represented by energy efficiency obligations • Funding will be channelled via retailers
Revenue regulation of gas and electricity networks	• Gas and electricity networks are subject to revenue regulation • Service levels are defined and incentivised by the regulatory framework	• Gas and electricity networks are 'natural monopolies' and efficient competition is generally not possible	• Relationship with end consumers is restricted and defined by regulation • Charging structures may need to reform to reflect locational and time-of-day issues • Innovation must be incentivised through the regulatory framework
Incentives for low-carbon electricity generation	• Carbon pricing through the EU ETS and UK Carbon Price Support (CPS) • Support for renewable electricity generation through the Renewables Obligation (large-scale) and Feed-in Tariff (small-scale)	• There are carbon externalities associated with fossil-fuelled generation • Renewable generation reduces dependence on fuel imports and some technologies are immature	• The generation mix is being changed from flexible thermal power stations to inflexible and intermittent plants • The value of demand-side management, storage and other sources of flexibility should increase

Policy area	Description	Rationale	Implications for change and innovation
Electricity market arrangements	• Arrangements to trade electricity is determined by a balancing and settlement code. This includes the role of the system operator in balancing. • A capacity mechanism is being introduced to ensure there is sufficient capacity to meet peak demands	• Electricity is expensive to store and therefore demand and supply must be balanced in real time. • There are concerns that the market may not deliver sufficient incentives to invest in capacity without intervention.	• The balancing and settlement arrangements will influence how smart meters are used to manage demand. • The design of future capacity markets will influence the need for and types of flexibility.

9 Annexe 4: Gas value chain map

This annexe presents our analysis of the value chain for providing gas to domestic and small business consumers in Great Britain. In this annexe we:

- describe what this value chain provides to domestic and small business consumers;
- present an overview of the value chain, the interactions and value at each stage;
- describe the business environment for companies operating in the gas sector; and
- use the business model canvas framework to describe the business models in each part of the value chain, including looking at developments over time, and drawing out learning.

The gas and electricity sectors have some features in common. We cross refer to them in the electricity annexe.

9.1 What is being provided to consumers?

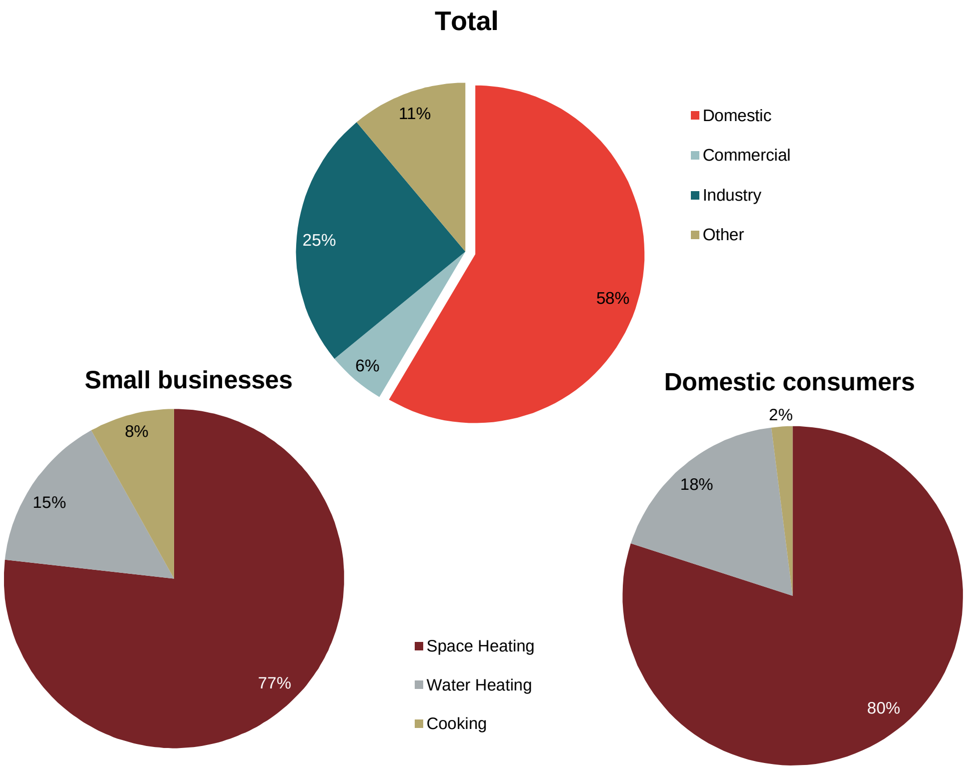
We begin by describing the uses of gas for domestic and small business consumers. We then discuss the features that gas supply must have to be useful to these consumers.

9.1.1 Domestic and small business consumption

The domestic and commercial sectors consume 64% of gas in Great Britain (Table 3). Domestic consumers typically use gas to meet their space heating (80% of domestic gas consumption), hot water (18%) and cooking (2%) needs. For small business which use gas, it is also used for space heating (76%), hot water (15%) and cooking (8%).[79]

[79] DECC (2012), *Energy Consumption in the UK*. Figures do not add up to 100% due to rounding errors.

Figure 13. Gas consumption by sector, and breakdown of domestic and small business consumption by use



Source: DECC, 2012, Digest of UK Energy Statistics, Table 4.2

Consumers' needs for gas vary dramatically over the course of the day, week and year, and are particularly sensitive to the external temperature. For example, peak daily winter demand is around seven times higher than minimum summer demand for domestic and small business customers.[80] These fluctuations are much greater than in the electricity sector, where a threefold difference is observed[81].

9.1.2 Which characteristics of gas are important?

To allow consumers to meet their space heating, hot water and cooking needs, the gas value chain must deliver with the following characteristics.

80 This is based on National Grid (2012), *Seasonal Demand Forecasts*. Figures uses were for non-daily metered (NDM) customers.

81 This is based on National Grid (2012) *Half-hourly Electricity Demands*. Figures are for the electricity market as a whole, not just domestic and small business.

- **Reliability**. Although there is some scope to store heat in homes (e.g. hot water tanks) consumers generally need a highly reliable supply of gas to ensure they can meet their heating needs.

- **Responsiveness**. Outside temperatures and needs for heat (e.g. whether the consumer is at home) vary significantly. Therefore to ensure heating needs can be met, the heating systems must be responsive.

- **Safety**. Natural gas is a flammable and toxic gas in high concentrations. High safety standards are therefore required to prevent leakages in the home and beyond.

We now discuss how the gas value chain has developed in a way that that allows these needs to be met.

9.2 Overview of the value chain

In this section, we describe each element of the value chain and look at the physical and contractual flows between each part. We look at the overall value of the gas sector, and where this value resides. Finally, we look at the breakdown of customer bills, in terms of the contribution of each part of the value chain.

9.2.1 Elements of the value chain

We divide the value chain into four parts (the section that follows explains the roles and interactions between these organisations in more detail).

- **Upstream.** In this we include gas producers (e.g. North Sea gas producers), large-scale storage operators and importers (interconnectors and LNG). The main role of the upstream part of the part of the value chain is to produce the gas consumers need in the right quantities, available at the right time and with the required quality, ensuring this is achieved safely and that environmental damage is limited. UK gas production is currently composed largely of multinational oil and gas majors.

- **Networks and System Operation.** The gas transmission network provides high pressure connections between gas producers/importers and power stations, storage operators and the gas distribution networks. The lower pressure distribution networks deliver gas to homes and small businesses. Transmission and distribution operators also provide some storage services within their networks.

  Because the fixed costs of networks are so high, it is only cost-effective to have one network in a given area. This means that they are “natural monopolies”. The network businesses (one transmission network and eight distribution networks plus a number of smaller, independent networks) are run as regulated monopolies. They are seen as 'low-risk' businesses with relatively stable revenues and most of their competitive advantage stems from operational efficiency.

The System Operator has residual responsibility for ensuring that gas demand and supply balance. Again this is run as a regulated monopoly and is owned by National Grid.

- **Retail.** The retail part of the value chain is responsible for purchasing gas from the wholesale market, selling gas to consumers and managing the billing. Six major retailers supply the majority of the domestic and small business market. These companies also sell electricity together with gas and also have sizable electricity generation businesses. Many of these retailers are also international, selling gas in a number of markets around Europe. Some of these companies are integrated with gas production in GB (Centrica and to a lesser extent SSE) and most own some gas storage assets.

These issues are all discussed in more detail later in the annexe.

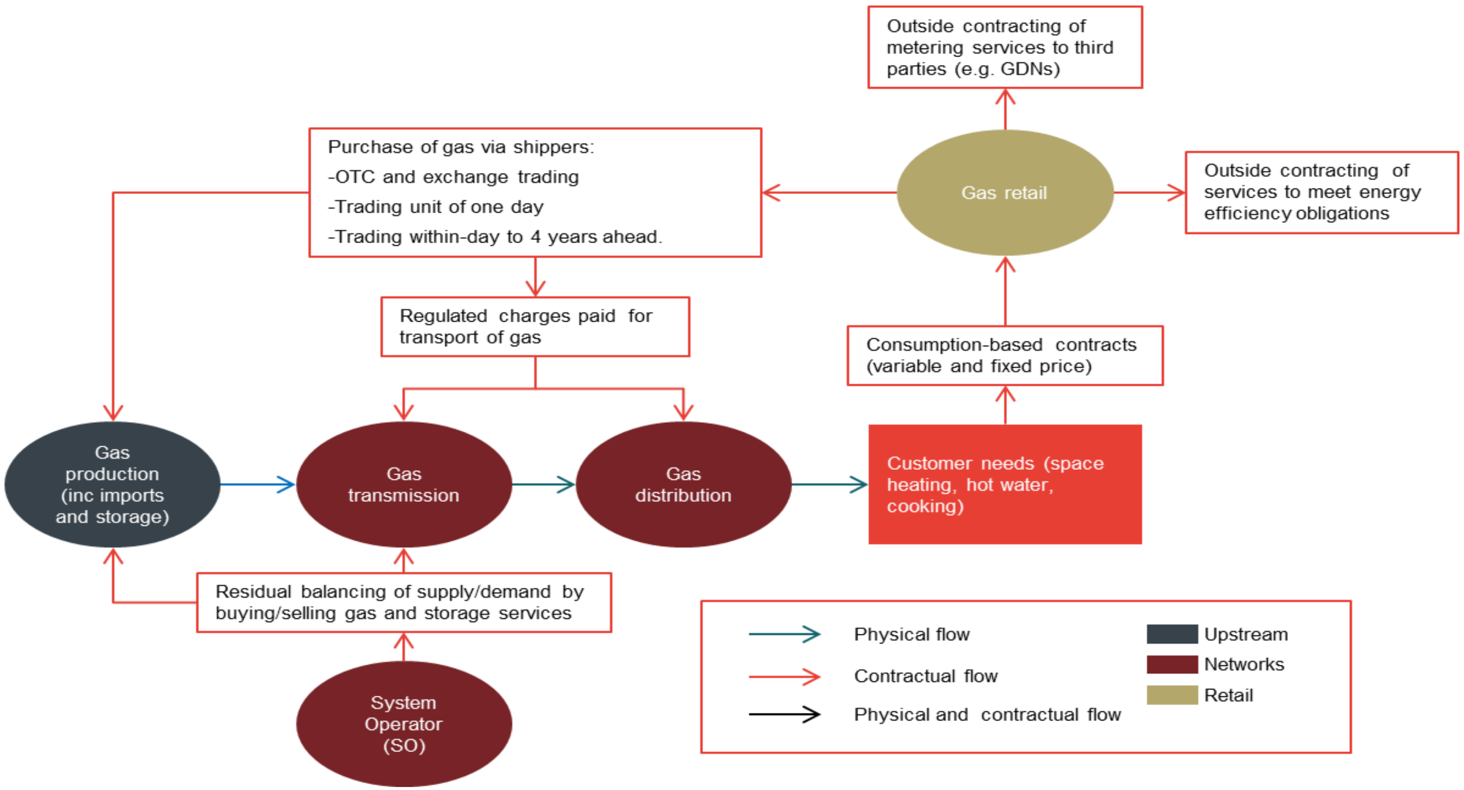
9.2.2 Interactions in the value chain

Figure 14 describes the interactions that occur across the value chain. It describes two types of flows.

- **Physical energy flows.** Physical energy flows from left to right across the value chain. Gas is produced or imported and injected into the transmission (high pressure) and distribution (low pressure) networks which transport this to homes and businesses.

- **Contractual relationships and financial flows.** Contractual and financial flows follow a more complex pattern in Figure 14. Gas retailers purchase gas from gas producers via "gas shippers" which in turn pay network operators for transportation of the gas. Finally, the System Operator purchases balancing services from producers and storage operators to ensure demand and supply are in balance (to the extent trade between retailers and producers has not achieved this).

Figure 14. Overview of the gas value chain



Source: Frontier Economics

9.2.3 Value added and profitability

The total value added[82] of the gas market for domestic consumers and small business is around £11bn/year. Figure 15 provides an overview of where value added resides in the gas value chain:

- **Gas production** itself makes up a significant proportion of the total value, at nearly £7bn. Net gas imports make up the largest portion of this, with approximately 44% of the gas consumed in the UK[83]. The majority of the remaining value is split between gas producers operating on the UK Continental Shelf (UKCS). The largest 5 operators produced 57% of the total UKCS production in 2011[84].The return on capital tends to be relatively high in this area, due to the risky nature of gas production.

- The **gas networks**, transmission, system operation and distribution, account for less than £3bn of the total value. This is a lower proportion of value than the equivalent networks in the electricity chain. This reflects the greater capacity constraints and losses involved in transporting electricity.

- **Gas retail** represents around £2bn per year in value added. Retailers purchase gas on behalf of their customers and then pay regulated 'use-of-system' charges to network operators for transportation services. The largest six firms represent around 99% of the energy retail market and 93% of the small business market[85].

- The total value of the related enabling technologies, including the annual purchase and maintenance of boilers, and the insulation market, is around £2bn. It is notable that only the value of production is significantly larger than the value of these after-sales services. These are discussed in more detail in the enabling technologies annexe.

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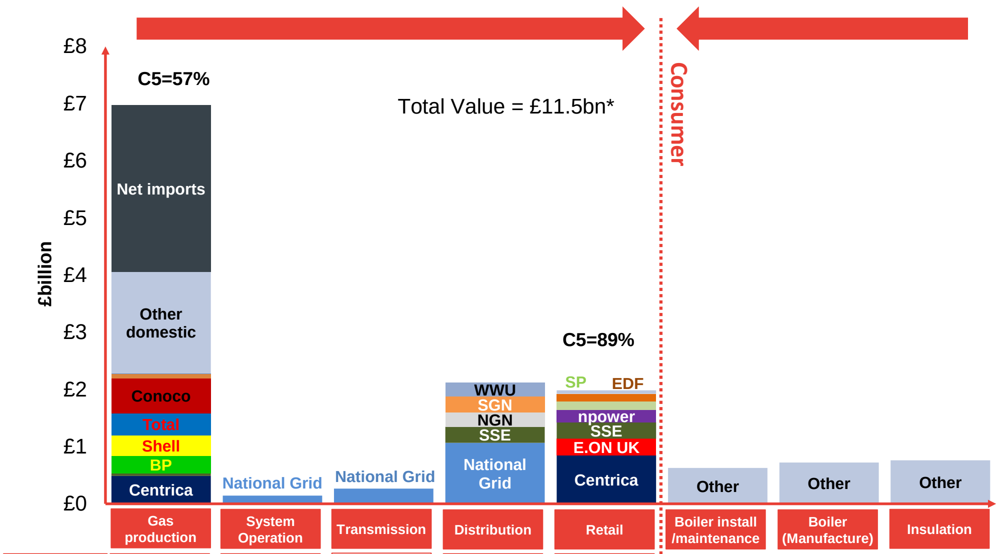
82 For a given part of a value chain, this is the revenues less outside purchases of materials and services (e.g. for gas retail this would entail revenues minus fuel costs and network charges).

83 DUKES Table 4.2

84 DECC "UK Production Energy Release" from UK PPRS "Petroleum Production Reporting System"

85 Ofgem (2012), *Retail Market Review - updated proposals for business*

Figure 15. The distribution of value added and profitability in the gas value chain (domestic and small business)[86]



	Gas production	System Operation	Transmission	Distribution	Retail
Operating margin	40%	2%	32%	30%	5%
Return on capital employed	10-30%	<10%	<10%	<10%	>100%

Note: C5 ratios refer to the market share held by the largest 5 businesses in the market. A higher C5 percentage therefore corresponds to a more concentrated market, where fewer companies hold a larger share.

* This value does not includes the market value of the enabling technologies.

Source: Frontier Economics based on OFGEM Supply Market Indicators, OFGEM Household Bills Explained, Company Annual Reports and DECC Digest of UK Energy Statistics.

The differences in the levels of **operating margins**[87] and the **returns on capital**[88] across the value chain may be explained by two main factors: (i) the capital intensity; and (ii) the risks in that part of the value chain.

- The **operating margins** (relative to revenues) in transmission and distribution are relatively high at around 30% but this margin must support a highly capital-intensive business. In contrast operating margins in gas retail, where capital employed is low, are small relative to revenues.

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86 Note: The ranges of return on capital employed in production and retail are based upon Centrica's reported segmental financial accounts 2011-2007. The returns in gas production are given as post-tax due to the high tax rates on UKCS (UK continental shelf) production. The retail returns are pre-tax. The returns on revenue for retailers are based on the average return in 2011 across the big six retailers. This therefore obscures occasional negative returns for individual retailers, occurring due to wholesales price fluctuations. Returns on revenue for regulated networks are taken from the latest OFGEM price control, using allowed revenues.

87 The operating margin is earnings (profits) as percentage of revenues.

88 The returns on capital are earnings (profits) expressed as percentage of capital employed.

- The (pre-tax) **returns on capital** in gas production are high reflecting the high risks involved in gas production (e.g. gas price, exploration and operational risks). In contrast, returns in gas transmission and distribution are below 10%, reflecting the regulatory framework which largely protects these firms from revenue risks. Returns on capital in retail are very high, although not very meaningful given the limited capital employed in the sector. Profitability of this sector is normally described in terms of margins relative to total revenue. These have fluctuated between 0.7% and 9.0% over the last 5 years[89]. Prior to that they had been negative for a number of years[90].

Each element of the value chain contains a set of services – some of which are contracted out. These are shown in Figure 16. Metering is the most interesting of these services, in terms of relevant insights that can be drawn, and the potential opportunities for future businesses. Metering is covered in detail in Annexe 11.

Figure 16. Activities within the value chain

	Gas production	Transmission	Distribution	Retail
Internal functions	• Operations • Trading • HR and finance	• Operations and maintenance • Construction • HR and finance	• Inspection and maintenance • Construction • IT systems (e.g. asset databases, work scheduling) • HR and finance	• Call centres • Billing systems • Trading and forecasting • HR and finance
Contracted externally	• O&M services • Equipment suppliers (e.g. Siemens) • Construction services (e.g. AMEC)	• O&M services • Equipment • Construction contractors (e.g. Murphy Group) • IT systems	• O&M services • Equipment • Construction contactors • IT systems	• Metering services (e.g. National Grid Metering Ltd) • ICT systems (e.g. GXS)

Source: Frontier Economics

9.2.4 Breakdown of customer bills

The contribution of each part of the sector to consumers' bills is shown in Figure 17. This shows that fuel production makes up the majority of customers' bills, at 52% of an average household bill. The transmission, system operation and distribution costs are the second largest component, but make up just 19%. Retail costs account for a further 15%, and environmental obligations and taxes comprise the remaining 14% (Box 3).

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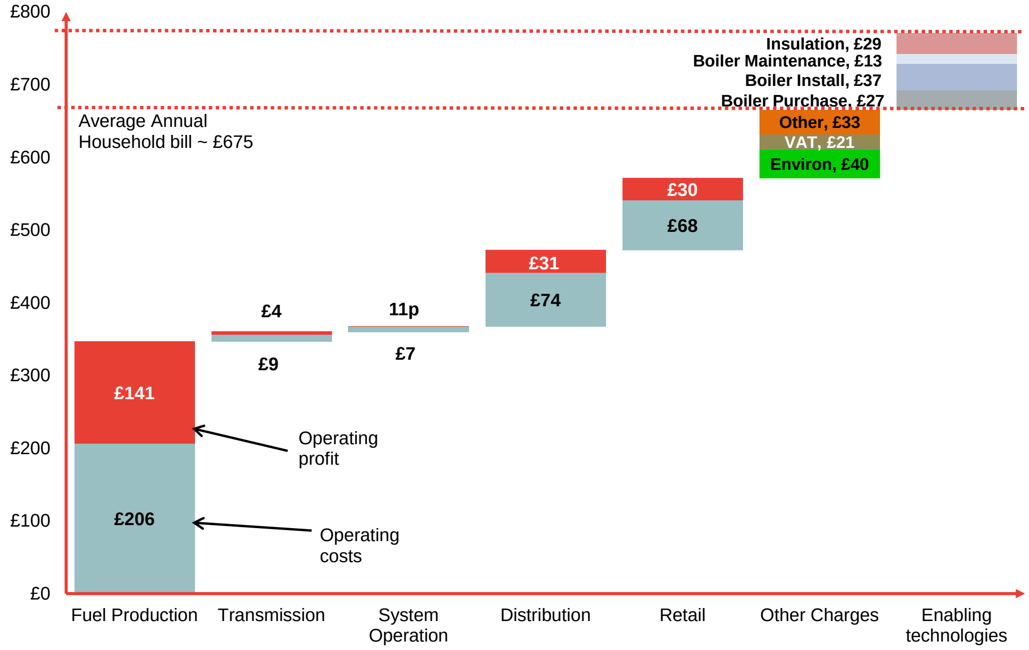
89 Ofgem (2013), *Electricity and Gas Supply Market Indicators*. We have used the figures for "Rolling Net Margin".

90 This is most likely explained by electricity retailers taking negative margins on gas as a way of entering the gas retail market.

Figure 17. Breakdown of an average household gas bill and average annual boiler expenditure[91]



Environmental charges include the Community Energy Savings Programme (CESP), Carbon Emissions Reduction Target (CERT), Renewables Obligation Certificates (ROCs), Feed in Tariffs (FiTs) and the Warm Homes Discount scheme. Insulation includes cavity and wall insulation.

Source: OFGEM Household Bills Explained, Digest of UK Energy Statistics, 2011 Segmental Statements of big six, OFGEM Transmission Price Control Review, OFGEM Distribution Annual Report 2010-11

91 Note: The costs associated with boilers and insulation are shown as total market value per household. This therefore does not represent the cost to a household of purchasing a boiler, instead it is intended to illustrate the relative value of such purchases on average across households.

Box 3. Impact of environmental policies on gas bills

Household gas bills contain several environmental charges;

- Carbon Emissions Reduction Target ("CERT") – this requires energy retailers to provide domestic energy efficiency measures for consumers which achieve a defined level of carbon savings. This added an average cost of £19 to household gas bills in 2011.[92]
- Community Energy Saving Programme ("CESP") - a joint scheme between retailers, generators and government to provide energy efficiency measures in low income areas. This was estimated to cost approximately £2 for every average household bill in 2011.[93]
- Warm Home Discount Scheme – a four year scheme beginning in April 2011. This scheme provides winter energy bill discounts to low income customers. This is funded by energy retailers, and is estimated to cost £5 per annum for the average household gas bill.[94]
- EU Emissions Trading Scheme – this is an EU carbon trading requirement for all energy retailers. This was estimated to add £17 to an average household dual-fuel bill in 2011.[95]

CERT and CESP will be replaced with the Energy Company Obligation in 2012. This combines the functions of CERT and CESP, providing energy efficiency measures, with a particular focus on low income areas. This has been estimated by the Committee on Climate Change to cost an average household approximately £33 per year for both gas and electricity.[96]

DECC analysis suggests the cost of these environmental charges is more than offset in terms of the overall bill by the reduction in energy consumed that they enable.

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92 NERA for Energy UK *Energy Supply Margins: Update March 2011*

93 NERA for Energy UK "*Energy Supply Margins: Update March 2011*"

94 NERA for Energy UK "*Energy Supply Margins: Update March 2011*"

95 Centre for Sustainable Energy and Association for Conservation of Energy (2012) *"Environmental and social levies: Past, present and future"*

96 Association for the Conservation of Energy report (2012) "*Impact of future energy policy on consumer bills*"

Figure 18 shows that the typical household gas bill has increased significantly since 2002, almost doubling in value in real terms. This increase has been driven by the following:

- **Increases in the underlying cost of gas.** There has been a trend towards higher and more volatile prices. This has become stronger since 2004 when the UK became a net importer of gas. This change was primarily driven by global energy market developments and the decline of UK Continental Shelf gas production. In particular, this change was driven by the rising global price of oil. This is because the UK market is physically connected to continental European gas markets, where gas contracts are indexed to the price of oil products. The impact of the rising oil price on gas prices in the UK has increased as UK Continental Shelf gas production has declined and imports have grown[97].This link may now be weakening with the expansion of markets in Liquefied Natural Gas (LNG)and the rapid increase in US production of unconventional gas.

- **Increases in transmission, distribution and retail costs**. The requirement to invest to replace and reinforce aging infrastructure has meant that the transmission and distribution element of the bills has risen since 2002. Retail costs have also increased during this period also. This is just a reversal of a period of very low and even negative margins. The retail, distribution and transmission costs have together increased by 88% since 2002.[98]

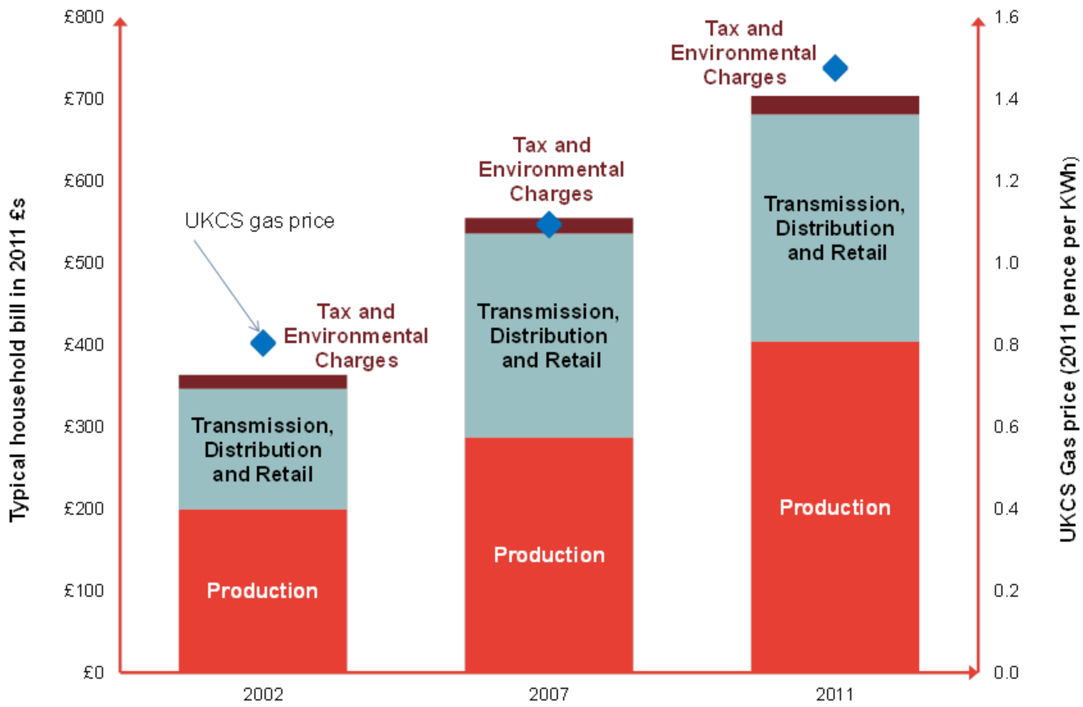
- **Environmental charges**. There has been a significant proportional increase in the taxes and environmental charges, although this remains a relatively small proportion of the bill. DECC estimate that energy and climate change policies will add around 5% to the average gas price paid by UK households in 2013, largely due the costs of ECO. However, at the same time, the policies to encourage energy efficiency also reduced energy consumption. DECC estimate that overall, policies will result a net reduction on bills of 6% on a household's gas bill and 5% on a household's dual fuel bill in 2013[99].

97 DECC (2013) *Estimated impacts of energy and climate change policies on energy prices and bills 2012*

98 Due to the data available, it is not possible to split the costs of retail, distribution and transmission. Therefore, the overall change is reported.

99 DECC (2013) *Estimated impacts of energy and climate change policies on energy prices and bills 2012*

Figure 18. Breakdown of a typical household gas bill over the last 10 years

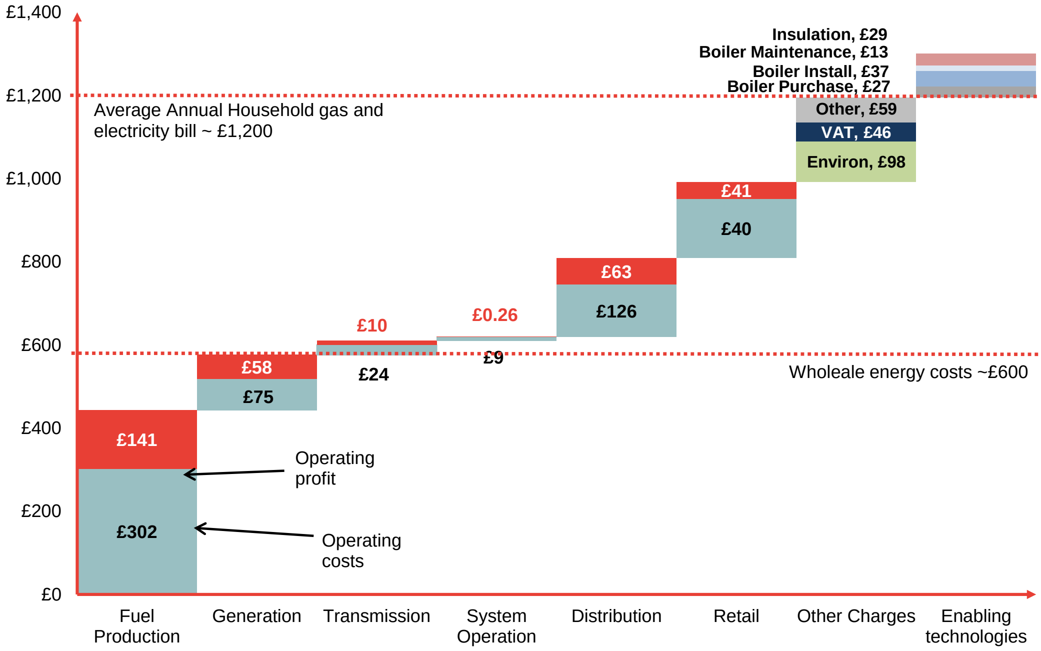


Source: OFGEM quarterly prices

The following diagram shows the average total energy bill for a household using gas and electricity. Figure 19 shows the average heating bill of a household with gas and electricity usage, split by the value added at each stage of the value chain.[100] The wholesale cost faced by retailers is shown to be considerably below the price to consumers with the remainder relatively evenly distributed between transmission and distribution costs, taxes and environmental costs.

100 This is based on assumed consumption levels of 3.3KWh and 16.9KWh for electricity and gas respectively, the average usage in the UK.

Figure 19. Average annual energy bill for a household with gas fired heating



Note: The enabling technologies costs are reported as the average spend for a household, therefore these are lower than the cost of purchase if it relates to a product with low take-up or infrequent purchase.

Source: DECC Quarterly Energy Prices, Consumer Council, OFT Market Investigation, OFGEM Household Bills Explained, OFGEM monthly review

This average assumes that the two fuels are purchased separately. However, 55% of electricity customers contract for gas and electricity using a dual fuel deal[101]. In 2011, a dual fuel customer was found to save, on average, £16 to £54 a year relative to a customer purchasing both separately.[102] There may also be additional time savings to the consumer associated with choosing a dual fuel deal.

9.4 Business environment

Understanding the business environment provides important context for understanding the value chain. In this section, we consider the main characteristics of gas production and consumption. We then provide an overview of the policy context.

101 DECC (2012), *Estimates of domestic dual fuel energy bills in 2011*

102 DECC (2012), *Estimates of domestic dual fuel energy bills in 2011*

We have identified seven features of gas, which can help us understand the value chain:

- **Gas is used by consumers to meet basic needs such as space heating, hot water and cooking**. The fact that gas fulfils basic needs, and that there are some particularly vulnerable customers is a major driver for Government intervention in this sector. The recent Hills Review of Fuel Poverty found that 2.7 million households in England had low incomes and faced high energy costs in 2009 (the most recent year with available data).[103] This fuel poverty is likely to contribute to the 27,000 excess winter deaths each year in England and Wales as well as to wider issues of ill-health.[104]

- **The most cost-effective way to transport gas on a mass scale is via pipeline networks**. Networks are 'natural monopolies'. Their fixed costs are so high that it is most cost-effective to have only one network in a given area. Regulating these natural monopolies is a significant area of Government intervention. The nature of gas networks also means that gas must be sold as a homogenous product. This means for example, that it is not possible for one household to get a different quality of gas supply to its neighbours – all the gas must come from the same network.

- **Gas supply and demand must be matched**. The capacity of the pipes and the infrastructure to inject gas into the network must be sufficient to meet large swings in demand over the course of the year. For example, peak daily winter demand is around seven times higher than minimum summer demand for small customers.[105] Some gas can be stored in the pipeline networks to help manage volatility in demand as well as through dedicated storage sites. Supply from an individual gas production platform may be inflexible and subject to interruptions but given the number of diversity of supply sources including LNG and storage, gas can be supplied to the GB market relatively flexibly.

- **Domestic and small business consumption is currently only measured periodically**. At present, most existing metering technology is 'dumb' meaning household consumption cannot be monitored in real-time. In particular, meters cannot communicate remotely to retail suppliers and therefore meter readings must be taken periodically (e.g. with the householder reporting a meter reading by phone or via the internet and/or

103 DECC (2012) *Hills Review Final Report*

104 DECC (2012) *Hills Review Final Report*

105 This is based on National Grid (2012) *Seasonal Demand Forecasts*. Figures uses were for non-daily metered (NDM) customers.

an employee of the retailer visiting to take a meter reading). This also means at present, there is very limited scope for management of consumer gas demand by time of week or month.

- **Boilers convert gas into heat flexibly and efficiently with variable reliability and space requirements**. Boilers typically provide heat with some flexibility and high efficiency. For example, space heating needs are typically met within an hour or less of controls being activated, if not managed by thermostat. Reliability can be variable depending of the age and model of boiler. The best condensing boilers are more than 90% efficient. Domestic boilers can also be wall hung or floor standing with the former taking up less space.

- **Security of supply is an issue and there are environmental externalities from gas production and use**. This includes carbon emissions associated with gas production and use as well as the potential environmental damage from gas leaks. A secure and reliable gas supply provides important input for a successful economy and security of supply for gas is a Government priority. Where the Government believes the market alone will not ensure there is sufficient reliable capacity in place to meet demand for gas, it intervenes.

- **There are safety issues associated with the production, transport and use of gas**. Natural gas is a flammable and toxic substance in high concentrations. This means all along the gas value chain, it must be handled and transported safely (e.g. in well-sealed pipes).

Table 3 summarises these characteristics and how they influence the value chain.

Table 3. Impacts of the characteristics of gas an each part of the value chain

	Upstream	Networks	Retail	Enabling technologies
Required to meet basic needs		Reliability of gas supply is important	Government intervention to protect vulnerable customers	Government intervention to help vulnerable customers
Networks are the most cost-effective method of mass transport		Networks are natural monopolies, regulated by Ofgem.	No differentiation in quality of supply	
Gas demand and supply must be matched	There is a role for storage operators	High capacity required. There is role for storage within the networks and for a central System Operator	There is interest in managing demand over days and weeks	
Consumption of gas can only be measured periodically			Limited capacity to influence demand over days and weeks	
Boilers are flexible. Reliability and efficiency can vary				Information and regulation around product standards can be important
Environmental externalities	Government intervention to reduce production emissions	Regulatory incentives to reduce emissions from leakages	Incentives to encourage energy efficiency	
Safety issues	Health and safety regulation is required all along the gas value chain to ensure processes and technologies for handling gas are safe			

9.4.1 Policy environment

As illustrated in **Table 3**, several of the characteristics of gas have led to significant policy intervention in the sector[106]. These factors all apply to electricity (discussed further in Annexe 5) also.

- **Use of gas and electricity to meet basic needs.** Because gas and electricity are required to meet some basic needs, DECC and Ofgem intervene in the market to protect vulnerable customers, for example through the Green Deal and the Energy Company Obligation (ECO).

106 A detailed overview of policy and the legislative framework is set out in Annexe 2.

- **Natural monopolies in networks.** Because of the monopoly characteristics of gas and electricity networks, Ofgem sets price controls for transmission and distribution.

- **Security of supply.** DECC and Ofgem monitor the security of supply and intervene where they view the market is not working.

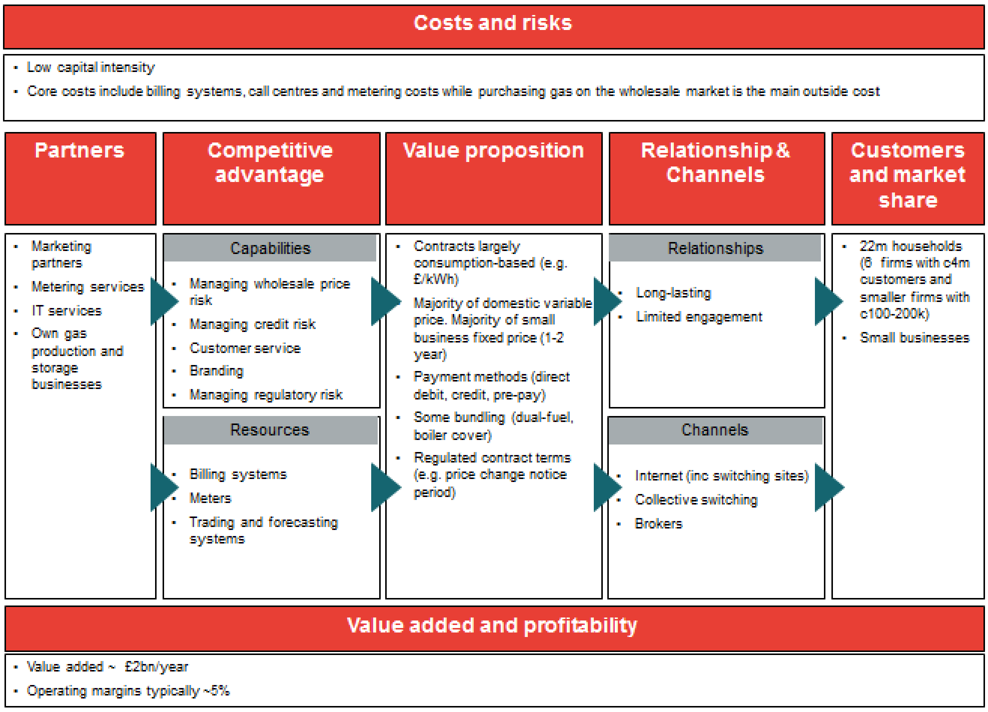
- **Environmental externalities.** DECC has implemented a wide range of policies to reduce the emissions from gas and electricity production and use.

In Annexe 1, we described the business model canvas, and how we use this as a framework for analysis of the value chain. We now go on to apply this framework to each part of the value chain.

9.5 Gas retail business model canvas

This section describes the retail sector, again using the business model canvas framework. **Figure 20** shows the business model canvas.

Figure 20. Gas retail business model canvas



Source: Frontier Economics, adapted from the Business Model Canvas from BusinessModelGeneration.com[107]

9.5.1 Costs and risks

The costs and risks associated with purchasing gas from the wholesale markets and selling it on to customers have a major impact on the way that gas retail business models have developed.

- **Cost structures**. Gas retail has a relatively low capital intensity. For example, over the last 5 years, Centrica's capex as a proportion of total expenditure (capex plus opex) for their retail business (including gas and electricity) has been 5% on average.[108] Significant operating costs are associated with billing, metering services, call centres and energy efficiency obligations (ECO, CERT, CESP) along with outside purchases of gas and payment of network charges.

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107 **Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.**

108 Calculations based on Centrica Annual Reports 2007-2011

- **Risks**. Key risks facing gas retailers include:
  - **Wholesale price risk**. Wholesale gas prices can be volatile. Some of this volatility can be passed onto consumers in variable price tariffs (but there are regulatory limits on the frequency of price changes), while for fixed price tariffs the retailer must manage the wholesale price risk and this can be a major issue for smaller retailers. This is discussed further in the contractual arrangements annexe.
  - **Credit risk**. Some customers may not pay their bills on time or at all.
  - **Reputation risk**. Relationships between gas companies and their customers are not always characterised positively. Negative press coverage can cause reputational risk for gas (and electricity) companies (Figure 21).

Figure 21. Examples of press coverage

Frozen to death as fuel bills soar: Hypothermia cases among the elderly double in five years
(Daily Mail, Feb 2012)

Ofgem's impotence
(Guardian Letters Page, March 2011)

How many venal fatcat energy companies does it take to power a lightbulb?
(Mirror, Oct 2011)

Energy giants 'overcharge families' as bills keep rising
(Telegraph, Feb 2012)

Source: Various

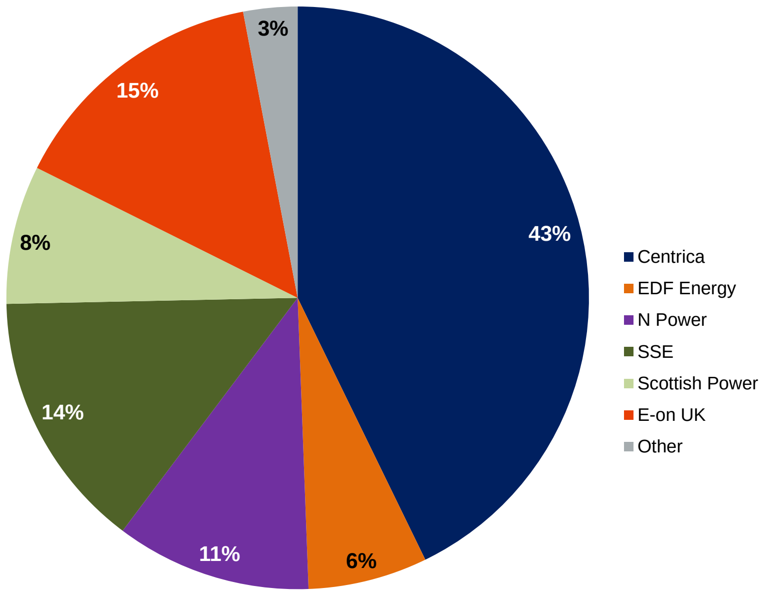
Customers and market share

Between them, gas retail businesses serve 22m domestic customers as well as a large number of small business customers[109]. The six largest gas retailers represent around 99% of the domestic market and 70% of the small business

109 DECC (2012), *Energy Consumption in the UK: Domestic Data Tables*. Data for small business customers is not available.

market.[110,111] The market shares for the domestic and small business markets in retail are shown below in Figure 22.

Figure 22. Retail gas market shares



Source: OFGEM Retail Market Review, 2011 Segmental Statements for "big six" retailers

The current pattern of ownership has been influenced by historical ownership structures. Until the late 1980s the gas industry was represented by one vertically integrated incumbent monopolist (British Gas). It was then privatised with Centrica acquiring the retail, trading and upstream production business. Competition in gas retail was gradually introduced in the 1990s with competition in the domestic sector introduced in 1998. Since then, Centrica's incumbent retail market share has remained high, but has been eroded from 63% in 2002 to 44% in 2011. The share has been absorbed relatively evenly by the other members of the "big six", most significantly by SSE, with only around 3% of the domestic and small business market accruing to new entrants. It is notable that until a few years ago retail margins in gas were negative which may be explained by electricity retailers accepting losses whilst they entered the gas retail market.

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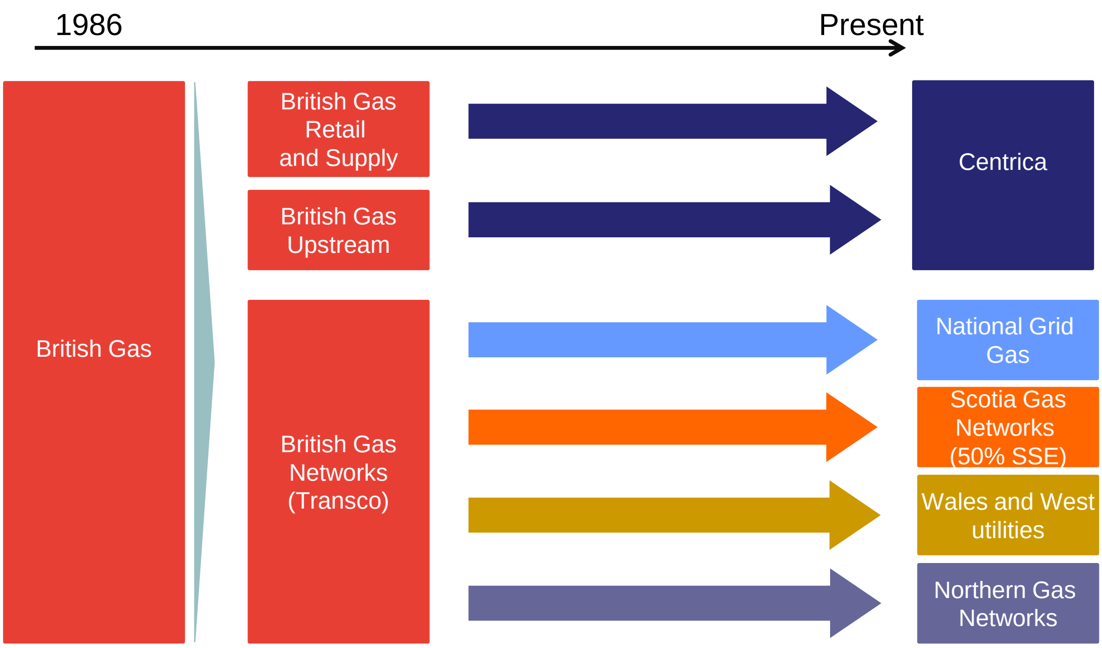
110 OFGEM Retail Market Review (2011), *Segmental Statements for "big six" retailers*; Ofgem (2012), *Retail Market Review: Updated Proposals for Businesses*

111 Small and micro businesses can obtain their supply of electricity and gas either directly from the energy companies or through brokers. There are 32 retailers of varying sizes, from small companies to large multinationals, supplying the non-domestic market.

Figure 23. Breakup of British Gas following privatisation



Source: Frontier Economics

Relationship and channels

The relationship of energy retailers with their customers tends to be long term, but with low-engagement from the customers. Legacy customers are still important. At the end of September 2012, 42% of domestic gas customers were still with their legacy retailer.[112]

The overall switching rate for gas customers has varied between 13-20% in recent years.[113] For gas, electricity and dual fuel, rates of switching differ across customer, with direct debit customers being more likely to switch than Standard Credit customers.[114] Ofgem has found that internet access is strongly associated with switching – the switching rate in 2009 was 20% for those with internet and only 10% for those without.[115] Ofgem research in 2010 found that door step selling remained the most frequent method, but that internet research was increasing in importance. In 2009, around a third of customers switched because

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112 DECC (2012), *Quarterly Energy Prices*

Ipsos MORI (2012) *Customer Engagement with the Energy Market – Tracking Survey 2012, Report prepared for Ofgem,*

114 DECC (2012), *Quarterly Energy Prices,*

115 Ofgem (2010), *Update on Probe Monitoring*

of door step sales, and around a quarter via online comparison sites.[116] However, following controversies around miss-selling all the major energy retailers have now abandoned door step sales[117]

Meanwhile, collective switching is growing in importance. Collective switching schemes bring consumers together to negotiate a group deal with their gas and electricity retailers, usually with a third party actively negotiating a better tariff for the group. In 2012, Which? and 38 Degrees ran the UK's first collective switching scheme, called the Big Switch. Over 37,000 people switched to a better deal under this scheme, gaining average savings of £223 a year.[118] DECC launched the £5 million Cheaper Energy Together fund to support the development of collective purchasing and switching schemes by local authorities or third sector organisations in GB.[119]

Brokers have an important role connecting small business to retailers. A survey by Ofgem found that over 40% of small businesses used energy brokers for gas contracts without dealing directly with retail suppliers.[120]

The relationships and channels between gas producers and retailers are dealt with in the upstream gas business model canvas.

Value propositions

Retailers offer value propositions directly to domestic and small business gas customers. We first consider the tariffs offered to domestic consumers. These can be described in a number of dimensions:

- **Payment methods**. Just over half of domestic customers pay monthly by direct debit with the remainder split by credit (quarterly billing) and pre-payment meters[121].

- **Consumption versus standing charges**. The majority of the domestic gas bill is generally represented by a variable charge (an average charge of £40/MWh in 2012) and a smaller fixed charge (£180/year). The fixed charge is usually designed to cover the fixed costs associated with retail supply (e.g. billing, call centres, metering and network charges). Based on an average

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116 Ofgem (2010) *Update on Probe Monitoring,*

117 http://www.bbc.co.uk/news/business-18708161 (accessed 02/03/12)

118 http://www.whichbigswitch.co.uk/closed/ (accessed 02/03/12)

119 DECC, https://www.gov.uk/collective-switching-and-purchasing (accessed 02/03/12)

120 Ofgem (2011) *Small and Medium Business Consumers' Experience of the Energy Market and their Use of Energy*

121 DECC(2012) *Domestic Energy Price Statistics*

annual household consumption of 18 MWh this implies the variable charge represents 82% of the total bill of £1000/year[122].

- **Variable versus fixed pricing**. Around three-quarters of domestic gas and electricity customers pay on a variable price basis, where the retailer may change price periodically[123]. This means retailers are able to pass on long-term wholesale price risks to such customers. For the remainder on fixed price contracts, contract lengths are between 1 and 2 years and therefore retailers are only taking on price risk within this timescale.

- **Length of contracts and churn**. Customers who are on a variable tariff are typically not locked into any contract period and can switch when they like. A fixed tariff deal will typically last 12-18 months. In 2011 13% of domestic customers switched gas retailer (with switching rates higher for those paying direct debit). Ofgem analysis suggests that many customers are slow to switch – over 63% of households report that they have never switched gas retailer[124].

- **Bundling**. Most customers pay for their gas and electricity together. The number of 'dual-fuel' customers (i.e. purchasing electricity and gas together) is currently around 75% of the domestic market. Given the number of households without a gas connection, this is around 85-90% of the potential market for gas.[125] A number of gas contracts are also sold together with boiler, central heating and plumbing maintenance contracts – these are typical structured like an insurance contracts with an annual or monthly fixed-fee.[126] These are discussed in more detail in the enabling technologies annexe.

Regulation and policy have a major influence on the gas retail value propositions. For example, some contract terms are regulated (e.g. price changes must be notified 30 days in advance). In addition, generally, there has been decreasing trust in the power of competition and increasing regulation for both gas and electricity (Figure 24). In 2011, Ofgem's Retail Market Review[127] concluded that

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122 Frontier calculations based on based on DECC (2012) *Domestic Price Statistics*

123 Over 55% of direct debit customers and 85% of standard credit customers are on fixed price tariffs. DECC, 2012, Tariff type variation in the domestic energy market.

124 Ipsos MORI (2012), *Customer Engagement with the Energy Market – Tracking Survey 2012, Report prepared for Ofgem*. Note some customers will switch retailer by default when they move house.

125 Cornwall Energy (2013), *Energy Spectrum: Issue 361*

126 British Gas's fixed-fee service and insurance contracts are typically for twelve months. They include insurance cover for central heating, boiler and controls, plumbing and drains and electrical appliances. Benefits "generally include repair and/or replacement of the items affected."

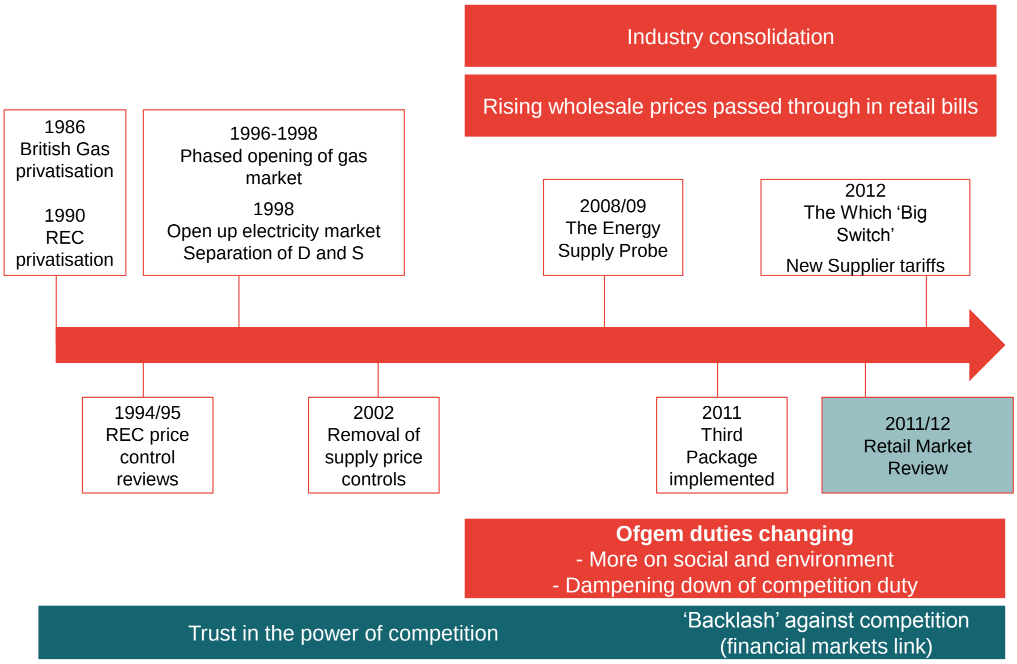
127 Ofgem (2011), *Retail Market Review*

competition in the market was not working effectively and that consumers are not switching because they are not engaged in the market. In particular, Ofgem concluded:

- there are too many tariffs;
- the tariffs and their terms and conditions are too complicated; and
- information provided is confusing/misleading.

In response to this, new Ofgem reforms to retail pricing are due to come into force from this summer. These aim to make the market simpler by restricting retailers to offering no more than four simple core tariffs each in electricity and gas.[128]

Figure 24. Retail competition: policy context



Source: Frontier Economics

Policies also obligate retailers to be active in energy efficiency. Under the Energy Company Obligation (ECO) energy retailers are obliged to deliver a certain amount of carbon emissions savings and heating cost reductions (for vulnerable groups) on behalf of their customers. These can be delivered through a variety of energy efficiency measures. The costs of this obligation are recovered through

128 Ofgem (2013), Press release, http://www.ofgem.gov.uk/Media/PressRel/Documents1/RMR%2021-02-13.pdf

customer bills. These apply to electricity retailers also and are covered in detail in the contractual arrangements annexe.

For small businesses, the typical nature of gas contracts is different. Although tariffs are still largely based on consumption, over 65% of small business tariffs are fixed price, typically for a period of 1-2 years.

New entrant retailers have also used a number of different offerings to attract customers.

- **Green or ethical tariffs.** Companies like Good Energy market tariffs based on the supply of energy from low-carbon or renewable sources.[129] Cooperative Energy markets itself as an ethical provider,[130] and companies like First Utility offer smart tariff packages, including a smart meter.[131]
- **"White label" or "affinity" deals** where supermarket brands act as a front for one of the larger retailers' businesses. The two main players in this market are Sainsburys (British Gas) and M&S Energy (SSE). There is no information on the market share of these products[132]. However, they were deemed to be important enough for Ofgem to change its RMR proposals to put in place measures to allow the schemes to continue[133]. Competition in this area relies on the strength of the white label brand and the additional benefits they can offer energy customers in terms of access to loyalty schemes and vouchers.
- **Tariffs bundled with other utilities.** The six largest retailers do not currently offer bundled tariffs including energy and other utilities. Bundled tariffs are however available in the UK (e.g. Utility Warehouse offers bundled telecoms and energy tariffs). These have not yet been widely adopted. Utility warehouse have 450,000 domestic and small business customers.[134] Commentators have suggested that while the tariffs are in line with mainstream offerings from other retailers, they can be around 20% more expensive than the best deals[135]. However, shopping around for the best deals individually can be time consuming. Therefore consumers may

129 http://www.goodenergy.co.uk/ (Accessed 05/03/13)

130 http://www.cooperativeenergy.coop/why-us/why-we-are-different/ (Accessed 05/03/13)

131 http://www.first-utility.com/home-energy/smart-tariff (Accessed 05/03/13)

132 Customer numbers are attributed in Ofgem's published data to the licensed supplier rather than the white label retailer.

133 The original proposals for limiting the number of tariffs that retailers could offer would have essentially ended these white label offerings.

134 https://www.utilitywarehouse.co.uk/static/about_us (Accessed 05/04/13)

135 http://www.guardian.co.uk/money/2009/dec/05/utility-warehouse-telecom-plus-distributor

benefit from the time savings associated with bundled deals. There are recent examples of retailers offering energy tariffs as well as other utility tariffs separately. For example, Sainsbury's offers an energy tariff supplied by EDF Energy and telecoms tariffs (some of which are in partnership with TalkTalk). These tariffs are not bundled but they do fall under one overarching brand, and suggest that some consumers are interested in more unified utility retail offers, which is already a feature in other countries.[136]

Competitive advantage

As gas is a homogenous product, competition must focus on factors other than the quality of the product itself. Since customers have a limited ability to differentiate between offerings in terms of quality, gas retailers primarily compete on price through a business model focussed on delivering a basic energy supply service at lowest cost.

The features of competition of a homogenous product means that purchasing strategy, financial risk management, marketing are of most importance. In particular, competitive advantage is driven by capabilities such as risk management, branding and customer service and resources such as billing, trading and forecast systems.

More specifically, sources of competitive advantage in gas retail include the following:

- quality of service (for example ease of payment and accuracy of billing);
- promoting loyalty, for example through reward schemes (e.g. over four million British Gas customers are enrolled on the Nectar loyalty programme[137]);.
- operational efficiency, including efficient billing and metering (e.g. online billing);
- wholesale trading and risk management, including opportunities to reduce costs and risks around procuring electricity through ownership of upstream gas production and storage assets; and

offering complementary and/or bundled services, for example boiler maintenance.

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136 For example in Australia: http://www.greentechmedia.com/articles/read/bundling-energy-and-telecom-down-under (Accessed 05/03/13)

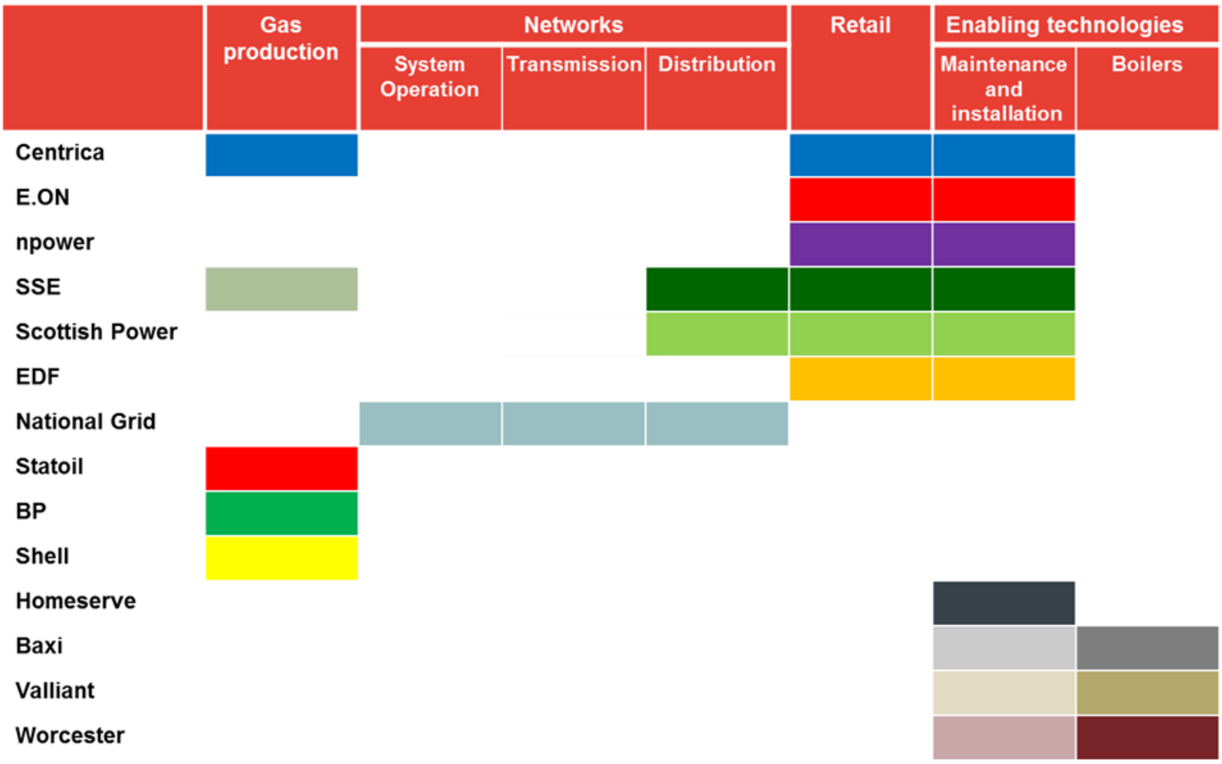
137 Centrica (2011), *Annual Report and Accounts 2011*

The gas value chain is characterised by some vertical integration between retail, boiler installation/maintenance and, to a lesser extent, gas production and storage. This is described in Figure 25.

A few gas retailers are integrated into firms who also have significant UK gas production assets (e.g. Centrica and to a lesser extent SSE) and most also have some gas storage assets. However, there is noticeably less vertical integration in the gas sector than in the electricity sector. This may reflect lower risks around retailers being able to meet customers' demand from the gas market. For example, gas production is a global market with many different players and potential sources (e.g. North Sea, interconnectors and LNG imports). Moreover, gas is more easily stored which is reflected in the market arrangements where balancing takes place on a daily rather than a half-hourly basis. Thus gas retailers are not exposed to the short term price spikes seen in electricity. Nevertheless, many gas retailers do appear to be attempting to manage some gas price risk through ownership of gas storage assets (Centrica, SSE, Scottish Power, E.On and EdF all own gas storage assets which Centrica owning around 70% of the total capacity).

All the major gas retailers also offer boiler servicing and maintenance contracts. This may be partly driven by the benefits in terms of customer retention. Finally, many of the large retailers are also active in gas retail in other markets across Europe (e.g. EdF, E.ON, RWE).

Figure 25. Major players in the gas value chain



Source: Frontier Economics

Partners

The two key interactions for gas retail suppliers are with gas producers and storage operators - from whom they purchase generation through a variety of contracts - and consumers whom they sell gas to. The former is covered above and the latter is covered in the section on upstream gas. They may also partner with third parties for metering services (see Annexe 11).

Value added and profitability

The total value added of gas retail for the domestic and small business market is around £2bn/year.

Returns on capital in retail are very high, of the order of 100%. However, this measure is not very meaningful in the gas retail context, given the limited capital employed in the sector. Profitability of this sector is normally described in terms of margins relative to total revenue. These have fluctuated between 0.7% and 9.0% over the last 5 years.[138]

9.6 Gas networks business model canvas

This section describes the gas networks sector (transmission and distribution) based on the business model canvas framework. Figure 26 shows the business model canvas for gas networks. System operation is covered in Box 4.

Gas networks businesses are all run as regulated monopolies. There is one gas transmission network (owned by one company) and eight gas distribution networks (owned by five companies)[139]. There are also a number of smaller networks which are extensions to area networks owned by Independent Gas Transporters (IGTs). A competitive market for connections has been introduced[140].

The System Operator function, which has residual responsibility for ensuring demand and supply balance, is also run as a regulated monopoly by National Grid.

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138 Ofgem (2013), *Electricity and Gas Supply Market Indicators*

139 Measures of market shares are not appropriate for networks since they are operated as geographically-separate monopolies.

140 Competition has grown rapidly in the gas connections area, to the extent that more than half of all connections are now installed by Utility Infrastructure Providers (UIPs) or Independent Gas Transporters (IGTs) rather than the former monopoly incumbent network provider

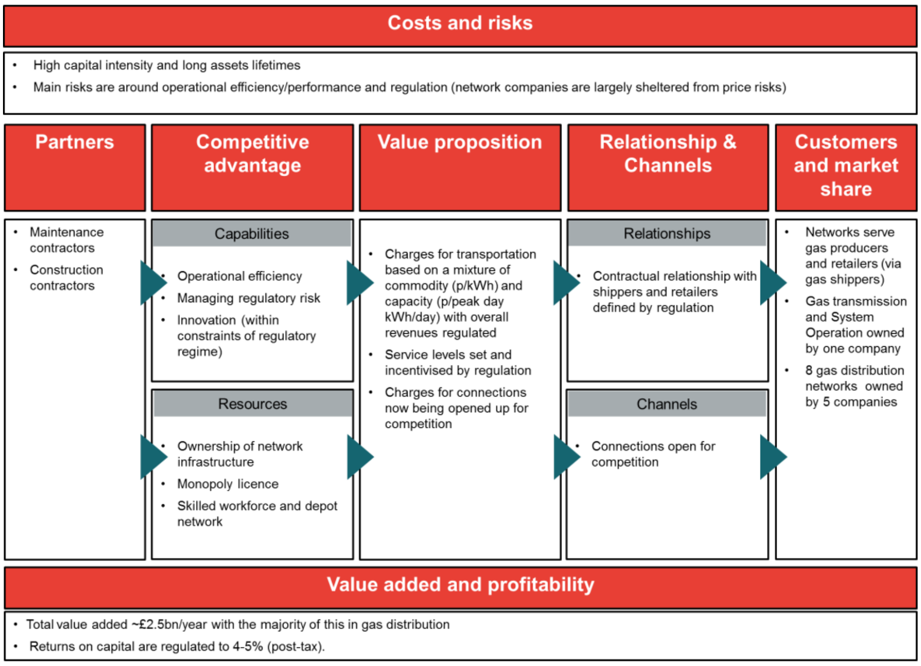
Box 4: Gas system operation

Gas travels through the gas transmission networks at roughly 25mph. Therefore, to ensure demand can be met the consistently, demand and supply must be carefully managed. Much of the management is delivered by gas producers, storage operators and retailers (including shippers) who are incentivised under the gas market arrangements to ensure the system is balanced. However, the System Operator also has responsibility for resolving any residual imbalances and ensuring the system is robust to shocks.

The System Operator achieves this by buying and selling gas (and using its own stored gas) to ensure demand can be met with high reliability. Usually this achieved by purchase of gas on the open market (the 'On the day Commodity Market').

System Operation is run as a regulated monopoly with incentives for managing the system efficiency provided under this framework. It is owned by National Grid. The total value added is small relative to other parts of the value chain, at less than £200m/year

Figure 26. Gas networks business model canvas



Source: Frontier Economics, adapted from the Business Model Canvas from BusinessModelGeneration.com[141]

9.7.1 Costs and risks

Gas networks are highly capital intensive businesses, although much of this capital investment was made in the past. For example, capital and repair expenditures represent around 60% of current expenditure for Gas Distribution Networks with operating expenditures representing the remainder.[142]

Approximately two-thirds of this capital expenditure is allocated for the replacement of iron mains in the current network.

Current operating expenditure is made up of the following;

- direct operating costs such as inspection costs, repairs and maintenance property, accounting for around 33% operational expenditure;
- business support functions such as finance and HR make up a further 13% of operating expenditure;

141 **Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.**

142 Ofgem (2012), *RIIO-GD1: Initial Proposals for Gas Distribution Networks (GDNs) - Headlines*

- "close-to-direct" costs such as IT and telecoms systems and operational training make up a further 21% with the remainder made up of non-controllable operating costs.[143]

The gas transmission operator National Grid Gas reported roughly twice as much capital expenditure to operating expenditure in 2010-11.[144]

To understand the risks facing the gas networks, we need to understand the regulatory system. As gas networks are natural monopolies, Ofgem regulates the companies to protect customers' interests. The price controls set the maximum amount of revenue which energy network owners can take through charges they levy on users of their networks to cover their costs and earn them a return.

Regulation of networks in both the gas and electricity sectors is going through a period of change. Since privatisation, GB gas networks have been regulated under an 'RPI minus X' framework. Under this framework, revenue allowances are fixed in advance for five years (the price control period). Adjustment of revenues has been allowed during the price control period for specified variables (e.g. changes in the volume of gas transported, customer numbers or other costs over which the networks have no control), for inflation and for certain types of costs that may be highly unpredictable (such as the costs of funding pension schemes). The network gains a financial benefit if it can outperform the underlying assumptions of the allowed revenue calculation, and faces a financial cost if it underperforms.[145] In addition, networks have been provided with incentives to deliver target levels of quality of service as well as environmental and social goals.

For the next price control period, from 2015, Ofgem is moving to a new performance-based RIIO (Revenue=Incentives+Innovation+Outputs) model. RIIO will retain the current system of an upfront price control so companies know the revenue they are allowed to earn, adjustments for inflation and a return on the regulatory asset value. However, under RIIO, companies will have to meet performance targets or face automatic penalties. The RIIO framework is also designed to reward innovation. The price control period is longer, and rewards are linked to delivering results. Smaller independent networks, which are called

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143 Ofgem "RIIO-T1: Final Proposals for National Grid Electricity Transmission and National Grid Gas" available at http://www.ofgem.gov.uk/Networks/Trans/PriceControls/RIIO-T1/ConRes/Documents1/3_RIIOT1_FP_Uncertainty_dec12.pdf

144 Ofgem "Transmission Annual Report for 2010/11" available at http://www.ofgem.gov.uk/Networks/Trans/RegReporting/Documents1/Transmission%20Annual%20Report%202010-11%20Final.pdf

145 Ofgem (2007), *History of Network Regulation*

independent gas transporters (IGTs) and are mainly built to serve new housing developments, are subject to 'lighter touch regulation.[146]

Safety is also a key part of the regulatory framework for gas network operators and a risk they must manage. The Health and Safety Executive (HSE) has primary enforcement responsibility for gas safety. This includes a requirement for each network owner to prepare a Safety Case, showing how it is safely managing the flow of gas. The Safety Case has to be accepted by HSE before gas can be transported. Safety can also be an important driver of cost. For example it was a requirement of the HSE that the networks undertook an accelerated programme for the replacement of iron pipes with polyethylene pipes because of the risk of a catastrophic incident, and the consequent effect this might have on public confidence[147].

In the past, the system of regulation has meant that networks are generally low-risk businesses as the price control removes much of the risk around revenues. The main risks facing networks business are around operational performance (including safety) and efficiency along with regulatory risk. This situation is unlikely to change substantially in the move to RIIO, although strengthening incentives may imply greater risks.

9.7.2 Consumers and market share

Gas networks physically serve consumers (including households and small businesses). Their main commercial customers are gas shippers. These gas shippers intermediate between gas producers and retailers, arranging and paying for transportation services from networks businesses. They are often integrated into retail businesses.

Measures of market shares are less relevant for networks as they are operated as geographically-separate monopolies. There is one gas transmission network in GB owned by one company (National Grid). There are 8 gas distribution networks owned by a total of 5 companies. In addition there are also a number of independent gas transporters (IGTs) which are typically built to serve new housing developments. National Grid owns the System Operation function of the gas networks.

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146 In 1995 the Gas Act 1986 was amended to allow for the creation of Independent Gas Transporters (IGTs), which develop, operate and maintain local gas transportation networks. These have mainly been built to serve new housing developments and approximately 1m customers are now connected to these networks in GB. Since they are also monopoly networks, they also require a licence and are subject to regulation. Although this is less onerous than the regulation applying to the eight principal regional gas networks, it largely restricts the charges that the IGTs can levy and the service they offer

147 Cambridge Economic Policy Associates for HSE/Ofgem (2011), *10 year review of the Iron Mains Replacement Programme*

Some networks firms are integrated into firms which have other networks businesses (e.g. National Grid also run electricity transmission networks) and one gas distribution network is owned by a firm which also has a retail gas business[148] (although these must be run under strict business separation).

9.7.3 Relationships and channels

The relationships and channels for gas networks are largely defined by how they are regulated as natural monopolies. Although the gas distribution networks have a physical link to domestic and small business customers' premises, the commercial relationship between networks firms and the end customers is limited by the regulatory license. However, in recent years, Ofgem has been trying to encourage gas distribution network (GDN) companies to engage with retailers (and others in the value chain) to ensure value is maximised throughout the value chain as we move to a low-carbon economy.[149]

While the regime for charging existing customers is based on regulation, over the last decade the market for connections has been opened up to competition by Ofgem. This creates a more open channel for customers wishing to connect to the gas networks to engage with alternative companies to their local GDN. Customers wishing to connect to a distribution network have three options available to them.[150]

- **Incumbent GDN.** The customer can pay the incumbent GDN an upfront fee to install the connection. The incumbent may choose to subcontract some of the construction work and will then operate the assets in return for annual Distribution Use of System (DUoS) charges, which the customer will pay through their bill to their retailer.

- **Independent Gas Transporters (IGTs).** A customer can also purchase a connection from an independent distribution licensee**.** IGTs can install and operate networks to new multiple connections- typically new build housing estates. The independent network connects to the incumbent network. To date, these networks are more common in gas than they are in electricity. The IGT will usually undertake the connection work for an upfront fee, and

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148 Scotia Gas Networks (SGN) are 50% owned by SSE.

149 For example, The Network Innovation Competitions are "annual competitions for electricity and gas, where network companies compete for funding for research, development and trialling for new technology, operating and commercial arrangements. Funding will be provided for the best innovation projects which help all network operators understand what they need to do to provide environmental benefits and security of supply at value for money as Great Britain (GB) moves to a low carbon economy"

150 Ofgem (2011), *Connections Industry Review 2009-10*

then operate the assets, again recovering their costs through DUoS charges through the retailer.

- **Utility Infrastructure Provider (UIPs).** UIPs are accredited to undertake connection works on gas networks. They may be affiliates of GDNs or IGTs or may be independent. A customer can contract with an UIP to install a connection to a GDN or IGT network for an upfront fee. However, the UIP is not licensed to operate the network and will transfer ownership of the asset the GDN or IGT for a fee once it is installed. Some UIPs are bringing in expertise from other utility sectors. For example, Veolia Water Infrastructure Services is active in the electricity and gas connections markets as an UIP.[151]

The development of a competitive connections market has developed faster in gas than it has for electricity. In 2010/11 around half of connections were made by the incumbent GDN with the remaining made by IGTs or Utility Infrastructure Providers (UIPs).[152]

9.7.4 Value propositions

The value proposition of networks businesses is largely defined by regulation.

- **Regulation determines the service being offered:** To be able to transport gas, transmission, distribution and independent network operators must hold a licence. The licences contain conditions which largely limit the activities of the companies and the value propositions that they are able to offer. For example, among other requirements, the licences put constraints on the quality of service and outputs that must be offered. Therefore policy essentially drives the service offerings.

- **Regulation determines the structure and overall levels of transportation charges**. The amount of revenue which networks companies can recover from customers and the structure of charges by which this is achieved are largely determined by regulation. Charges are typically a mixture of a commodity charge (p/kWh), a capacity charge (p/peak day kWh/day) and a standard charge (p/day)

9.7.5 Competitive advantage

As networks are regulated monopolies they do not directly compete with other firms. Therefore their competitive advantage largely stems from how they

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151 http://www.veoliawater.co.uk/uk-water/ressources/documents/1/43217,DRYHOLME-Case-Study-FOR-WEB.pdf , accessed 05/03/12

152 Ofgem (2012), *Connections Industry Review 2010-11*

perform relative to the regulatory incentives. In particular their competitive advantage is dependent on:

- **Operational efficiency and performance**. With revenues regulated, ensuring that operation and capital costs are incurred efficiency is very important. Revenue can also be improved under the regulatory framework by improving performance (e.g. safety and reliability);and
- **Managing regulatory risk**. Networks businesses need to manage the price control process to ensure their allowed revenues are fair and that the business is viable. In addition, the risks associated with meeting other regulatory requirements can be high and may not be fully compensated for in the price control. For example the Health and Safety Executive's iron mains replacement programme introduced in 2002 required at risk iron gas mains to be decommissioned within 30 years. Between 2002/3 and 2009/10, GB gas distribution networks reported that they spent £4.8bn on the policy[153].

Innovation is also likely to become an increasingly important source of competitive advantage for gas network operators under RIIO.

9.7.6 Partners

While the commercial relationships with other parts of the gas value chain are limited by regulation, many networks firms will contract to third parties for some maintenance and construction services.

9.7.7 Value added and profitability

The value added on the gas transmission networks (attributable to domestic and small business) is around £0.3bn/year. The total value added of the gas distribution networks is much higher at £2bn/year.

The profitability of the gas networks businesses is largely determined by the target rates of return set by the price control,[154] which are in turn factored into the allowed revenues. Typical allowed returns on capital for gas networks are between 4% and 5%. The actual returns received depend on how networks businesses perform relation to their targets and incentives.

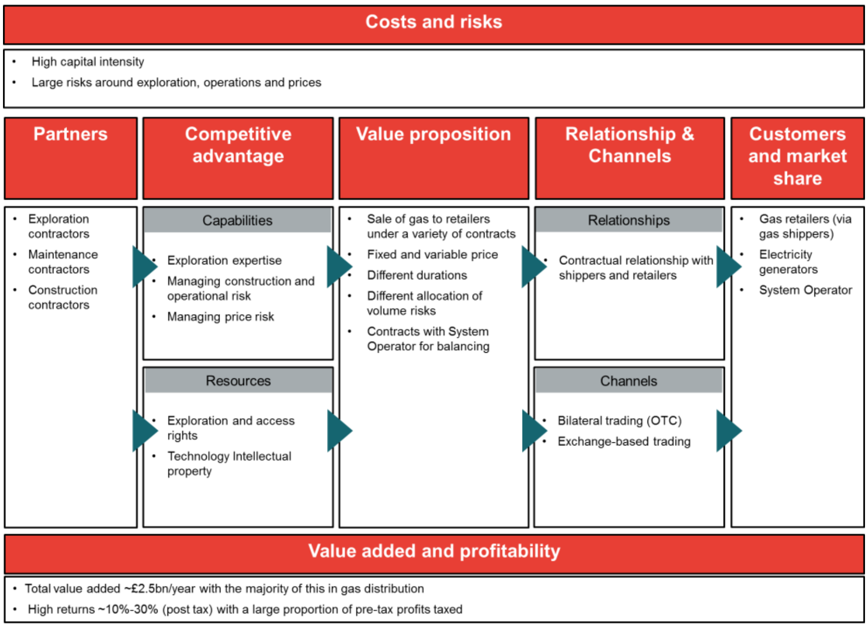
153 Cambridge Economic Policy Associates for HSE/Ofgem (2011), *10 year review of the Iron Mains Replacement Programme*

154 These are set according to assessments of the costs of capital facing networks businesses.

9.8 Upstream gas business model canvas

This section describes the upstream gas sector (in which we include gas production and large-scale gas storage as well as considering imports via interconnectors and LNG) based on the business model canvas framework. Figure 27 shows the business model canvas for upstream gas.

Figure 27. Gas upstream business model canvas



Source: Frontier Economics, adapted from the Business Model Canvas from BusinessModelGeneration.com[155]

9.8.1 Costs and risks

Upstream gas production is a relatively capital-intensive business. At present, capital expenditure represents around 50% of total expenditures on oil and gas production in UK Continental Shelf (UKCS). Given that the oil and gas production in the UKCS is a relatively mature industry, much of the capital investment has taken place in the past this much likely understates the capital-intensity of the industry. The largest component of capital costs is the drilling of

155 **Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.**

development wells which currently represents 52% of spend.[156] Gas storage (typically in underground caverns) is also a capital intensive business.

Gas producers are exposed to a wide range of risks. Some of the most prominent include:

- operational risk (including those around 'blowouts' of offshore gas wells);
- price risks (i.e. volatility in wholesale gas prices); and
- exploration risks around the viability and the resource in gas fields and much of the capital spend is represented by development drilling.

Reflecting the high capital requirements for gas production and the high risks associated with it (e.g. exploration, operational) and the fact that it is a global market, UK gas production is currently composed largely of multinational oil and gas majors.

For gas storage operators the risk profile is slightly different. Operational risk and price risk are both important. However, in the latter case volatility in prices is crucial to the viability of the business. Depending of the type of store (e.g. diurnal versus seasonal), volatility in daily or seasonal prices can be more important. In gas storage, most of the large gas retail suppliers are active as well as some oil and gas majors which may provide these firms with advantages managing risks around gas price volatility.

9.8.2 Consumers and market shares

The market for gas production is represented by a diverse range of players operating in the UK Continental Shelf (UKCS) while around 50% of gas used in GB comes from by imports via interconnectors or LNG terminals. Most gas production infrastructure in GB (and beyond) is owned by large oil and gas majors who are horizontally-integrated in markets across the world. This size allows firms to spread the risks around exploration and operations across a large number of projects and to generate economies of scale. The UK now imports around 50% of its gas from overseas.[157]

The levels of gas storage in GB are relatively small compared to other major countries in Europe. However, the market is growing with a number of new projects in the pipeline. Centrica has the largest share of the market with its

156 Scottish Enterprise (2012), *Spends and Trends UKCS 2012*

157 Centrica (2011) *Annual Report*

Rough facility (which represents over 70% of the storage capacity). E.ON, EdF, Scottish Power and SSE also own facilities which are much smaller.[158]

9.8.3 Relationships, channels and value propositions

The relationship between gas producers and storage operators and other parts of the value chain is largely a contractual one with gas shippers (and in turn retailers). Gas producers trade gas with shippers and retailers through a variety of contract types. These allocate price and volume risks between these parties in different ways and over different durations (e.g. fixed versus floating price contracts; fixed versus floating volume contracts).

Channels for trading may be over-the-counter (OTC), where two companies contract bilaterally (including via brokers), or exchange based where parties trade anonymously. The OTC market currently accounts for the majority of gas traded.[159] There is also some contracting with the System Operator where gas is brought/sold to ensure system balancing.

Gas can be purchased up to 4 years ahead and beyond to allow retailers to hedge price risks. However, most of the liquidity in the market is concentrated between two and 12 months ahead and is limited beyond two years ahead. The majority of trading volume is concentrated in seasonal products.

These channels and relationship are discussed in more detail in the contractual arrangements annexe.

9.8.4 Competitive advantage

Important sources of competitive advantage associated with gas production include:

- **Rights to exploration and ownership of gas fields**. A fundamental driver of competitive advantage is the ability to identify and access high quality gas fields. Access to the gas fields for exploration and development is determined by licensing rounds. The Petroleum Act 1998 vests all rights to Great Britain's oil and gas resources in the crown, but DECC grants licences that confer exclusive rights to explore for and exploit those resources. These licenses include annual rental charges to ensure licensees have an incentives to exploit the resource or pass the rights on.

- **Exploration, construction and operational efficiency**. Gas exploration, and the construction/operation of gas platforms are highly complex and

158 Reuters (2012) *Planned UK Gas Storage Facilities,* http://uk.reuters.com/article/2012/07/24/britain-gas-storage-idUKL6E8IC5WX20120724

159 Ofgem (2009), *Liquidity in the GB Wholesale Energy Markets*

technical requiring high skills, sophisticated technologies and risk management processes.

- **Managing safety risks and regulatory compliance**. The process for gas extraction is regulated to ensure safety. DECC provides guidance to companies on oil and gas field development plans as well as flaring and venting, and cessation of production and ensure these are followed.[160] The Health and Safety Executive (HSE) is responsible for regulating the risks to health and safety arising from work activities in the offshore industry on the UK continental shelf. Along with general health and safety law, HSE uses a number of specific legislation to regulate the oil and gas industry.[161]

For gas storage the sources of competitive advantages are slightly different. Construction and operational efficiency remain important. On the latter, the ability to managing the levels of gas in store to maximise the potential revenues from price volatility is particularly important.

9.8.5 Partners

Gas producers and storage operators use a wide variety of outside contractors to provide services around exploration, construction and operations.

9.8.6 Value added and profitability

The total value added of upstream gas (attributable to domestic and small business) is almost £7bn/year[162].

Much of the profits from UK gas production are transferred to the taxpayer. All UKCS gas fields are subject to a special tax on profits (currently this is between 61% and 82% of profits[163]). Despite this post-tax returns on capital are still typically well above 10%, reflecting the high risks involved in gas production (e.g. gas price risk and operational risks).

160 DECC (2013), *Oil and gas: fields and field development* https://www.gov.uk/oil-and-gas-fields-and-field-development

161 http://www.hse.gov.uk/offshore/law.htm

162 Not this number is highly variable given the volatility in wholesale gas prices.

163 Oil and Gas UK (2012), *Economic Report 2012*

10 Annexe 5: Electricity value chain map

This annexe presents our detailed analysis of the value chain for providing electricity to domestic and small business consumers in Great Britain. In this section we:

- describe what this value chain provides to domestic and SME consumers;
- present an overview of the value chain, the interactions and value at each stage;
- describe the business environment for companies operating in the electricity sector; and
- use the business model canvas framework to describe the business models in each part of the value chain, including looking at developments over time, and drawing out learning.

10.1 What is being provided to consumers?

We begin by describing the uses of electricity for domestic and SME consumers. We then discuss the features that electricity supply must have to be of value to these consumers.

10.1.1 Domestic and small business consumption

The domestic and commercial sectors consume 59% of UK electricity production (Figure 28). Domestic consumers typically use electricity to meet their lighting needs and to run appliances such as televisions and home computers. These uses account for 72% of domestic electricity consumption[164]. Electricity can also substitute for gas in cooking and heating: cooking accounts for 5% of domestic use of electricity use and heating accounts for a further 22%.[165] For households that use electric heating as their main source, heating use can be a substantial part of their electricity consumption.[166] For small businesses, a lower

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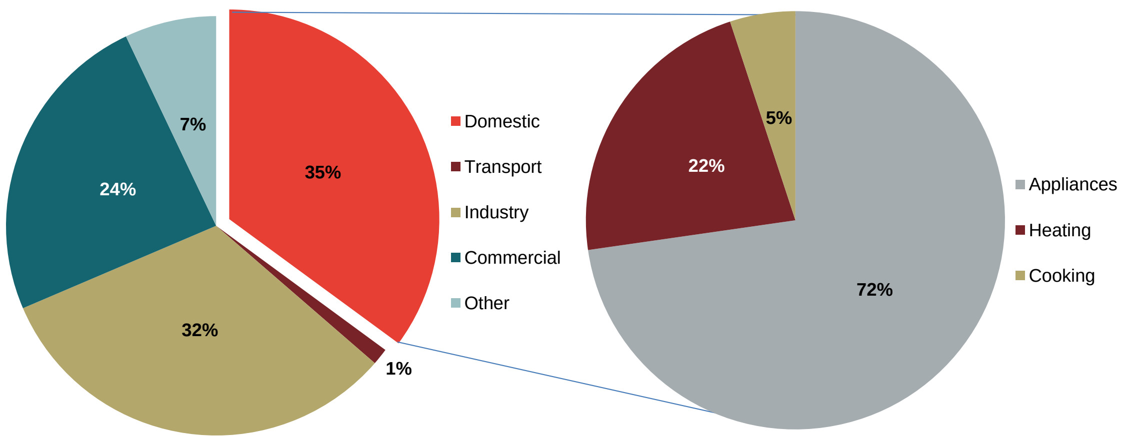
164 DECC (2012), *Bespoke analysis of data supplied by the Building Research Establishment and AEA Energy and Environment*

165 DECC (2012), *Bespoke analysis of data supplied by the Building Research Establishment and AEA Energy and Environment* Figures do not add up to 100% due to rounding.

166 In 2010, a household without electric central heating had an electricity bill of £10.47 a week, whereas a household with electric central heating had an electricity bill of £15.04. Assuming the difference is solely down to the central heating, this means that £4.57 a week (£203.76 a year) is spent on electric central heating, or 30% of their total electricity bill. This should be seen as a lower bnd on the proportion of electricity consumption used on heating in households with electric central heating, as these consumers often pay a lower price for this electricity (e.g. on Economy 7 tariffs, which charge lower prices overnight) and part of the typical electricity bill is fixed (rather than

proportion of electricity is used for lighting and a greater proportion used for heating and cooling[167].

Figure 28. Electricity consumption by sector



Source: DECC (2012) *Digest of UK Energy Statistics*, Table 5.2

Consumer demand for electricity varies over the course of the day, week and year although currently to a lesser degree than it does in the gas sector. For example, the peak daily annual demand is around three times higher than minimum annual daily demand. Peak demand during a given day can be around twice as high as minimum demand.[168]

10.1.2 Which characteristics of electricity are important?

To allow consumers to meet their appliance use, cooking and heating needs, the electricity value chain must deliver electricity reliably and to a certain quality standard.

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varying with usage). Table 2.6.2 of DECC Quarterly Energy Prices, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/49380/qep262.xls

167 Exact statistics are difficult to derive here as the DECC data defines a category for services rather than small business.

168 This is based on National Grid, 2012, Half-hourly Electricity Demands. Figures are for the electricity market as a whole, not just domestic and small business.

- **Reliability**. Electricity is expensive and difficult to store, particularly at domestic and SME level. It must therefore be provided to customers as they demand it. The reliability of electricity supply is important to consumers and so the cost of supply interruptions (e.g. blackouts) is high. Ofgem research estimates the costs of a one hour power outage to be between £0.30 and £26 for domestic users, whereas for non-domestic users the range is from £3/kWh to £180/kWh according to the 23 studies reviewed, with the costs for SMEs likely to be at the higher end of the scale.[169]

- **Quality**. Electricity must be provided at a consistent level of voltage (around 230V) and frequency (around 50Hz) to be useful. System frequency is determined and controlled by the second-by-second balance between system demand and total generation.[170]

The electricity value chain has developed in a way that allows these requirements to be met.

10.2 Overview of the value chain

In this section we describe each element of the value chain and look at the physical and contractual flows between each part. We then look at the overall value of the electricity sector, and where this value resides. Finally, we look at the breakdown of customer bills, in terms of the contribution of each part of the value chain.

10.2.1 Elements of the value chain

We divide the value chain into four parts.

- **Upstream.** There are two parts to the upstream generation sector.
  - The upstream fuel part of the value chain is responsible for producing and delivering fuel to generators.
  - The generation part of the value chain then transforms primary input such as gas, coal, and renewable resources into electricity. It must produce this electricity reliably (in the right quantities, at the right time) and with the required quality (e.g. voltage and frequency).

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169 Rekkon (2012), Desktop review and analysis of information on Value of Lost Load for RIIO-ED1 and associated work, http://www.ofgem.gov.uk/Networks/ElecDist/PriceCntrls/riio-ed1/consultations/Documents1/RIIOED1ConResVOLL.pdf

170 National Grid, http://www.nationalgrid.com/uk/Electricity/Balancing/services/frequencyresponse/

We focus on the generation part of the value chain in this Annexe. The characteristics of the upstream fuel market are covered for the case of gas in more detail in Annexe 4.

- **System operation.** National Grid has a licence obligation to control frequency within the limits specified in the 'Electricity Supply Regulations', i.e. ±1% of nominal system frequency (50.00Hz) save in abnormal or exceptional circumstances. National Grid must therefore ensure that sufficient generation or demand (or both) are held in automatic readiness to manage all credible circumstances that might result in frequency variations.[171]

- **Networks.** The electricity transmission networks provide high voltage connections between the many electricity generators around the country and the lower voltage distribution systems. The lower voltage distribution networks then deliver electricity to consumers including homes and small businesses.

- **Retail.** The retail part of the value chain is responsible for purchasing electricity from the wholesale market, selling electricity to consumers and managing the billing. As part of this, retailers are responsible for ensuring consumers have a meter.

10.2.2 Physical and contractual flows

Figure 14 describes the interactions that occur across the value chain. It describes two types of flows.

- **Physical energy flows.** Physical energy flows from left to right across the value chain. Primary fuels such as gas and coal feed into the electricity generation sector. Electricity produced by the generation sector is fed through the transmission and distribution networks[172] until it reaches consumers.[173] Consumers gain value from this electricity, through their use of appliances and enabling technologies.

- **Contractual relationships and financial flows.** Contractual and financial flows follow a more complex pattern in **Figure 29**. Consumers pay retailers

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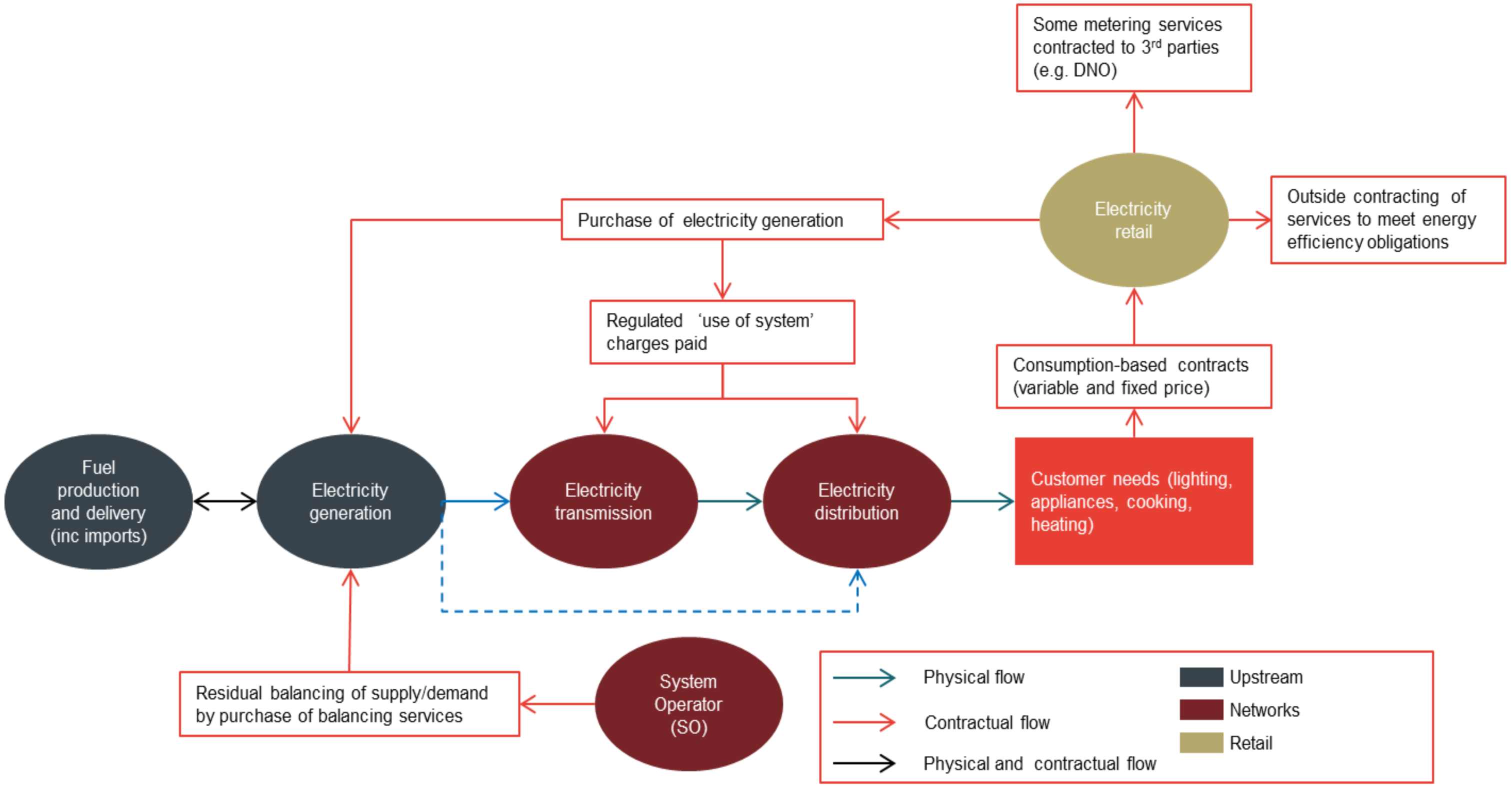
171 National Grid, http://www.nationalgrid.com/uk/Electricity/Balancing/services/frequencyresponse/

172 Smaller sources of generation, such as wind farms, may connect directly to the distribution network. This is referred to as “embedded” generation”, and is represented by the dotted line in the diagram.

173 Consumers with generation equipment (such as solar photovoltaic cells) may be able to reverse part of this flow, contributing electricity to the distribution network. However such embedded generation is likely to remain insubstantial compared to more centralised forms of generation for the foreseeable future, and so the related physical and contractual flows are not included here for clarity.

for the supply of electricity, usually through both a fixed and a variable charge. Retailers purchase electricity from generators, and both retailers and generators pay electricity transmission and distribution networks for use of their systems. There are also contractual relationships and financial flows between fuel producers, and electricity generators (electricity generators pay fuel producers for fuel) and between consumers and producers of appliances (consumers purchase appliances). Finally, the System Operator purchases balancing services from generators (and from some very large consumers).

Figure 29. Overview of the electricity value chain



Source: Frontier Economics

10.2.3 Value of the electricity market

The total value of the electricity market for domestic consumers and small business is around £12bn/year. **Figure 30** provides an overview of where value added[174] resides in the electricity value chain. This shows a spread of value added across the sector

- **Electricity generation** and the associated **fuel production** represent over £8bn in value added per year. The market for electricity generation is composed of a diverse range of players. The five largest generators represent about 60% of the market.

- The **electricity networks** (including system operation) businesses represent a smaller portion of value added, with distribution being the largest component.

- **Electricity retail** represents around £3bn per year in value added, similar to electricity distribution. Electricity retailers purchase electricity on behalf of their customers from generators. Retailers and generators then pay regulated 'use-of-system' charges to network operators for transportation services. The largest six firms represent around 99% of the total energy retail market and 93% of the small business market[175].

- The market for **electrical heat enabling technologies** (electricity appliances) is relatively large, representing almost £2bn per year of value added. This consists of a wide range of electrical heating and cooling such as air conditioning and pumps and insulation[176]. This is discussed in more detail in the enabling technologies annexe. There is also a wider market for electrical appliances, including televisions, computers and fridges, worth around £6bn per year.

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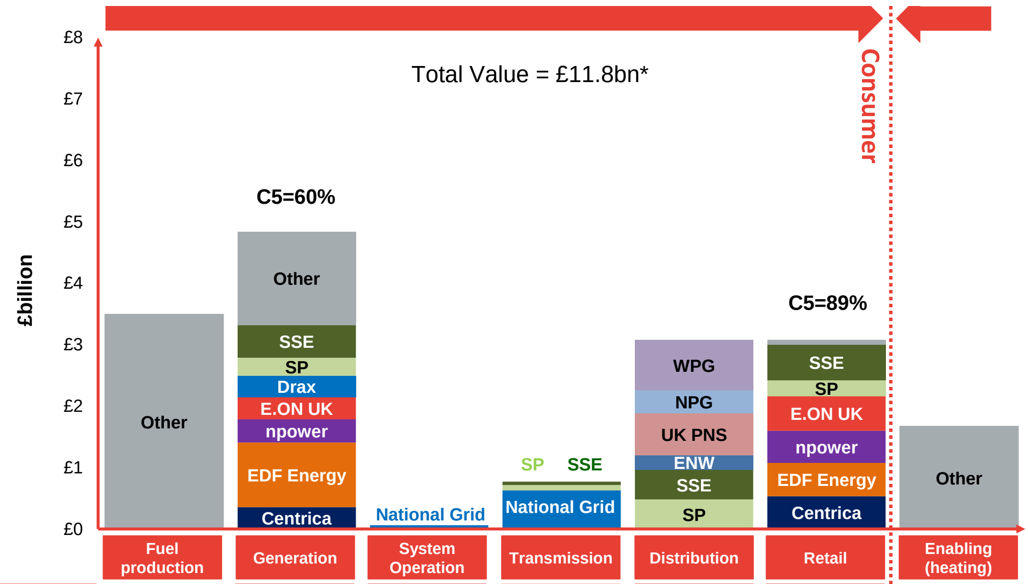
174 For a given part of a value chain, value added is the revenues less outside purchases of materials and services (e.g. for gas retail this would entail revenues minus fuel costs and network charges).

175 Ofgem (2012), *Retail Market Review - updated proposals for business*

176 The value of insulation also appears in the gas value added chart. Therefore the total value of enabling technologies in gas and electricity should note be summed across the two charts.

Figure 30. Indicative value added in the electricity value chain[177]



	Fuel production	Generation	System Operation	Transmission	Distribution	Retail	Enabling (heating)
Operating margin (indicative)		25%	9%	26%	38%	2%	
Return on capital employed		6-8%	<10%	<10%	<10%	>100%	

Note: C5 ratios refer to the market share held by the largest 5 businesses in the market. A higher C5 percentage therefore corresponds to a more concentrated market, where fewer companies hold a larger share.

* This does not include the value of the heat enabling technologies market, as a proportion of this relates to the other energy sources

Source: Frontier Economics based on Ofgem Supply Market indicators, Ofgem Household Bills Explained, Company Annual Reports and DUKES.

Margins and profitability vary across the sector. As in the gas sector, the differences in the levels of operating profits and the returns on capital across the value chain may be explained by two important factors: (i) the capital intensity; and (ii) the risks in that part of the value chain.

- The **operating margins** (relative to revenues) in generation, transmission and distribution are relatively high at above 25%. These margins must support highly capital-intensive businesses in the case of transmission and

177 Note: The ranges of return on capital employed in generation are based upon Centrica's reported segmental financial accounts 2011-2009, over which period Centrica had an established and representative fleet of power stations. The returns on retail capital employed are based on Centrica financial statements for 2011-2007 and incorporate both the gas and electricity retail business. The retail returns on revenue are based on the average return in 2011 across the big six retailers. This therefore obscures occasional negative returns for individual retailers, occurring due to wholesale price fluctuations. For return on revenue for generators, the return is calculated for four of the big six which report fuel costs in their segmental statements (Centrica, EDF Energy, Scottish Power and E-on) and independent power producer Drax. Returns on revenue for regulated networks are taken from the latest OFGEM price control, using allowed revenues.

distribution while generators face a range of major risks (e.g. construction, wholesale price and operational risk) and investment lead times of many years. In contrast operating margins in electricity retail, where capital employed is low, are small relative to revenues.

- The **returns on capital** for generation are below 10%. Returns in electricity transmission and distribution are also below 10%, reflecting the fact that the regulatory framework largely protects these firms from revenue risks. Returns on capital in retail are very high, although not very meaningful given the limited capital employed in the sector. Profitability of this sector is normally described in terms of margins relative to total revenue. These have fluctuated between 1.9% and 7.1% over the last 5 years[178].

Each element of the value chain contains a set of services – some of which are contracted out. These are shown in **Figure 31**. Metering is the interesting of these activities, in terms of relevant insights that can be drawn, and the potential opportunities for future businesses. Metering is covered in detail in Annexe 11.

Figure 31. Activities within the electricity value chain

	Generation	Transmission	Distribution	Retail
Internal functions	• **Operations** • **Fuel procurement and logistics** • **Trading**	• **Operations and maintenance** • **Control centre** • **Construction** • **HR and finance**	• **Maintenance and fault-checking** • **Control centre** • **Construction** • **IT systems** (e.g. asset databases, work scheduling) • **HR and finance**	• **Call centres** • **Billing systems** • **Trading and forecasting** • **HR and finance**
Contracted externally	• **O&M service contractors** (e.g. Siemens) • **Equipment suppliers** (e.g. Siemens) • **Construction services** (e.g. Alstom)	• **O&M service contractors** (e.g. ENS) • **Equipment suppliers** (e.g. ABB) • **Construction services** (e.g. ENS)	• **O&M service contractors** (e.g. ENS) • **Equipment suppliers** (e.g. ABB) • **Construction services** (e.g. ENS)	• **Metering services** (e.g. DNOs) • **ICT systems** (e.g. GXS)

Source: Frontier Economics

10.2.4 Breakdown of customer bills

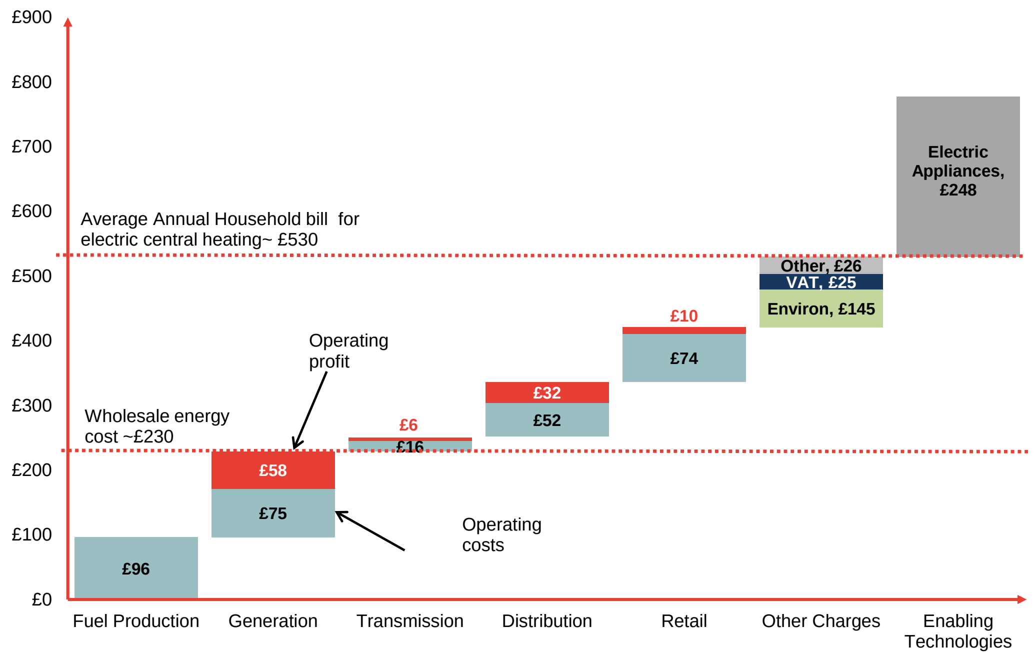
The contribution of each part of the sector to average consumers' bills is shown in Figure 32.

This shows that wholesale energy costs, consisting of generation and fuel production, make up 43% of the average customer bill. Transmission, system operation and distribution costs make up a further 20%. Retail costs, including

178 Ofgem (2013), *Electricity and Gas Supply Market Indicators*

metering, sales and billing, add a further 16%. The remaining 21% of the average bill is made up of environmental charges and taxes (Box 5).

Figure 32. Breakdown of an average annual household electricity bill

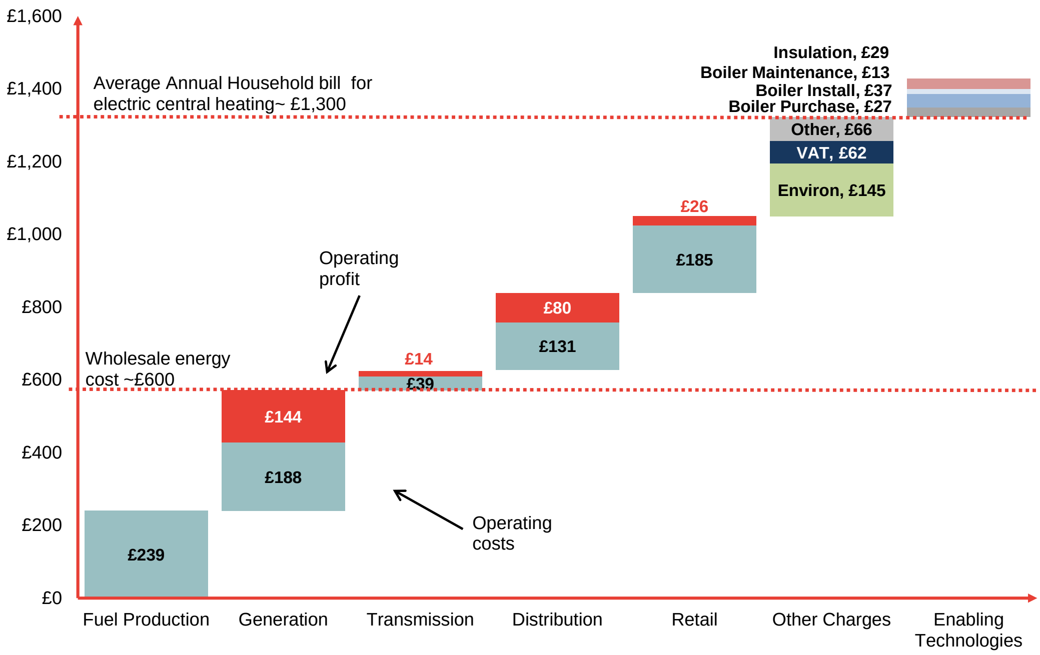


Environmental charges include the Community Energy Savings Programme (CESP), Carbon Emissions Reduction Target (CERT), Renewables Obligation Certificates (ROCs), Feed in Tariffs (FiTs) and the Warm Homes Discount scheme.

Source: Ofgem Household Bills Explained, Digest of UK Energy Statistics, 2011 Segmental Statements of big six, Ofgem Transmission Price Control Review, Ofgem Distribution Annual Report 2010-11

Figure 32 shows the equivalent average household bill for a home using only electricity (rather than both electricity and gas, which are used by most consumers)

Figure 33. Average annual energy bill for a household with electric heating[179]



Source: DECC Quarterly Energy Prices Table 2.6.2, Consumer Council, OFT Market Investigation, OFGEM Household Bills Explained, OFGEM monthly review

179 Note: This is based upon the average electricity cost of a household with electric central heating PLUS the average electricity cost of a house without electric heating from DECC quarterly energy prices, as this gives a cost in line with other sources, such as http://www.which.co.uk/energy/creating-an-energy-saving-home/guides/home-heating-systems/electric-central-heating/ and http://www.centralheating.co.uk/system/uploads/attachments/0000/0158/Choice_of_Fuel_Good_Practice_Guide.pdf

The enabling technologies costs are reported as the average spend for a household, therefore these are lower than the cost of purchase if it relates to a product with low take-up or infrequent purchase.

Box 5. Impact of environmental charges on electricity bills

Household electricity bills contain several environmental charges;

- Carbon Emissions Reduction Target (CERT) – this requires energy retailers to provide domestic energy efficiency measures for consumers which achieve a defined level of carbon savings. The average cost to a household from this obligation was estimated at £19 in 2011.[180]
- Community Energy Saving Programme (CESP) - a joint scheme between retailers, generators and government to provide energy efficiency measures in low income areas. This was estimated to cost approximately £2 per the average household bill in 2011.[181]
- Feed in Tariffs (FITs) - this applies only to electricity bills. From April 2010, energy companies must pay a generation and export tariff to small, low-carbon generators such as those household photovoltaic panels. This was estimated to add £2 to the average household bill.[182]
- Renewable Obligations- this requires retailers to source a certain amount of electricity from renewable sources. Retailers must purchase Renewable Obligation Certificates of this value from renewable generators, or face a penalty. This is estimated to make up 3.4% of the average household electricity bill, approximately £18 per year.[183]
- Warm Home Discount Scheme – a four year beginning in April 2011, this scheme provides winter energy bill discounts to low income customers. This if funded by energy retailers, and is estimated to cost £5 per annum for the average household electricity bill.
- EU Emissions Trading Scheme – this is an EU carbon trading requirement for all energy retailers. This was estimated to add £17 to an average household dual-fuel bill in 2011.[184]

DECC analysis suggests the cost of these environmental charges is more than offset in terms of the overall bill by the reduction in energy consumed that they enable[185].

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180 NERA (2011) *Energy Supply Margins: Update*

181 NERA (2011) *Energy Supply Margins: Update*

182 Centre for Sustainable Energy and Association for Conservation of Energy (2012) *Environmental and social levies: Past, present and future*

183 https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/the-renewables-obligation-ro, Accessed 03/04/13.

184 Centre for Sustainable Energy and Association for Conservation of Energy (2012) *Environmental and social levies: Past, present and future*

The change in the levels and components of a typical household electricity bill over the last 20 years is shown in Figure 34. This shows that, in real terms, the average household electricity bill fell between 1990 and 2002, before increasing to 2011. This was driven by the following factors.

- **Changes in the wholesale price of electricity**. The wholesale price of electricity fell in the early 2000s, as underlying fossil-fuel prices fell. It rose in 2007 as result of rising fossil fuel and carbon prices, but has dropped off again since, partly due to an increase in spare generation capacity on the system due to the recession.

- **Increases in transmission, distribution and retail costs.** The requirement to invest to replace and reinforce aging infrastructure has meant that the transmission and distribution element of the bills has risen since 2002. Retail costs also have increased during this period also, reversing a period of very low and even negative margins. The costs of retail, distribution and transmission have increased by 35% since 2002.[186]

- **Environmental charges.** There has been a significant proportional increase in the taxes and environmental charges. DECC estimate that energy and climate change policies will add around 17% to the average electricity price paid by UK households in 2013, due the costs of ECO, the Renewables Obligation and small-scale Feed-in-Tariffs (FITs) obligation on retail prices[187] This increase also includes the effect of the EU ETS and Carbon Price (included in the generation category in **Figure 34**). However, at the same time, the policies to encourage energy efficiency will also reduce energy consumption. DECC estimate that overall, policies will result in a net reduction on bills of 3% on a household's electricity bill and 5% on a household's dual fuel bill[188].

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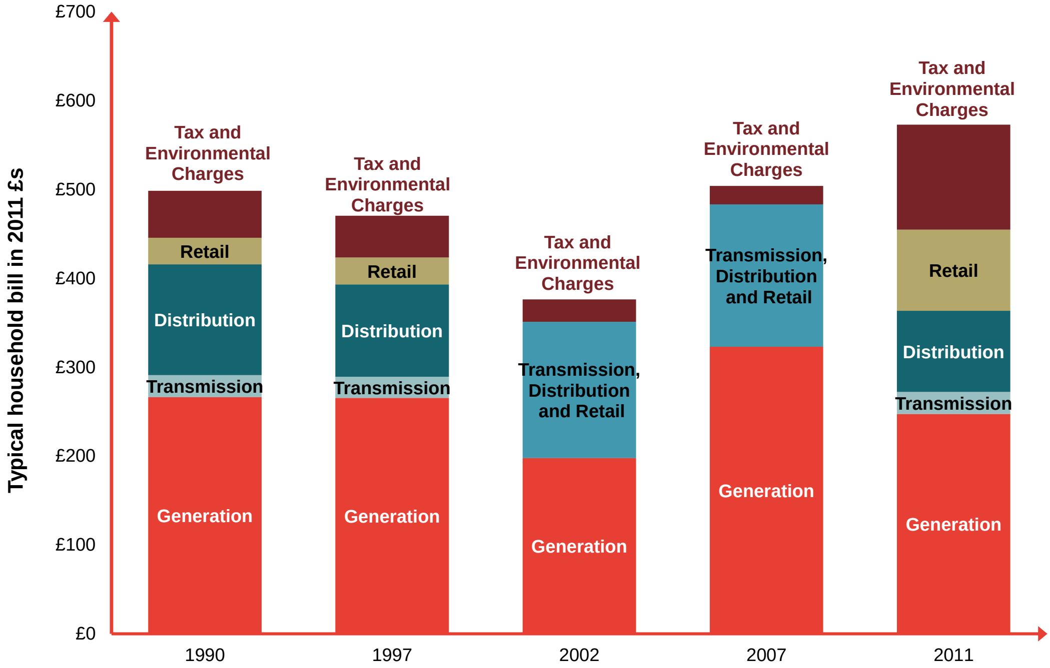
185 DECC (2013) *Estimated impacts of energy and climate change policies on energy prices and bills 2012*

186 Due to the data available, it is not possible to split the costs of retail, distribution and transmission in 2002. Therefore, the overall change is reported.

187 See Annexe 7: Enabling technologies value chain map

188 DECC (2013) *Estimated impacts of energy and climate change policies on energy prices and bills 2012*

Figure 34. Breakdown of a typical household electricity bill over the last 20 years



Source: Ofgem quarterly prices

10.4 Business environment

Understanding the business environment provides crucial context for understanding the value chain. In this section, we consider the main characteristics of electricity production and consumption. We then provide an overview of the policy context.

We have identified five characteristics of the current electricity system, which can help us understand the value chain.

- **Electricity is required to meet the basic needs of consumers.** Electricity is used by consumers to meet basic needs such as lighting, cooking and in some cases, heating. As described in Annexe 4, fuel poverty is a major priority for Government intervention in the energy sector.[189]

- **Electricity supply and demand must be matched in real time.** Electricity is currently difficult and expensive to store. At the same time,

189 DECC (2012) *Hills Review Final Report*

consumer demand fluctuates, and can be difficult to predict. This means that supply and demand must be matched all times. There is currently little flexibility on the demand side – few enabling technologies (with the exception of Economy 7 storage heaters) include the ability to store energy or delay use. This means to ensure that demand can be met at all times, enough generation and network capacity must be available to meet expected peak demand, with a margin to take account of the risk of plant or network failures. In response to this, the sector has developed in a way that allows it to respond flexibly to changes in demand.[190] It also means that in the move to a low-carbon economy, as supply becomes less flexible, the role for customer flexibility (demand side response), technologies which add flexibility to the system (such as storage), and technologies which help predict changes in demand and supply may increase.

- **The only viable way of transporting electricity in bulk is through networks of wires.** The electricity transmission network(s) provide high voltage connections between the many electricity generators around the country and the lower voltage distribution systems. These lower voltage distribution networks then deliver electricity to homes and small businesses. Transporting electricity incurs a cost in terms of losses: electrical energy is lost as energy is lost as it passes through the networks (approximately 8% of electricity generated[191]). Generators and retailers do not have any alternative options for transporting electricity in bulk. This has two implications.
  - Like gas networks described in Annexe 4, Electricity networks are **natural monopolies**, and must be regulated to ensure pricing is fair.
  - Like gas, electricity must be sold as a **homogenous product** – that is, it is not possible for one particular producer to sell a specific unit of electricity that has been produced by them to an identified customer.
- **Domestic and SME consumption of electricity can only be measured periodically.** One of the functions of retail supply is to accurately monitor consumers' electricity consumption and bill consumers accordingly. At present, most existing metering technology is 'dumb' meaning household consumption cannot be monitored in real-time and meter reading requires a site visit. In particular, the meters cannot communicate remotely to retail suppliers and therefore meter readings must be taken periodically (e.g. with

190 The flexibility and reliability of the current GB generation mix varies substantially across technologies. Hydro stations (including pumped storage) and open-cycle gas/oil turbines are very flexible and can start in seconds and minutes respectively. Coal stations and gas CCGTs are less flexible (they can reach full capacity within a few hours) while nuclear is typically inflexible.

191 DECC (2012) *Digest of UK Energy Statistics*

the householder reporting a meter reading by phone or via the internet and/or an employee of the retailer visiting to take a meter reading). This limits the granularity with which retailers can charge for electricity. For example, unless their customers have smart meters, it is not possible for retailers to vary their charges by time of day. There are two exceptions to this.

- Customers on Economy 7 tariffs[192] are metered separately for their consumption on and off peak (where off peak is generally overnight). Sustainability First research has found that around 7 million households in GB have Economy 7 meters.[193]
- In addition, roll out of smart meters has begun and should be complete across domestic and small business customers by 2019 (see Annexe 11). Widespread rollout of smart meters will make available near real time information on energy use.

- **There are market failures associated with electricity supply.** The electricity generation sector produces emissions of greenhouse gases and other pollutants. There are also externalities associated with all electricity infrastructure, including electricity transmission and distribution, for example in terms of the impact on landscapes. Because of these externalities, the electricity sector is characterised by a high degree of intervention at present. Additional intervention is in place to deliver security of supply. A secure and reliable electricity supply provides important context for industry and investments and security of supply of electricity is a Government priority. Where the Government believes the market alone will not ensure there is sufficient reliable electricity capacity in place to meet demand, it intervenes.

Table 4 summarises the impact of these characteristics across the value chain.

192 Including variants to the Economy 7 tariffs such as Economy 10 and Scottish teleswitching.

193 Sustainability First (2012) *GB Electricity Demand, Paper 3,*

Table 4. Impact of the characteristics of electricity on each part of the value chain

	Upstream	Networks	System operation	Retail
Required to meet basic needs				Government intervention to protect vulnerable customers
Supply and demand must be matched in real time	Flexible plants are important Enough capacity is in place to meet peak demand	Enough capacity is in place to meet peak demand.	There is a role for a central System Operator	Increasing interest in encouraging demand-side response (DSR)
The only way of transporting electricity in bulk in through networks		Networks are natural monopolies, regulated by Ofgem		Homogenous product. Competition over risk management and marketing, rather than on product quality
Domestic and SME consumption is measured periodically				Limited capacity to introduce time of use tariffs (except where Economy 7 meters are in place)
Environmental externalities and security of supply	Government intervention to reduce emissions and to ensure enough capacity is in place			Government intervention to reduce consumption

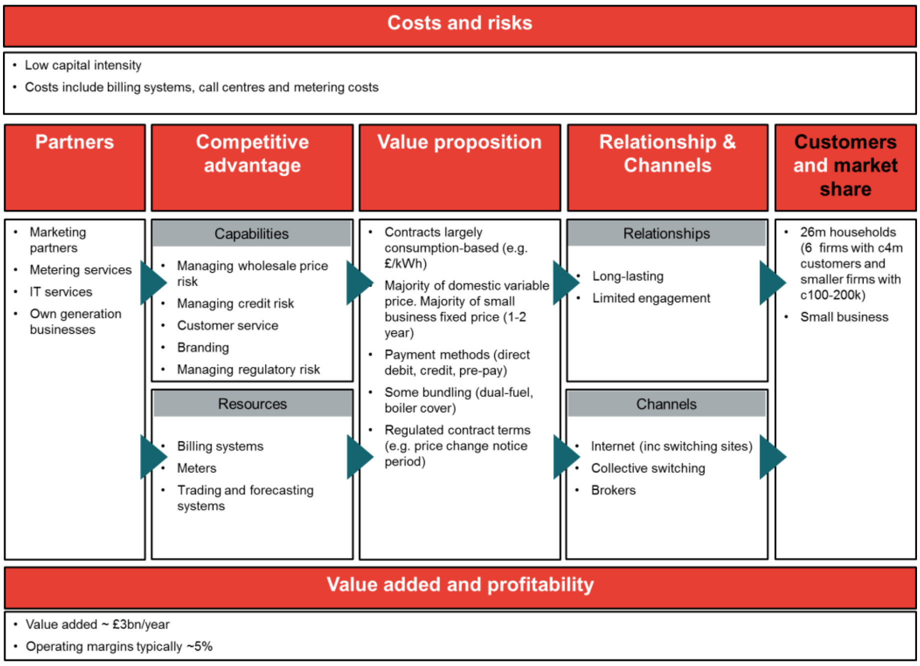
Annexe 1 describes the business model canvas framework. We now go on to describe the business model canvas for each area of the value chain.

10.5 Electricity retail business model canvas

The retail part of the value chain is responsible for purchasing electricity from the wholesale market and selling electricity to consumers, as well as ensuring consumers have meters. This section describes the retail sector, based on the business model canvas framework. Metering is covered in Annexe 11.

Figure 35 shows the business model canvas for electricity retail.

Figure 35. Retail business model canvas - electricity



Source: Frontier Economics, adapted from the Business Model Canvas.[194]

10.5.1 Costs and risks

The costs and risks associated with purchasing electricity from the wholesale markets and selling it on to customers impact the way that retail business models have developed.

- **Cost structures.** This part of the sector has a relatively low capital-intensity. For example, over the last 5 years, Centrica's capex as a proportion of total expenditure (capex plus opex) for its retail business (including gas and electricity) has been 5% on average.

- **Risks.** There are three main risks associated with electricity retail businesses.

  Wholesale price, balancing and liquidity risk. Wholesale electricity prices can be highly volatile over time. To the extent customers are on fixed price tariff (or prices cannot be adjusted quickly) retail suppliers must bear these wholesale price risks (which can be mitigated through a hedging strategy[195]). Under the GB market arrangements, an electricity

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194 From BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas

195 This is discussed in Annexe 8: Contractual arrangements

retailer must purchase electricity from generators to match the demand of its customers. There are penalties for being 'out-of-balance' if retailers do not achieve this (See Box 6). If the market becomes illiquid in certain periods, the costs of adjusting an unbalanced position can be high. One effect of these risks is that they can increase the costs of trading as contract counterparties require collateral to cover credit risk. This may be a particular problem for smaller, less capitalised retailers.

- **Consumer credit risk.** Some customers may not pay their bills on time or at all.

We describe how the retail businesses manage these risks in the next sections.

Box 6. Balancing risk

Retailers and generators in wholesale markets pay or receive "cash-out" for differences between their contracted positions and the physical volumes they generate or demand. The price they face depends on whether they are long or short of physical energy compared to their contracts, and whether this imbalance is in the same or in the opposite direction from the system:

- **The main cash-out price** is calculated as the average of the most expensive 500MWh of actions taken by the system operator to overcome the energy imbalance on the system in the half hour settlement period. If the participant's imbalance is in the same direction as the system imbalance (if it contributes to the system imbalance), the participant pays the main price.
    - **If the system is short** (if the SO has had to buy more power than it sold back), a system buy price is calculated. If a participant's short position has contributed to this overall imbalance it pays the system buy price.
    - **If the system is long** (of the SO was a net seller), a system sell price is calculated. If a participant's long position has contributed to this overall imbalance it pays the system sell price.
- **The reverse price** is the market price before gate closure. If the participant's imbalance is in the opposite direction to the system (if it counteracts the system imbalance), the participant pays the reverse price.

There is substantial risk associated with balancing prices for electricity retailers and generators. In 2010, the spread between the system sell price and the system buy price was 27%. The spread exceeded 50% for 11% of settlement periods[196].

Imbalance prices are intended to serve as an incentive for market participants to efficiently manage their contractual energy position ahead of gate closure.

Ofgem has raised concerns that the current balancing arrangements are not working as well as they could.[197] In particular, various features dampen balancing and investment incentives and undermine the role of cash-out in providing security of supply. Ofgem is currently considering ways to improve the balancing arrangements and their contribution to delivering an efficient level of security of supply.

196 Ofgem (2011) *Electricity Cash Out Issues Paper*

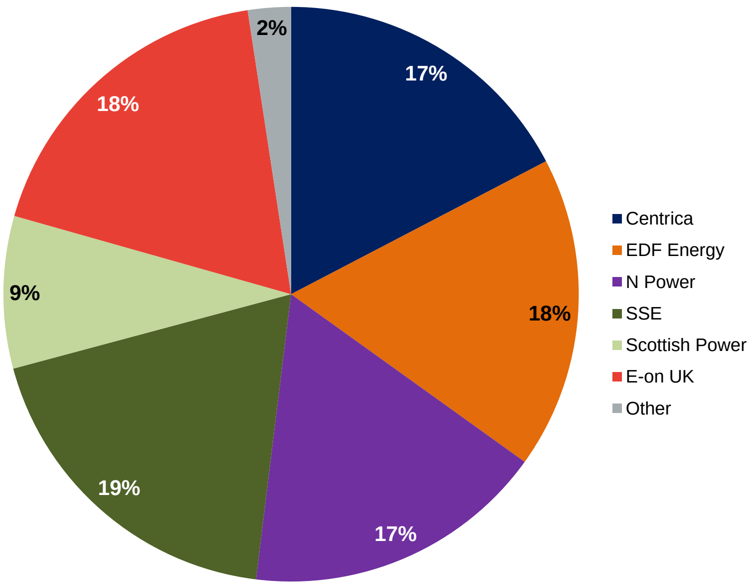
197 See Ofgem (2012a).

10.6.1 Customers and market share

Between them, electricity retail businesses serve 26m[198] domestic customers and a large number of small business customers. In this section, we discuss how these customers are spread across retailers, how this has evolved over time, and the policy intervention in this area.

Figure 36 shows that the six largest retail companies have around 98% of the market, with around four million domestic customers each.

Figure 36. Electricity retailers market share



Source: Digest of UK Energy Statistics, 2011 Segmental Statements for "big six" retailers

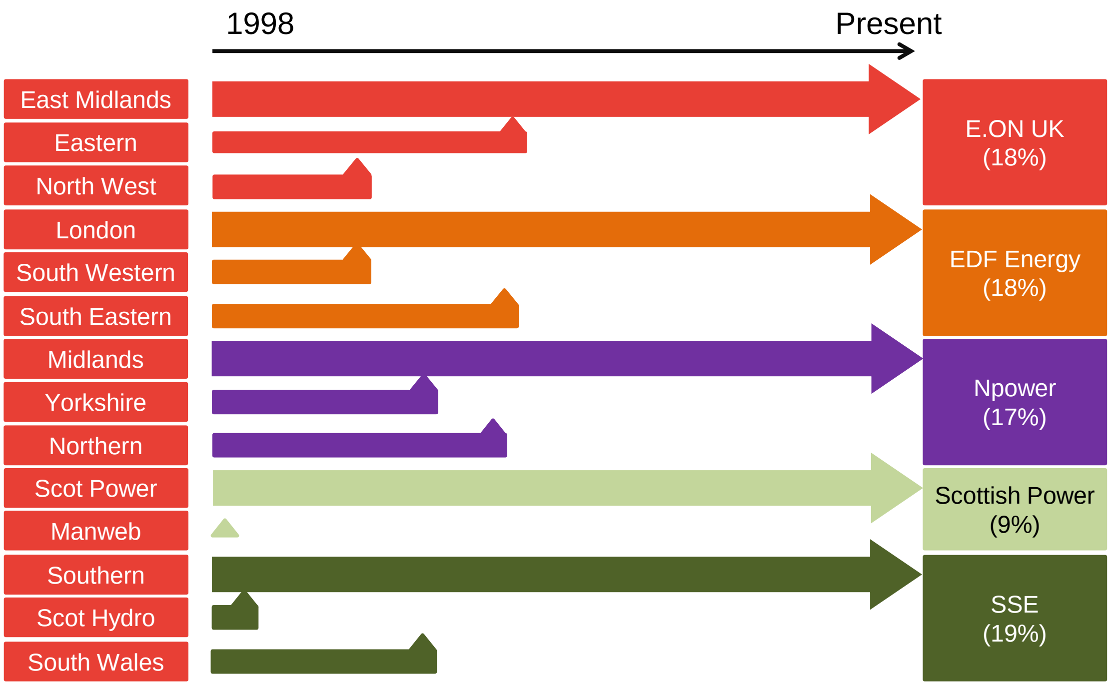
Historical ownership patterns have helped determine this outcome. Prior to liberalisation in 1989, all generating capacity and transmission in England and Wales was nationally owned by the Central Electricity Generation Board (CEGB). The generated electricity was then distributed and retailed to customers by 12 area boards. In Scotland, the North Scotland Hydro-Electric Board (NSHEB) and South Scotland Electric Board (SSEB) owned the generation, transmission, distribution and supply. Following the Electricity Act 1989, the CEGB was split into three generation companies and a transmission company, which were gradually privatised. The 12 area boards became 12 local area

198 DECC (2012), *Energy Consumption in the UK – domestic data tables*

distributors, each holding a share of National Grid, which owned the transmission network for England and Wales.

The retail activity was progressively opened up to competition based on the size of customer from 1990, culminating in full choice by 1998. Figure 37 shows the evolution of the now 14 local area incumbent retailers from separate entities into five of the six current major retailers. This shows that the number of retailers in the market was highest in the period immediately following market opening – with all 14 former public electricity retailers as well as British Gas and a number of new retailers in the market.

Figure 37. Electricity retail market consolidation over time



(2011 retail electricity market shares in brackets)

Source: Based on Ofgem(2008) *Supply Market Probe*

The share of the new entrants never became large. In 2002, entrants such as Virgin Energy, Saga, Union Energy and Severn Trent Energy accounted for only 300,000 customers.[199] There was significant exit in the early 2000s, for example with at least 11 market exits by independent retailers between 2000 and 2004

199 Simmonds, G (2002), *Regulation of the UK electricity industry.*

(almost all supplying electricity rather than gas).[200] A period of consolidation then followed.

The share of the five former incumbents has remained relatively consistent over time; by September 2012, 38% of households were still supplied by their respective incumbent retailer.[201] The only major entrant into electricity retail over this period was Centrica, the previous incumbent in gas supply. In 2008 Energy, Ofgem found that the active retailers that were not former incumbents (including Centrica) served less than 0.3% of the domestic electricity supply.[202]

More recently, there has been limited market entry– for example Ovo Energy entered the electricity retail market in 2009 and had 70,000 customers by January 2012 according to Which?; while Co-operative Energy entered in 2011 and had 100,000 customers by January 2013.[203] However, the number of customers supplied by entrants remains small.

Despite this consolidation, the number of retailers compares well to numbers elsewhere in Europe (Figure 38).

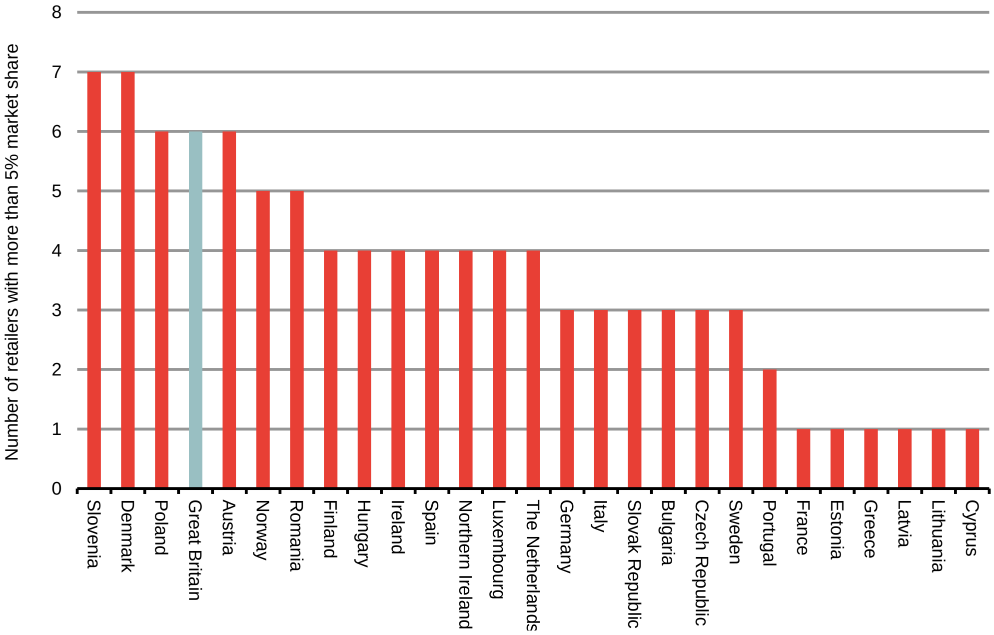
200 Cornwall Consulting for Energywatch (2004) *Business Energy Markets 2004*

201 DECC (2012), *Quarterly Energy Prices December 2012.*

202 Ofgem (2008) *Retail Supply Probe.*

203 http://www.cooperativeenergy.coop/2013/01/22/co-operative-energy-attracts-100000-customers-in-less-than-two-years/ (Accessed 05/03/12)

Figure 38. Number of companies with over 5% share of whole retail market



Source: European Commission (2010) *Report on Progress in Creating the Internal Gas and Electricity Market*

10.6.2 Relationship and channels

The most important interactions for electricity retail suppliers are with electricity generators (from whom they purchase generation through a variety of contracts) and consumers (to whom they sell electricity). Retailers also pay networks for use of their services. We cover the consumer relationship in the next section.

Purchasing generation

Managing the risk associated with the purchase of electricity from generators is an important function of the retail businesses. These businesses use a number of strategies.

- **Short term trading on wholesale markets.** Retailers will trade electricity for every half hour during the day to manage less predictable changes in supply and demand. Around a third of over the counter (OTC) trades for baseload power, nearly 80% of OTC trades for off-peak power and nearly 50% for peak power are in the spot/prompt market.[204]

- **Hedging on longer term markets.** Longer term price risks are managed by buying products months or years ahead of delivery. Less than 20% of baseload, less than 10% of peak and less than 5% of off-peak OTC trades are for products more than a year ahead.[205] Ofgem have raised concerns about the liquidity of longer dated products[206] and have proposed additional interventions to help increase this liquidity.[207]

- **Vertical integration with generators.** Vertical integration also helps companies manage their exposure to fluctuating wholesale prices. Retailers can avoid costly imbalance charges by settling their position internally between the generation and retail parts of the business. Figure 39 shows the electricity market is characterised by a high degree of vertical integration between retail and generation with the six vertically integrated companies covering 99% of the electricity retail market.[208] The benefits of vertical integration to generators are discussed in the upstream section.

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204 Ofgem (2012), *Wholesale Power market liquidity, consultation on a Secure and Promote licence condition*

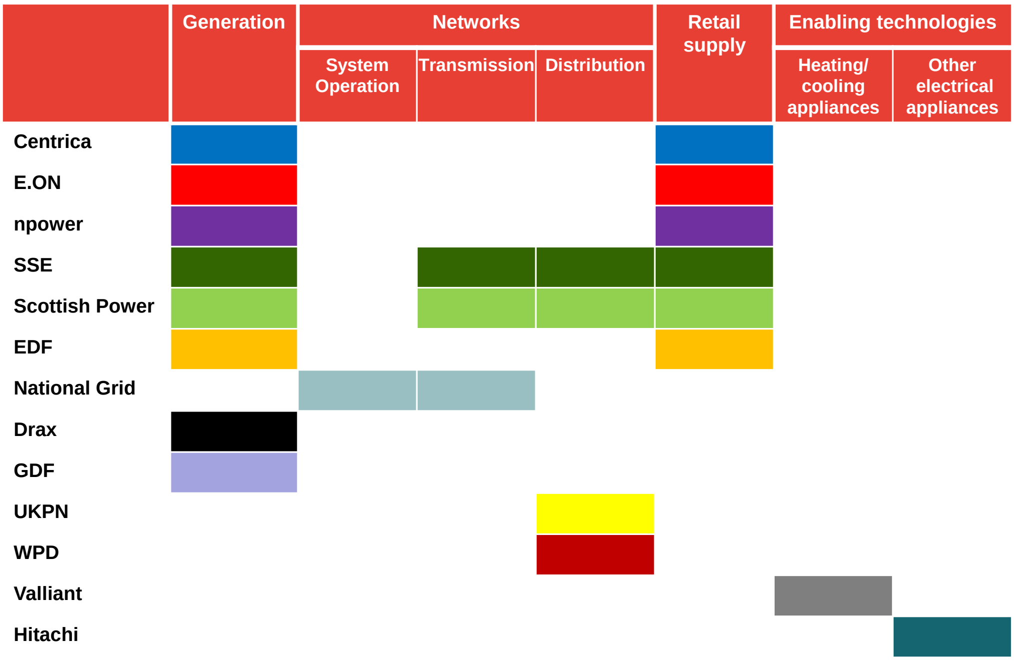
205 Ofgem (2012), *Wholesale Power market liquidity, consultation on a Secure and Promote licence condition*

206 Ofgem (2012), *Retail Market Review: Intervention to enhance liquidity in the GB power market*

207 Ofgem (2012), *Wholesale Power market liquidity, consultation on a Secure and Promote licence condition*

208 Ofgem (2011), *Retail Market Review: Findings and Initial Proposals*

Figure 39. Vertical integration in the electricity sector



Source: Frontier Economics

Paying for use of the networks

Retailers also pay networks use of system charges. Demand-side charges for domestic and small business consumers are generally made up of a consumption charge (p/kWh) and a fixed charge (p/household/day).[209] The consumption charge can either be flat, or two-rate, based on peak and off peak consumption. The level of the charges varies by region.

10.6.3 Value propositions

This section focusses on the value propositions offered by retailers to their customers. Value propositions to domestic customers can be characterised as follows.

- **Payment methods.** Just over half of customers pay by direct debit with the remainder split by credit (i.e. quarterly billing) and pre-payment meters. Direct debit bills were around £40 lower on average in 2012 than in standard credit and pre-payment bills.[210]

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209 Technically the change is per Meter Point Administration Number (MPAN), which generally corresponds to a household.

210 DECC (2013), *Annual Domestic Energy Bills*

- **Consumption versus standing charges.** In general the majority of a standard domestic customer's bill is represented by a variable charge (an average charge of £130/MWh in 2012) and a smaller standing charge (£61/year) which may be designed to cover a number of the fixed costs associated with retail supply (e.g. billing, call centres, metering and network charges). Based on an average annual household consumption of 3.3 MWh this implies the variable charge represents 88% of the total bill of £490/year. For Economy 7 tariffs the variable charge is £150/MWh in the day and £60 at night with a fixed charge of £76/year. The average total bill is £740/year (reflecting electricity is generally being used for heating in these homes) with the variable charges representing 90% of this.[211]

- **Variable versus fixed pricing.** Around three-quarters of domestic customers are on variable price tariffs. (including over 85% of standard credit customers and over 50% of direct debit customers) and are subject to prices which are changed periodically, with 30 days' notice, at the retailers' discretion. Exact splits of fixed price tariffs cannot be determined due to the nature of the data but we estimate these to be a minimum of 5% of standard credit customers and 20% of direct debit.[212] The average length of a fixed price contract is typically 1-2 years.

- **Length of contracts and churn.** Customers who are on variable tariffs are typically not locked into any contract period and can switch when they like. A fixed tariff deal will typically last 12-18 months. Customers are still free to switch, subject to paying a penalty exit fee (which has to be clearly notified to them on signing up to the tariff). In 2011, 14% of domestic customers switched electricity retailer (with switching rates higher for those paying direct debit). Many customers are extremely sticky – over 65% of households report that they have never switched retailer.[213]

- **Bundling.** The number of 'dual-fuel' customers (i.e. purchasing electricity and gas together) is currently around 75% of the domestic market. Given the number of households without a gas connection, this is around 85-90% of the potential market.[214]

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211 DECC (2012), *Domestic Price Statistics*

212 DECC(2012) *Tariff type variation in the domestic energy market*,

213 Ipsos MORI (2012) *Customer Engagement with the Energy Market – Tracking Survey 2012, Report prepared for Ofgem*

214 Cornwall Energy (2013), *Energy Spectrum: Issue 361*

- **Time of use charging.** Some customers are on Economy 7 tariffs. Economy 7 was designed to allow customers with electric storage heating to use cheap electricity during the night (when demand is low) for their heating needs. These customers are metered separately for their consumption on and off peak (where off peak is generally overnight). Sustainability First research has found that around 7 million households in GB have Economy 7 meters. Only around 3-3.5 million of these customers are on the Economy 7 tariff.[215]

For small businesses, the typical nature of contracts is different. Although tariffs are still largely based on consumption, over 65% of small business for tariffs are fixed price, typically for a period of 1-2 years. Another notable feature of the small business market is the role of brokers – a survey by Ofgem found that over 30% of SME's used energy brokers without dealing directly with retailers.[216] There is less bundling of electricity contracts with gas contracts for SMEs because many businesses use electricity only.

10.6.4 Competitive advantage

Since electricity is a homogenous product, competition must focus on factors other than the quality of the product itself. Electricity retailers primarily compete on price though a business model focussed on delivering a basic energy supply service at lowest cost. Customer service is also important – retailers have lost market share when their IT systems have failed.

The features of competition of a homogenous product mean that purchasing strategy, financial risk management, marketing and customer service are of most importance. In particular, competitive advantage is driven by capabilities such as risk management, branding and customer service; and resources such as billing systems, meters and trading and forecast systems.

Sources of competitive advantage in electricity retail are similar to those discussed in Annexe 4 for gas. They include the following:

- quality of service (for example ease of payment and accuracy of billing);
- promoting loyalty, for example through reward schemes (e.g. over 4 million of British Gas customers are enrolled on the Nectar loyalty programme);[217]
- simplification of billing or simplification of payment;

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215 Sustainability First (2012) *GB Electricity Demand, Paper 3,*

216 Ofgem (2012) *Quantitative Research into Non Domestic Customer Engagement and Experience of the Energy Market*

217 Centrica (2011) *Annual Report and Accounts 2011*

- operational efficiency, including efficient billing and metering (e.g. online billing);
- managing price, credit and liquidity risk;
- wholesale trading, including opportunities to reduce costs and risks around procuring electricity through ownership of upstream fuel assets; and
- economies of scale, for example associated with fixed costs of IT and billing systems.

10.6.5 Partners

Retail businesses partner with generators and to a much lesser extent with other business in utility supply.

- **Vertical integration.** Around 99% of domestic supply is controlled by firm which are vertically integrated with a significant generation businesses.[218] A few of these also have upstream fuel businesses, in particular Centrica.

- **Horizontal integration.** Many of the large retailers are also active in electricity retail in other markets across Europe (e.g. EdF, E.ON, RWE). There is also some involvement with other utilities (for example SSE also supply telecoms and water, while Centrica owned a telecoms company OneTel before selling it in 2005). All the major energy retailers provide both gas and electricity.

10.6.6 Value added and profitability

Our estimate of the return on capital in the retail sector is around 75%. This reflects the fact that retail is not a capital intensive sector.

Profitability for electricity is normally described in terms of margins relative to total revenue. These have fluctuated between 1.9% and 7.1% over the last 5 years.[219]

10.7 Electricity networks business model canvas

The electricity **transmission networks** provide high voltage connections between the many transmission-connected electricity generators around the

218 Ofgem (2011), *Retail Market Review: Findings and Initial Proposals*

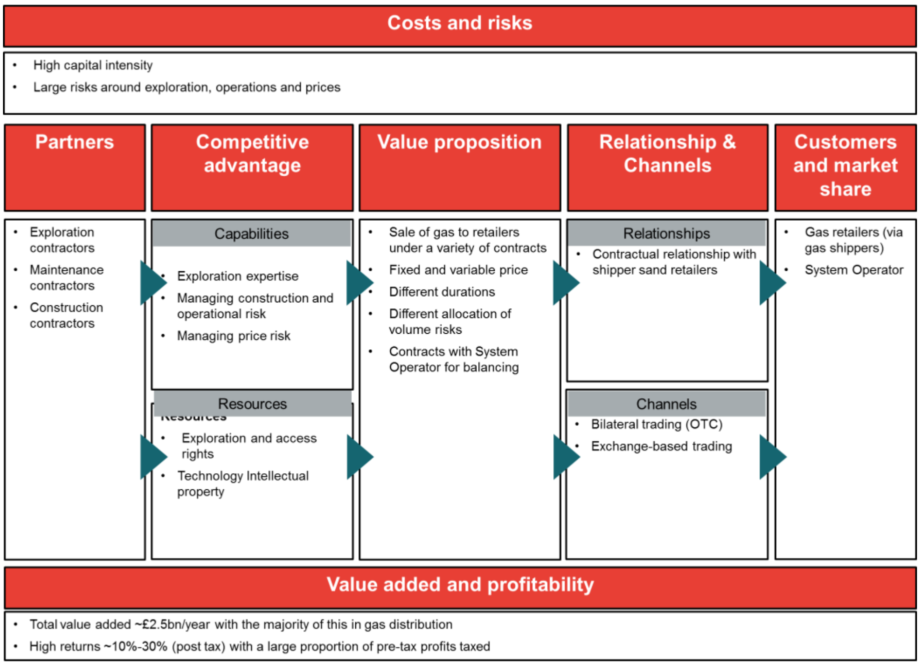
219 Ofgem (2013) *Electricity and Gas Supply Market Indicators*. Note this differences between this range and that in Figure 2 reflect the different sources, Those in Figure 2 are taken from segmental statements reports by the largest six retailers.

country and the lower voltage distribution systems. These lower voltage **distribution networks** then deliver electricity to homes and small businesses as well as connecting distribution-connected generation.

The transmission network owners are required to ensure that sufficient capacity is available on the GB electricity transmission network to deliver security of supply for consumers. they are able to meet peak demand for consumers. The DNOs also have a role in delivering the required capacity to ensure that retailers can transport electricity to their final consumers.

Figure 40 shows the business model canvas for electricity networks.

Figure 40. Business model canvas- electricity networks



Source: Frontier Economics, adapted from the Business Model Canvas[220].

10.7.1 Costs and risks

Transmission and distribution networks are highly capital intense businesses. For transmission, build costs represent over 95% of life-time costs (excluding the cost of energy and power losses, which are not directly incurred by the transmission owner).[221]

220 From BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas

221 Based on a discount rate of 6.25%. Parsons Brinkerhoff (2012) *Electricity Transmission Costing Study*.

The total network costs (including costs of finance) attributable to domestic and small consumers are around 25% of the total bill which represents an annual cost of around £5bn[222] per year or £125/year for a typical domestic customer.

The majority of these costs are associated with distribution, representing 18% of bills, with transmission representing 5%.

We now describe how the annual expenditure of an electricity distributor is split between direct capital and operating costs of running the network, and indirect operating costs.

- Around 40% of the annual total expenditure of distribution companies is spent on capital expenditure[223].
- A further 20% is made up of Network Operating Costs, the costs of maintaining the operations. This consists of tasks such as checking for and dealing with faults, and tree cutting around the network.
- Network supporting activities such as engineer management, call centres and control centre operations make up a further 20% of costs.
- Business support functions such as IT, HR and finance tend to be around 15% of costs.
- The remaining 5% is made up of non-operating capital assets, i.e. assets not used in the distribution network[224].

For the electricity transmission operators, a greater proportion of costs are capital expenditure. In 2010-11, controllable operating expenditure (excluding costs outside of the operator's discretion, such as Ofgem fees) was less than a third of the size of capital expenditure.[225]

To understand the risks faced by networks, we need to consider the regulatory system. Electricity networks are natural monopolies – in a given area, there is no alternative way of transporting electricity in bulk (it would not be cost effective to supplicate the network). Because of this, Ofgem regulates the companies to

222 This assumes that the network charges are cost-reflective.

223 This is far lower than the proportion capital expenditure makes up of lifetime costs as much of this cost is sunk upon market entry

224 Ofgem "Electricity Distribution Annual Report for 2010-11" available at http://www.ofgem.gov.uk/Networks/ElecDist/PriceCntrls/DPCR5/Documents1/Electricity_Distribution_Annual_Report_for_2010_11.pdf

225 Ofgem "Transmission Annual Report for 2010/11" available at http://www.ofgem.gov.uk/Networks/Trans/RegReporting/Documents1/Transmission%20Annual%20Report%202010-11%20Final.pdf

protect customers' interests. As described for gas in Annexe 4, regulation of networks is going through a period of change. The price control period is longer, and rewards are linked to delivering results. The main risks facing network operators are around costs and operational performance. They are largely sheltered from price and demand risk as a result of the price control framework.

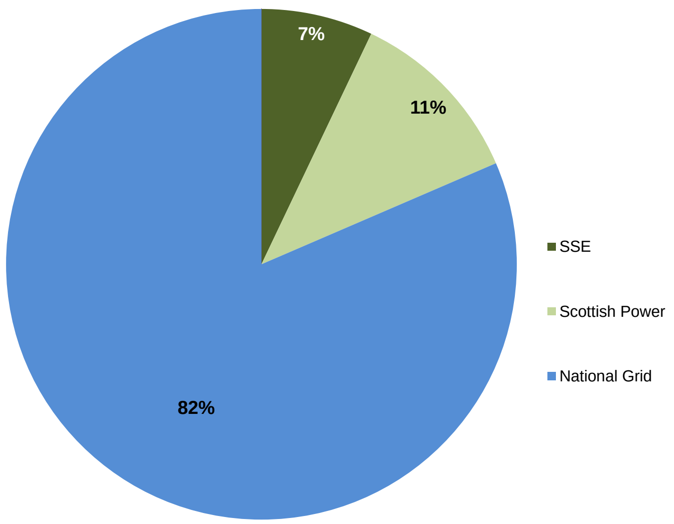
10.7.2 Customers and market share

Three companies own and operate the electricity transmission networks and fourteen companies run the regional electricity networks.

- **Transmission**. NGET owns the transmission network in England and Wales, SHETL and SPTL own the transmission networks in the Scottish Hydro and Scottish Power regions. Since these companies are regulated monopolies, market share is not a relevant measure. However, Figure 41 shows how these networks compare in size.

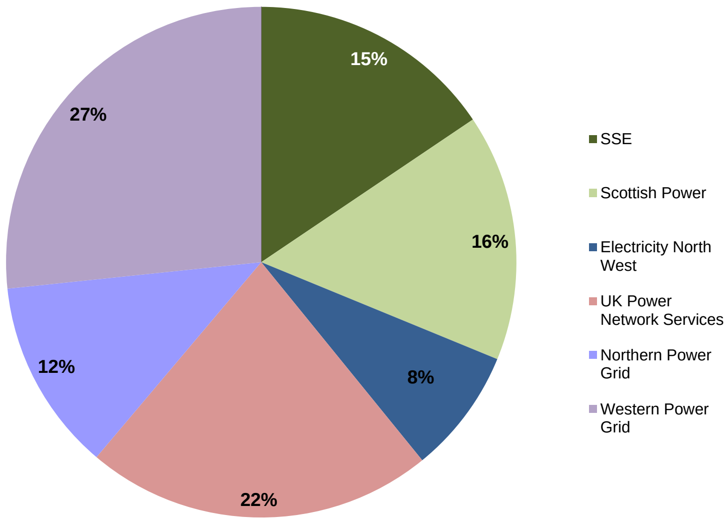
- **Distribution**. There are 14 electricity Distribution Network Operators (DNOs). Historically, these were all owned by all owned by the Public Electricity Suppliers (PESs), which also owned the corresponding retail business in each supply area. Since privatisation, there has been significant merger/takeover activity and many of the electricity DNOs are now held within common ownership. Their relative sizes are shown in Figure 42.

Figure 41. Electricity transmission networks



Source: Ofgem (2011) *Transmission Price Control Review* 4

Figure 42. Electricity distribution networks



Source: Ofgem (2011) *Electricity Distribution Annual Report 2010-11*

10.7.3 Relationships and channels

Since privatisation, the main relationships for networks have been with their users: principally generators and retailers. These relationships and the use-of system charges they involve are regulated by Ofgem.

As well as this regulated relationship, competition exists in the connections metering markets as well as in the market for offshore grids.

Competition in the connections market

While the regime for charging existing customers is regulated, Ofgem has promoted a competitive market for new connections. Customers wishing to connect to a distribution network have three options available to them.[226]

- **Incumbent DNO.** The customer can pay the incumbent DNO an upfront fee to install the connection. The incumbent may choose to subcontract some of the construction work and will then operate the assets in return for annual Distribution Use of System (DUoS) charges, which the customer will pay through their bill to their retailer.

- **Independent Distribution Network Operators (IDNOs).** A customer can also purchase a connection from an independent distribution licensee. IDNOs can install and operate networks to new multiple connections-typically new build housing estates[227]. The independent network will connect to the incumbent network and be embedded in the local incumbents' areas. To date, these networks are less common in electricity than they are in gas. The IDNO will usually undertake the connection work for an upfront fee, and then operate the assets, again recovering their costs through DUoS charges through the retailer. DNOs can also operate in a similar way to IDNOs outside the region in which they are the incumbent. For example, SSE owns and operates an out of area network.

- **Independent Connections Providers (ICPs).** ICPs are accredited to undertake connection works on electricity networks. They may be affiliates of DNOs or IDNOs or may be independent. A customer can contract with an ICP to install a connection to a DNO or IDNO network for an upfront fee. However, the ICP is not licensed to operate the network and will transfer ownership of the asset the DNO or IDNO for a fee once it is installed. Some ICPs are bringing in expertise from other utility sectors. For example, Veolia Water Infrastructure Services is active in the electricity and gas connections markets as an ICP.[228]

Ofgem's latest review of the connections market found that competition is starting to take hold in certain areas, with the overall number of connections being carried out by the incumbent electricity DNOs falling from 87% in 2009-10 to 77% in 2010-11. The IDNO share rose from 9% to 15%, while the ICP share rose from 4%-8% over the same period[229]. Increasing competition in the market for connections is expected to help meet the rising levels of demand for connections (connections involving distributed generation rose over 200% between 2008/9 and 2009/10)[230] and to drive improvements in the level of service.

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227 In 2011 there were six licensed IDNOs. These are Independent Power Networks Limited, The Electricity Network Company Ltd, Energetics Electricity Limited, ESP Networks Limited, EDF IDNO and ECG Distribution.

Competition in the metering market

Until 2007, retailers provided meters through the distribution networks, which were obligated to provide them as part of their regulatory function. After 2007, price controls were removed and the market for meter providers was opened to competition, with the choice of registered meter operator now at the discretion of both the retailer and the consumer. Following this change, retailers have increasingly taken the metering service in-house. In 2010 only a tenth of meters were owned by new, commercial meter operators, according to Ofgem's Review of Metering Arrangements. Metering is covered in more detail in Annexe 11.

Competition in offshore transmission assets

Offshore transmission assets transport electricity from offshore generation sites (usually offshore wind) back to the GB grid. When generators invest in offshore plants, they can construct the transmission assets themselves and transfer the assets to an Offshore Transmission Owner (OFTO) after construction or opt for an OFTO to undertake the construction. OFTOS are selected by Ofgem through a competitive tender process. There were almost £4 billion of bids for the first £1.1 billion of assets tendered by Ofgem.[231]

A move to contracting with consumers

New types of relationships are emerging due to innovation trials under the Low Carbon Networks Fund.

Today, electricity flows are relatively predictable and stable, flowing from generation on the transmission system towards consumers whose behaviour is predicted from well-established statistical models. This means that network owners can invest so that the network is, generally able to carry all consumer demand. In the future however, network flows may become increasingly complex as more generation is connected to local grids, and as new technologies such as heat pumps significantly increase the consumer load. In the future it may increasingly make sense for DNOs to contract with consumers (either directly or through an intermediary) to manage some of these complex flows.

Ofgem established the Low Carbon Networks (LCN) Fund as part of the 2010-2015 price control. The Fund makes £500m available to projects sponsored by DNOs that trial new technology, operating and commercial arrangements that may help in this transition to a low-carbon economy.[232]

LCN projects are allowing DNOs to develop relationships and trial new ways of working in two ways.

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231 DECC, https://www.gov.uk/electricity-network-delivery-and-access (Accessed 06/03/13)

232 Ofgem, http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/Pages/lcnf.aspx (Accessed 05/03/12.

- A central objective of the LCN Fund is to foster collaboration between DNOs and other parties in the energy supply chain. The extent to which this collaboration is encouraged is one of the criteria that projects seeking funding are evaluated against.[233] DNOs have worked on these projects with retailers, aggregators and technology retailers, among others.
- Some of the trials are bringing DNOs closer to building direct consumer relationships – for example by looking at the extent to which consumer demand side response can help meet DNOs needs.

10.7.4 Value propositions

Contracts between networks and their users come in the form of use-of-system charges. For generators these are mostly based of a fixed annual charge related to the capacity of the power station (£/MW/year) and differentiated by location to reflect the higher costs transporting electricity from places that are farther away from demand source. For retailers, these vary in structure, but for domestic and SME consumers, retailers are charged a fixed charge per connection as well as a charge per unit of consumption. The levels of these charges are determined by the regulatory system.

As described above, new consumers are generally charged an upfront fee for connections.

As described in Annexe 4 for gas networks, the value proposition of electricity networks businesses is largely defined by regulation, with regulation determining the service being covered, and the structure and overall levels of charges.

10.7.5 Competitive advantage

Networks' performance is determined by their operational efficiency and the extent to which they can manage regulatory risk.

Operational efficiency and the ability control costs are the key means by which regulated networks companies can outperform the returns allowed in their price controls. Electricity transmission and distribution has previously required limited innovation and there has been little focus on this by network companies.[234] However, increasing electricity demand due to electrification of heat and transport, as well as integration of distributed and intermittent generation will

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233 Ofgem (2012) *LCN Fund Governance Document (version 5)*,

234 E.g. Pollitt and Bialek note that spending on RD&D by network companies fell substantially following liberalisation (Pollitt, M., and Bialek, J., Electricity network investment and regulation for a low carbon future, available at: http://www.dspace.cam.ac.uk/bitstream/1810/194734/1/0750%26EPRG0721.pdf.

require substantial change.[235] Because of this, regulatory reforms have been introduced to incentivise innovation (e.g. RIIO, LCNF), which should provide small advantages to firms who are more innovative. This suggests a shift towards both efficiency and innovation driving competitive advantage for regulated networks.

In the move to a low-carbon economy, as networks face new challenges, innovation will become an increasingly important driver of performance for networks. One role of programmes such as the LCN Fund is to prepare network businesses culturally for these new innovation challenges.

As described above, distribution networks already face competition in the market for new connections and in the provision of metering. Efficiency and performance in delivering the capital works associated with new connections, and managing the resulting networks will drive their competitive advantage here.

The most important resources for networks are the ownership of the network infrastructure, the holding of the monopoly licence and the management of a skilled workforce.

10.7.6 Partners

At present, networks partner with contractors for reinforcement and maintenance of their assets, as well as providers of the capital goods that they use.

10.7.7 Valued added and profitability

The value added on the electricity transmission networks (attributable to domestic and small business) is around £0.8/year. The total value added of the electricity distribution networks is much higher at £3.1bn/year.

The profitability of the electricity networks businesses is largely determined by the target rates of return set by the price control,[236] which are in turn factored into the allowed revenues. Typical allowed (post-tax) returns on capital for electricity networks are between 4% and 5%.[237] The actual returns received depend on how networks businesses perform relation to their targets and incentives.

235 Recognised for example in National Grid Electricity Transmission's Climate Change Adaptation Report, available at: http://www.nationalgrid.com/NR/rdonlyres/E56234DB-3B35-49CC-9FC0-2A6F44F4052E/45162/nationalgridccareport100931.pdf.

236 These are set according to assessments of the costs of capital facing networks businesses.

237 Ofgem (2009), *Electricity Distribution Price Control Review: Final Proposals*

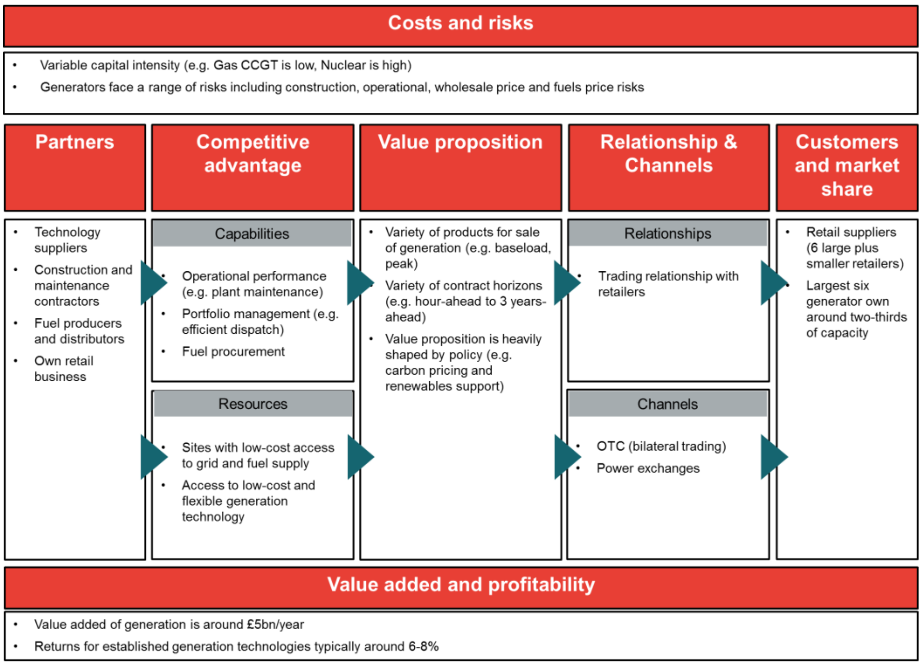
10.8 Upstream business model canvas

The upstream fuel part of the value chain is responsible for producing and delivering fuel to generators. The generation part of the value chain then transforms primary input such as gas, coal, and renewable resources into electricity. It must produce this electricity reliably (in the right quantities, at the right time) and with the required quality (e.g. voltage and frequency).

We focus on the generation part of the value chain in this section. The characteristics of the upstream fuel market are covered for the case of gas in more detail in Annexe 4.

Figure 40 shows the business model canvas for the upstream electricity sector. We now describe what it shows, beginning with the costs and risks networks face, then working from right-to-left, before showing what value added and profitability these business models deliver.

Figure 43. Business model canvas- electricity generation



Source: Frontier Economics, adapted from the Business Model Canvas[238].

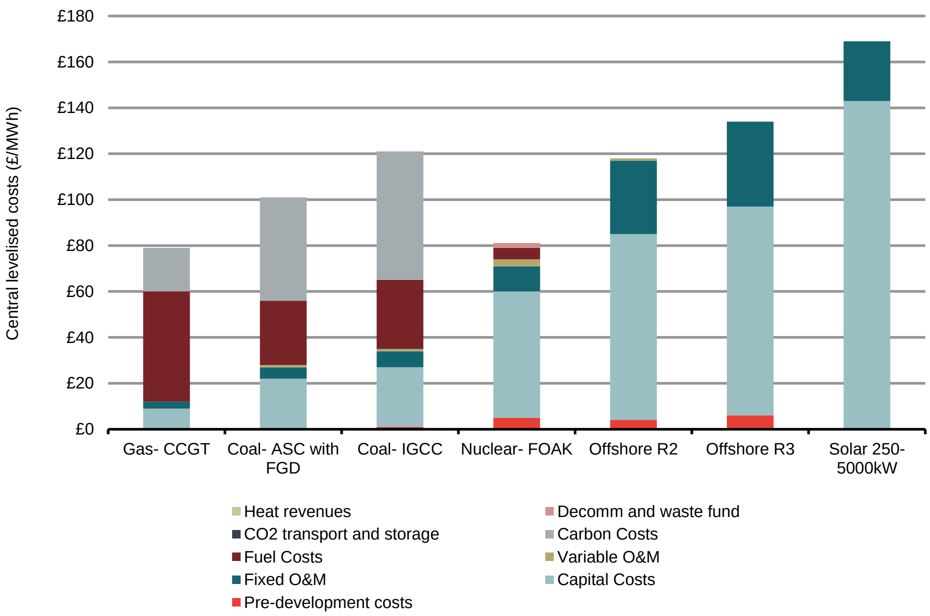
10.8.1 Cost and risks

The capital intensity of the upstream generation business varies by generation technology. Over the past two decades the generation mix has been dominated by gas CCGTs,[239] coal and nuclear. **Figure 44** shows how the capital intensity of these technologies compares. This shows that CCGTs are the least capital intense of the generation technologies. Fuel costs dominate capital costs, assuming they are running baseload. Coal is slightly more capital-intensive. Nuclear is very capital intensive, with very low fuel and operating costs with the renewable technologies (offshore wind and solar) being the most capital intensive.

238 From BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas

239239 Combined Cycle Gas Turbines

Figure 44. Breakdown of the costs of generating technologies[240]



Source: Parsons Brinkerhof,(2012). *Electricity Generation Cost Model Update*

Note: Parsons Brinkerhof's data are based on expert interpretation of raw market and project data, plant modelling and bottom up costings.

Another feature of electricity generation costs is the large size ('lumpiness') of investments and long lead times and lifetimes. A new gas CCGT is typically sized at around 900 MW, representing over 1% of GB capacity, and costs around £600m,[241] with a lead time of 3 to 6 years and lifetimes of up to 40 years.[242]

Flexibility is also important. The average peak availability of a gas or coal station is typically around 90%.[243] This means therefore that a margin of capacity over peak demands is required to ensure these can be met with a high probability. Equally the generation fleet must be flexible enough to be able to meet swings in electricity demand.

These aspects are an important determinant of the risks faced by the generator.

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240 Note: These estimates are for new build stations while all plant currently in place was built at least a decade ago). They also include higher carbon costs than present levels)

241 Parsons Brinkerhoff (2012) *Electricity Generation Cost Model Update*,

242 Energy and Climate Change Committee: Written evidence submitted by InterGen UK http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/275/275we32.htm (Accessed 07/03/13)

243 Parsons Brinkerhoff (2011), *Electricity Generation Cost Model – 2011 Update*

- **Wholesale electricity price risk.** Because of the lead times associated with generation investments, investors must make a decision to build plant several years before it is actually needed. The plant will then remain on the system for up to 40 years. This means that owners of generation plant are exposed to risks around the volume of demand, which in turn determines the wholesale price and their revenues. In particular, prices in the market can be very sensitive to how tight capacity margins are. The more capital-intense is the technology, the greater is the exposure to these risks.

- **Fuel price risks**. The prices of fuel (such as coal and gas) needed to run power stations can volatile. As shown in Figure 44, for gas this makes up a large proportion of revenue.

- **Operational risks.** Unplanned outages can imply major losses of revenues for generators.

- **Construction risks.** The construction of a large power station can be a highly complex project with significant potential for cost and timing overruns.

The greater the capital intensity of the plant, the more important are electricity price, operational risks and construction risks and the less important are fuel price risks.

10.8.2 Customers and market share

The largest six generators held over two thirds of generation capacity (69%) in 2011.[244]

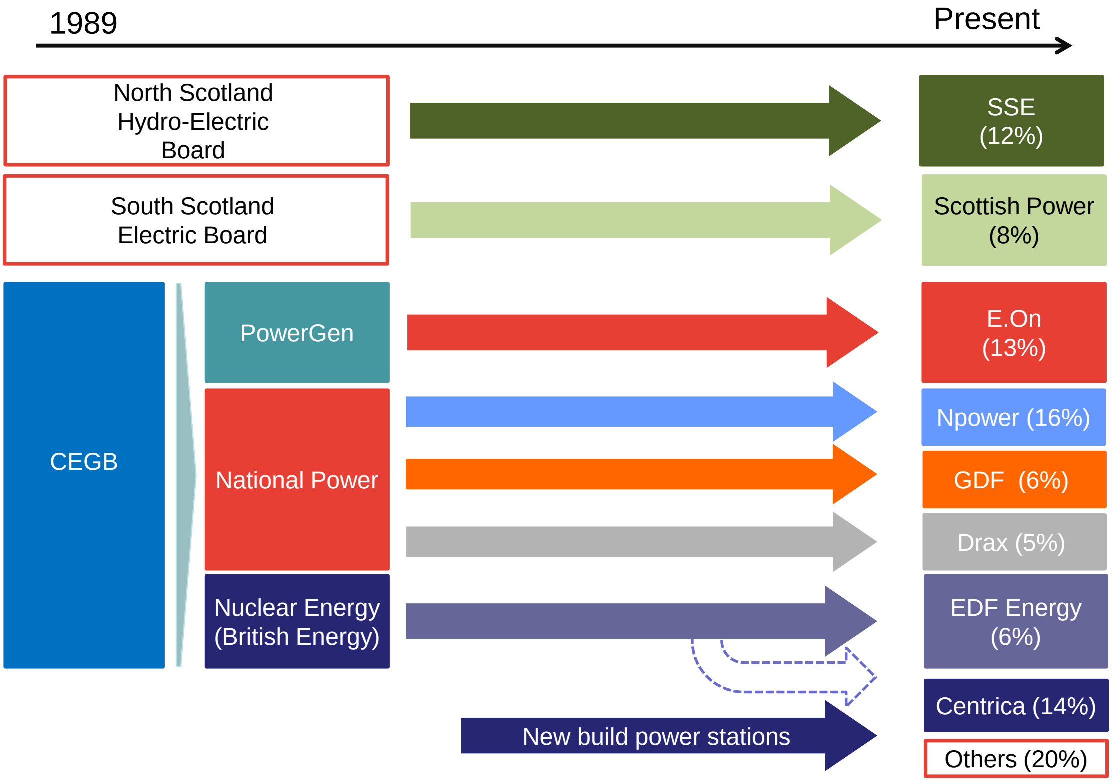
The generation market has become considerably less consolidated since privatisation of the three companies holding the generating capacity of the CEGB in 1990. In contrast to the retail market and networks, the incumbents have not consolidated horizontally over time, but have been split and sold existing power stations to various entrants into generation. Up until 2001, ownership of the main generators did not change significantly. In 2001, National Power was separated into Innogy and International Power. Powergen was purchased by E.ON in 2002 and Innogy was bought by RWE. In the early 2000s, new entrants (mainly American companies) joined the market. However, these later exited. For example, American Electric Power (AEP), exited the market in 2004 when the sale of its UK assets was used to reduce debt and strengthen its balance sheet.[245] This pattern of exit resulted in the share of generation capacity

244 Frontier Economics analysis based on DECC (2012), *Digest of UK Energy Statistics*

245 http://www.aep.com/newsroom/newsreleases/default.aspx?id=1140 (Accessed 06/3/12)

from the largest six generators increasing to 50-60% between 2004 and 2008.[246] In 2007, Iberdrola merged with Scottish Power. [247] Figure 45 illustrates the change in ownership from 1989 to 2011.

Figure 45. Generation market composition in 1989 compared to 2011[248]



(2011 generating capacity share in brackets)

Source: Frontier Economics based on Simmonds, G. (2002) *Regulation Of The UK Electricity Industry 2002*.

While horizontal consolidation has not been a feature, there has been a significant move towards vertical integration through takeovers since 2001/2, following a number of bankruptcies around that time.[249] Vertical integration is a common feature in energy markets around the world. It helps companies manage the risks associated with lumpy and long-lived assets that have one use, and have an uncertain demand associated with them.

246 Ofgem, 2008, *Energy supply probe – initial findings report*

247 Ofgem (2009), *Context of Energy Regulation Since Privatisation*,

248 Note: this diagram is intended to give an illustration of the breakup of the national power stations; however, the full generating capacity of each current firm will also be supplemented by new build power station.

249 Ofgem (2009), *Context of Energy Regulation Since Privatisation*

10.8.3 Relationships, channels and value propositions

The "build, own and operate" model is common amongst generation owners but this still includes various outside contracting. In particular, developers of generation plant typically contract for equipment such as turbines, construction work and long-term maintenance contracts.

Generators have relationships with retailers, networks, the system operator and fuel suppliers.

Retailers

Generators sell electricity to retailers through the wholesale markets. Trading/sale of electricity takes place at a portfolio levels for larger generation firms. Independent generators may contract with these portfolio firms (e.g. via a long-term power purchase agreement) or trade directly in the wholesale market.

There are a wide variety of wholesale electricity contracts between generators and retail suppliers. Trading takes place from one hour ahead of real-time to 2-3 years ahead, but most liquidity is concentrated within-year. Contracts cover many different products (e.g. baseload, peak and off-peak).

Managing the risk associated with the sale of electricity to retailers is an important function of generation businesses. Like retailers, generators employ short term trading on wholesale markets along with hedging on long term markets.

As shown in Figure 39, vertical integration is also a common strategy.[250] Vertical integration began to become important in GB in response to the introduction of the New Electricity Trading Arrangements (Neta, later expanded and re-named Betta) in 2001. Investing in long-lived assets that have a high sunk cost because they have only one use, and have an uncertain demand associated with them is very high risk. Vertical integration can be a sensible, and low cost, way in which this risk can be managed, and is common in energy markets around the world. It can encourage investment in generation by providing more certainty to investors. However, these advantages may not be crucial for generators: around one-third of the generation market is now represented by independent generators (although these are often large multinational firms).

A notable feature of the GB electricity market under Betta is that it is run as an "energy-only" market with trading based on generation produced and no market for capacity. Prior to Betta and Neta capacity payments were made to generators, and many electricity markets around the world employ capacity mechanisms. As a result of concerns that the "energy only" electricity market may not give sufficient incentives for investment in capacity as more low-carbon generation is

250 Ofgem (2011) *Retail Market Review: Findings and Initial Proposals*,

built, DECC are now proposing to introduce a capacity mechanism as part of the Electricity Market Reform (EMR) package. In this market, generation (and non-generation providers of capacity like demand side response and storage) will receive a payment for providing reliable capacity. In return, they will be obliged to deliver energy at times of system stress. The capacity market will work alongside the wholesale electricity market.[251]

Also as part of the EMR package, long-term contracts for low-carbon generation are being introduced with contract terms (including price) defined by DECC.[252] In these ways, the value propositions in generation are increasingly being defined by policy.

Networks

Generators are charged for access to the transmission system (or in the case of smaller generators, the distribution system). This includes an initial connection charge and an on-going annual payment based on capacity (£/MW/year) and the location of the plant (reflecting higher costs associated with transmitting electricity in places further from demand). Transmission charges are currently being reformed to rebalance the charge towards having a significant generation-based element reflecting that it is not just peak supply and demands that drive transmission costs, particularly as the level of wind on the system grows.[253]

System Operator

National Grid procures Balancing Services in order to balance demand and supply and to ensure the security and quality of electricity supply across the GB Transmission System. This includes contracting with generators for reserve services and balancing energy which can be an important source of revenues for some plant, particularly those which are flexible.

The costs to National Grid procuring balancing of these are recovered through Balancing System Use-of-System (BSuOS) charges on generators (and demand). These are largely based on generation (MWh).

In both the gas and electricity markets participants are given strong incentives to ensure demand and supply balance. For example, retailers are charged for any differences between the energy the sell to consumers and the amount they have contracted from the wholesale market. These charges target the costs incurred by the System Operator (SO) in resolving imbalances in demand and supply to those parties who create the costs (i.e. those parties who do not balance their inputs and outputs within the relevant balancing period). Therefore parties who are not

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251 DECC (2012), *Annex C: Capacity Market Design and Implementation Update*,

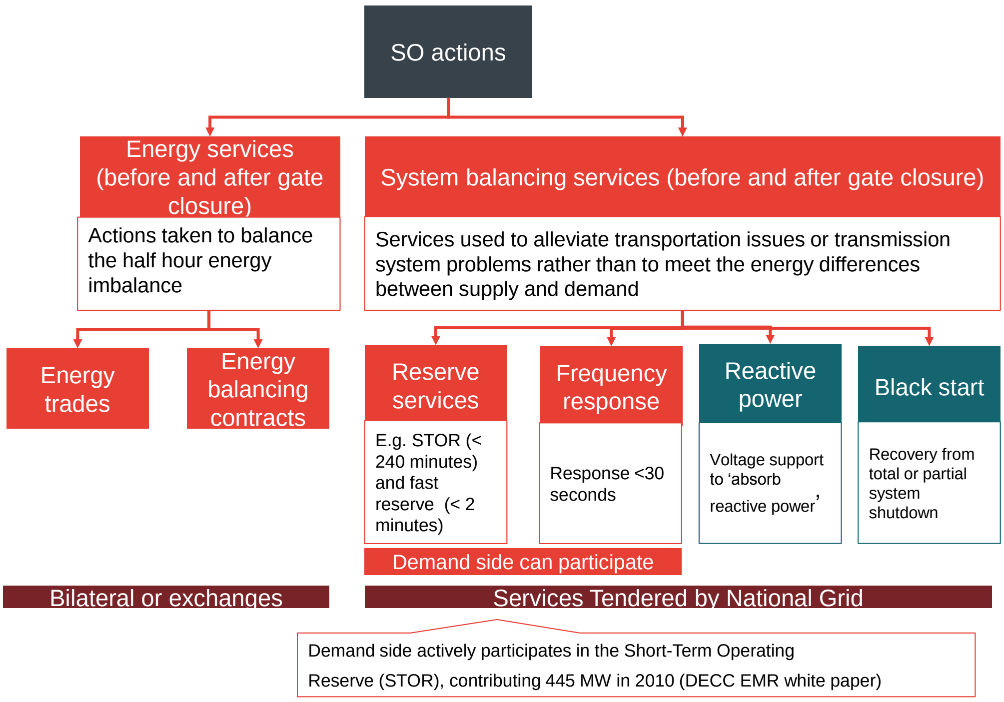
252 DECC (2011), *Planning our electric future: a White Paper*

253 Ofgem (2012), *Electricity transmission charging arrangements: Significant Code Review conclusions*

in balance incur charges that reflect the costs incurred by the SO in addressing the imbalance. These are known as cash out prices.

In electricity the strength of these incentives in currently being reviewed. This is due to concerns that they do not fully reflect the costs to customers of supply interruptions and therefore may under incentivise investment in generation and other measures that improve reliability . The System Operator's actions are described in Figure 46.

Figure 46. System Operator actions



Further detail on the System Operator is provided in Box 7.

Box 7. System Operator and the role of aggregators

National Grid is the electricity transmission system operator for Great Britain. This means that it must match demand and generation in real-time to maintain the security and quality of electricity supply.

In practice, this requires that National Grid contracts for a number of services to ensure it meets these requirements. A key cut-off point is gate closure (which occurs 1 hour before each half hour settlement period, at which generators and retailers must inform the SO of their physical production and consumption plans. At this point generators and retailers must also inform the settlement administrator of their contract positions.

The two main types of action taken by the SO are energy services and system balancing services, described below.

Energy services

These are actions taken to balance the half hour energy imbalance. There are two key types of energy services the SO is involved with, before and after gate closure: energy trades and energy balancing contracts.

These may be bilateral or through exchanges. Participants before gate closure can include physical traders (generators, retailers and the SO), as well as non-physical traders such as banks. After gate closure, bilateral trades take place between the SO and generators or retailers.

System balancing services

These are services used to alleviate transportation issues, transmission system problems and ensure the resilience of the system.

The system balancing services tendered by National Grid include the following.

- **Reserve services.** Examples of these include STOR (which is for response in less than 240 minutes, and can be as little as 20 minutes) and fast reserve (which must respond in less than 2 minutes).

- **Frequency response.** This is to maintain frequency, and requires a response time of less than 30 seconds.

- **Reactive power.** Reactive power provides voltage support.

- **Black start.** This is to provide recovery from a total or partial system shutdown.

Contracts are typically bilateral, and include payment for availability, plus additional payment for the actual delivery of a service. The providers of these services include generators and (for reserve services and frequency response) demand side response (DSR). DSR can be provided by large electricity users, or a portfolio of agents put together by an aggregator. More detail on aggregators is set out below.

The role of aggregators

Commercial aggregators (for example Flexitricity and EnerNOC) are companies that group balancing resources together and sell them to the System Operator as a single service. The aggregator is then paid for the availability and use of the service, and the aggregator uses this revenue to pay the balancing resources that provide the service.

The balancing resources aggregated together are typically industrial and commercial entities which have a large electricity load and the ability to reduce it quickly without suffering significant disruption (for example by switching to using back-up diesel generators rather than grid electricity, or changing the use of large-scale refrigeration).

To be effective, aggregators must demonstrate the following.

- Detailed knowledge of the needs and capabilities of National Grid and the balancing resources. This is needed to be able to group flexibility services appropriately.

- Ability to reliably deliver flexibility services. This requires effective communications channels in the event of flexibility being called upon, and monitoring (e.g. minute by minute metering) to ensure that resources deliver the service that they are contracted for.

10.9.1 Competitive advantage

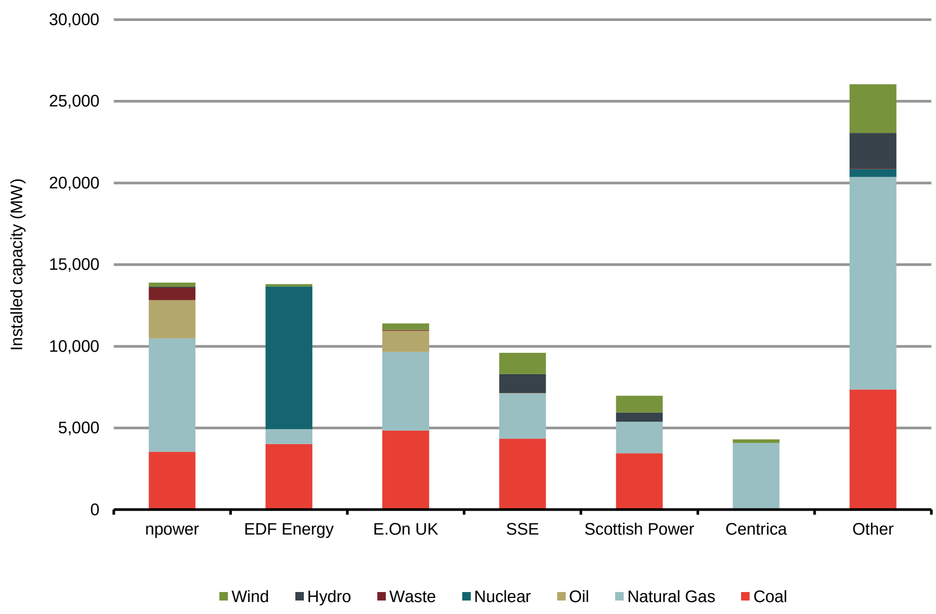
There are a number of potential sources of competitive advantage associated with electricity generation.

- Access to sites with low-cost and reliable access to fuel supply chains and to the electricity grid is important.

- Generators must also access low-cost, efficient and reliable technology. This includes optimising the mix of generation technologies in the portfolio. For example, depending on the relative prices of gas, coal and carbon, the profitability of gas CCGTs relative to coal can vary significantly. Policy can be a major driver of the relative attractiveness of different generation technologies (e.g. through carbon pricing and renewables support). Figure 47 shows how the generation mix of major companies varies by the largest companies.

- Operational performance (e.g. maintaining plant reliability, maintaining the plant's efficiency) can drive competiveness.
- Trading and operational planning (e.g. ensuring plant profitability is maximised by have plant available and dispatching it to capture the highest prices) is also important.

Figure 47. Mix of capacity by company



Source: DECC (2012) *Digest of UK Energy Statistics,* Table 5.1

[254] .

[254] Purvin & Gertz Inc. for DECC, 2011, Developments in the international downstream oil markets and their drivers: implications for the UK refining sector, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48142/2259-int-downstream-oil-mkts-drivers.pdf.

11 Annexe 6: District heating value chain map

District heating schemes exist to produce homes and businesses in a local area with a direct supply of heat (for space heating and hot water) This annexe presents our analysis of the value chain for providing district heating to domestic and small business consumers in Great Britain.

11.1 What is being provided to consumers?

We begin by describing the uses of district heating for domestic and small business consumers. We then discuss the features that district heating must have to be useful to these consumers.

11.1.1 Domestic and small business consumption

District heating schemes provide homes and businesses within a local area with a supply of heat for space heating and hot water.

A district heating network may be supplied with heat by a dedicated boiler, which is typically gas- or waste-fired in the UK. Combined Heat and Power (CHP) can also be used as the source of the heat.[255] CHP generates electricity as well as heat (using CHP, electricity and heat can be produced at a greater fuel efficiency compared to if they were produced separately).[256] Around 72% of the UK's district heat is fuelled by gas-fired CHP[257].

Approximately 2% of the housing stock is connected to district heating systems. 89% of the dwellings served by district heat are flats while the remaining 11% are houses.[258] District heating is more prevalent in social than private housing, in part because it is more suited to higher density dwellings such as purpose built flats. District heating is also used in small business (such as shops and offices) and campus establishments including hospitals and educational institutions.[259]

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255 Within this annexe, references to CHP refer only to community-scale CHP facilities used for district heating. CHP can also be used at larger scales (within a transmission-connected power plant) or, at the other extreme, within domestic CHP units installed within individual households or premises.

256 CHP plants in the UK mainly provide services for industrial users – it is estimated that oil refineries and the chemicals, paper, publishing and printing industries account for 76% of CHP electrical capacity. Carbon Trust (2010), *Introducing combined heat and power*,

257 DECC (2013) *The future of heating: meeting the challenge*

258 Energy Saving Trust (2011), *The applicability of district heating for new dwellings*

259 Building Research Establishment for DECC (2012), *District heating – heat metering cost benefit analysis*. Heat and the City Project (2012), *DH Vanguard Projects*

Overall, there are around 2,000 networks serving approximately 210,000 dwellings and 1700 commercial and public buildings across the UK[260].

11.1.2 What characteristics of district heating are important to consumers

To allow consumers to meet their space heating and hot water needs, the district heating value chain must deliver heat reliably and to a certain quality standard.

- **Reliability.** Consumers generally need a highly reliable supply to meet their heating needs. This is particularly the case for district heating, where a large number of households are reliant upon the centralised heating apparatus.

- **Quality.** District heating provides piped hot water to end consumers, which is then used for space and water heating. There are temperature losses during transportation, and to be useful the water must be a sufficiently high temperature at the point of delivery.

- **Responsiveness.** Outside temperatures and needs for heat (e.g. whether the consumer is at home) vary significantly. The district heating system (and associated controls) must be able to deliver heat flexibly.

11.1.3 International experience of CHP and district heating

This section summarises some key details on district heating outside the UK. While the use of district heating is currently relatively low in the UK, some other countries, particularly in Europe, use district heating more extensively, so could provide useful lessons for the UK.

It is estimated that CHP-fed district heating supplies 15% of heat demand in the EU-27 countries.[261] For some European countries, including Denmark, Sweden, Latvia, the Netherlands and Finland, CHP and district heating is more widespread. For example, district heating has market shares of around 49% in Finland, 50% in Sweden and almost 70% in Denmark, including networks served by CHP and other sources of heat. [262]

- Countries where district heat is prevalent tend to have cold climates necessitating more use of heat, and strong policy support aiming to deliver security of supply. Different support mechanisms have been used for CHP and district heat. For CHP, incentive mechanisms have included feed-in-tariffs, investment subsidies, exemption from specific taxes, preferential grid

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260 DECC (2013) *The future of heating: meeting the challenge*

261 European Environment Agency (2012), *Combined heat and power (CHP) (ENER 020) – Assessment published April 2012*

262 DECC (2012), *The Future of Heating: A strategic framework for low carbon heat in the UK*

access, and fuel subsidies.[263] As part of Denmark's heat strategy, local authorities were required to produce heating plans and were given powers to make take up of public supply of heating[264] compulsory in both existing and new buildings. Installing electric heating in new buildings was banned.[265]

- Features of district heating networks internationally include flexibility – for example district heating in Sweden has moved from heating oil providing 84% of district heat in the early 1980s to a wide range of sources by the early 2000s, including 28% solid biofuel.[266] District heating networks in Scandinavian countries are more concentrated in dense areas, and proposed solutions to enable networks to expand to less dense areas include greater use of storage.[267]

- Scandinavian district heating networks tend to be larger scale than those that currently exist in the UK. Unlike UK district heating networks, which tend to have one (or a small number) of heat sources per network, they often include many sources. This may include systems with peaking plant or storage located close to demand, with fewer baseload heating sources. Larger scale networks can help balance demand, for example where domestic and commercial users have peak demand at different times. Multiple generation sources can also introduce competition on the network. Large-scale networks have often been achieved through the connection and expansion of smaller heating networks, emphasising the importance of a flexible network design.

- The monopoly nature of heating networks can raise competition concerns, where consumers may be locked into long-term contracts and connecting to the network may have been compulsory. For example district heating pricing is currently being investigated by the German Cartel Office in 30 supply areas.[268]

We now discuss how the CHP and district heating value chain has developed in a way that that allows these needs to be met.

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263 European Environment Agency (2012), *Combined heat and power (CHP) (ENER 020) – Assessment published April 2012*

264 This could include natural gas heating as well as district heating.

265 Danish Energy Authority (2005), *Heat Supply in Denmark, http://193.88.185.141/Graphics/Publikationer/Forsyning_UK/Heat_supply_in_Denmark/html/chapter03.htm*

266 Wagrowski, Wlodek (2012), *District heating in Sweden*

267 Energy Saving Trust (2011), *The applicability of district heating for new dwellings*

268 Lang, M., and Mutschler, U. (2013) *German Cartel Office launches investigation into district heating prices, http://www.germanenergyblog.de/?p=12471*

11.2 Overview of the value chain

In this section we describe each element of the value chain and look at the physical and contractual flows between each part. We then look at the overall value of the district heat sector.

11.2.1 Elements of the value chain

We divide the value chain into four parts.

- **Upstream.** The upstream part of the value chain includes CHP plants and other district heating plants (e.g. waste incineration producing heat only). The role of the upstream part of the district heating and CHP part of the value chain is to convert fuels into hot water (or steam) and electricity for households and commercial users to consume. These need to be produced at the right time and with the right quality (i.e. temperature for hot water). In most cases, to minimise losses during transport, district heating plants are located close to demand and are often connected to the electricity distribution network. There is very close functional integration between the upstream and network parts of the value chain.

- **Networks.** Heat networks typically distribute heat using hot water (heated to 80 to 120 C). Because heat is lost through the network, district heating is best suited to areas with a high heat demand density[269]. By their nature district heating schemes are local monopolies and therefore the nature of competition tends to be 'for the market' rather than 'in the market'. The public sector has an important role to play in enabling viable district heating network business models for developers.[270] This is because of local authorities' planning powers and ability to coordinate between developers and consumers (such as public buildings and social housing groups). The higher prevalence of district heating in social housing than private housing also means that local authorities are more likely to be involved in the networks.

- **Retail.** This part of the value chain is concerned with ensuring consumers receive the heat supply in their homes and businesses and that they are billed accordingly for it. The nature of the retail supply of district heating is influenced by the technology available to monitor the levels of heat being taken by the consumer (i.e. whether heat meters have been installed). 25% of households with district heating have heat meters, while bills for the

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269 DECC (2012), *The Future of Heating: A Strategic Framework for low carbon heat in the UK*

270 Pöyry and Faber Maunsell (2009), *The potential and costs of district heating networks, A report to the Department of Energy and Climate Change*

remaining 75% are either apportioned based on total use in the building or based on a points system.[271] Retailing of CHP and district heat is often provided by the same organisations and consortia that own the plant and heat network infrastructure.

- **Enabling technologies.** District heating enabling technologies allow consumers to meet their space heating and hot water needs by controlling the amount of heat they receive. The key enabling technologies associated with district heating are heat exchangers (used for the delivery of heat) and top up boilers (used to supplement district heat).

11.2.2 Interactions in the value chain

Figure 48 describes the interactions that occur across the value chain. It describes two types of flows.

- **Physical energy flows.** Physical energy flows from left to right across the value chain. Heat and power is produced, and the heat is then distributed via heat networks which transport it to homes and businesses. Power from CHP may be distributed directly to large energy users, or sold via the distribution network. Previously CHP plants were incentivised to sell electricity via "private wires" rather than the distribution network due to the distribution charging structure. Ofgem is currently proposing "Licence Lite" licencing arrangements to enable smaller scale electricity generators, like CHP plants, to gain better access to the retail market. This would remove the requirement to be party to industry codes, which tend to be too costly and complex for small players[272].

- **Contractual relationships and financial flows.** Heat and power generators buy fuel and convert this into heat and electricity. Heat is then sold to heat networks while the electricity is exported. Electricity exports could be direct to customers or to the distribution grid. Depending on the contractual arrangements, the benefits from selling surplus power may be shared with a corresponding heat network's customers. For example this is the case for the Pimlico District Heating Undertaking (PDHU), where this revenue is reinvested in Westminster housing.[273] The heat networks operate as local monopolies and provide heat to end consumers through a heat

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271 For example the points system used by the London Borough of Lambeth is based on the number of rooms and whether they have direct or indirect heating. Building Research Establishment for DECC (2012), *District heating – heat metering cost benefit analysis*

272 DECC (2013) *The future of heating: meeting the challenge*

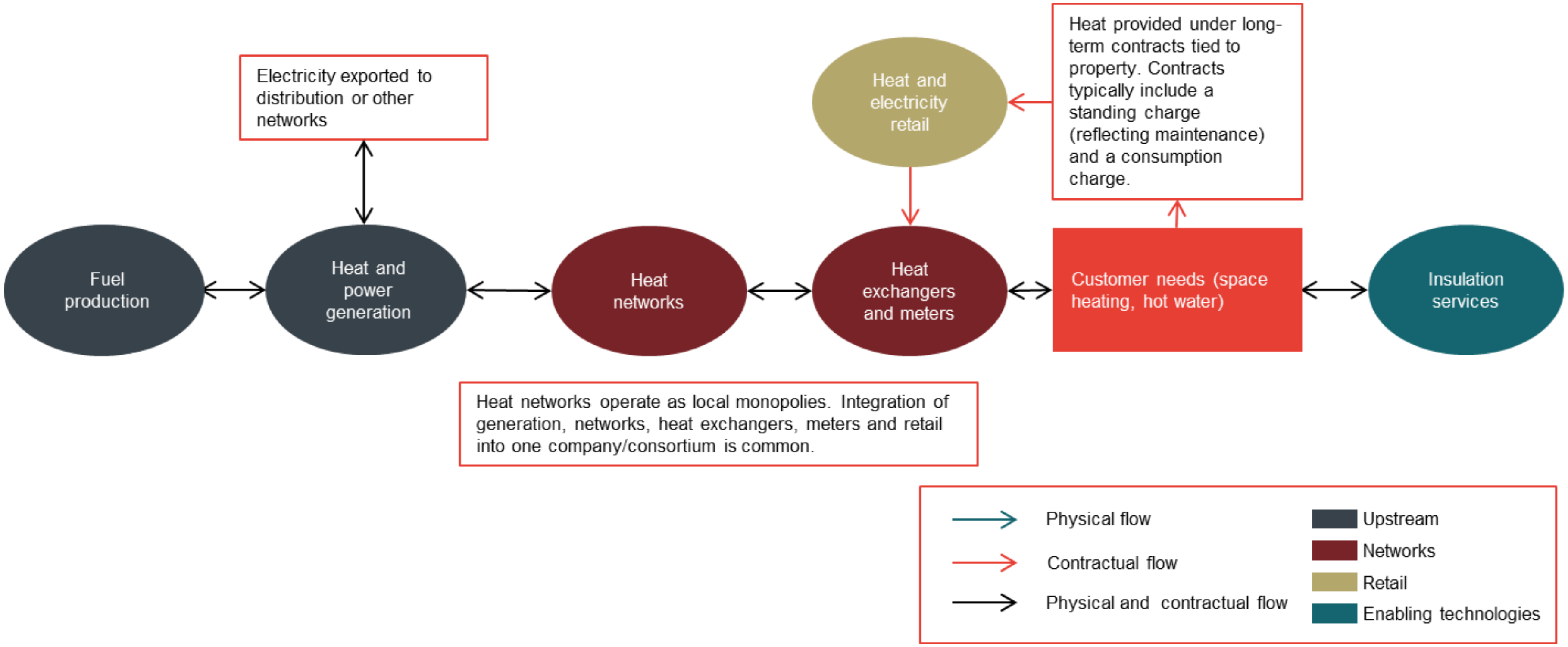
273 CityWest Homes (2013), *The Pimlico District Heating Undertaking (PDHU)*, http://www.cwh.org.uk/locations/churchill-gardens/the-pimlico-district-heating-undertaking-pdhu-/

exchanger which is usually metered for commercial consumers, and often not metered at the household level for domestic consumers (though meters are standard in new heating networks). End consumers pay retailers, and this is likely to be under long-term contracts or featuring a demand guarantee given the monopoly nature of the network and the need to recover high capital costs associated with setting up the network.[274] A lack of standard contractual arrangements was found to be a key barrier for both private and public sector led development of district heating networks in the UK.[275] In practice, generation, networks, heat exchangers, meters and retail may be integrated, resulting in the financial flows between a smaller number of parties.

274 Greater London Authority (2013), *District heating manual for London*

275 BRE, University of Edinburgh and the Centre for Sustainable Energy (2013), *Research into barriers to deployment of district heating networks*

Figure 48. District heating value delivery map



11.2.3 Value of the market

We estimate that the value of the market for district heating in the UK is currently around £200m to £400m per year.[276]

11.3 Business environment

To understand how the value chain and its component business models have developed, we first consider the characteristics of CHP and district heating production and consumption. We then look at the policy context.

11.3.1 Characteristics

We consider five main characteristics of district heating.

- **District heating meets consumers' basic needs for space and hot water heating.** Like all energy value chains we are looking at, the supply of district heating fulfils basic needs. Fuel poverty and its contribution to ill-health and excess winter deaths is a major driver for government intervention to protect vulnerable consumers. This policy driver may be particularly important in the district heating sector, which is disproportionately found in social housing where consumers are more likely to be vulnerable.

- **Heating networks can also provide cooling.** This can be done by building a cooling network alongside the heating network, as in Helsinki and Copenhagen.[277] Cooling can be supplied using excess heat (e.g. from a CHP plant), or using existing cold water (e.g. seawater). In the UK, this is likely to be most relevant for commercial and office buildings. Cooling demand is dwarfed by heating demand, but it is expected to grow over time. As a result, heating networks that also include some cooling could become increasingly relevant. Use of CCHP and district heating/cooling networks is currently limited – the Olympic Park and Stratford City as well as the Media City scheme in Salford are recent examples. It has a shorter cooling network in parallel to the heating network.[278]

- **Heat is distributed via pipeline networks.** District heating is delivered through pipe networks using hot water (or steam). This has two key implications.

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276 Frontier calculations based on DECC data

277 Greater London Authority (2013), *District heating manual for London*

278 DECC (2013), *The future of heating: meeting the challenge*

  - **District heat networks are natural monopolies.** The fixed costs of setting up a network connecting heat production to end users are so high that it is most cost-effective to have one network in a given area. This is similar to the electricity and gas sectors, where distribution networks are natural monopolies. Unlike the electricity and gas sectors, district heat networks are not heavily regulated. This may reflects the current small size of district heating networks, the possibility of competing 'for the market' and the high involvement of local authorities.
  - **Some heat is lost during distribution**, which makes more dense developments more suited to district heat. For example, suitable sites may include town centres with a high concentration of commercial users within a relatively small area, or apartment blocks where many households can be supplied through a single connection between the building and the network.

- **Consumption of heating is not always measured, and where it is measured, this only periodic.** At present, only an estimated 25% of households with district heating have heat meters.[279] This proportion is higher for commercial district heating consumers, but nonetheless existing metering technology is usually 'dumb' meaning that consumption cannot be monitored in real-time. This limits the scope for managing heating demand.

- **There are environmental externalities from heating production, but CHP plants may entail lower greenhouse gas emissions than conventional heating and power generation.** Generating heat is associated with carbon emissions. However, the environmental externalities associated with some types of district heat production may be lower than the conventional alternatives. For example, waste incineration to generate heat may avoid environmental costs associated with landfill. The use of CHP is also more fuel efficient than producing electricity and heat separately.

11.3.2 Policy environment

Several of the characteristics of district heating mean that there are significant policy incentives around the introduction of district heating sourced from CHP plants. Incentives for CHP include exemption from the Climate Change Levy (CCL), enhanced capital allowances and subsidies under the Renewables Obligation for biomass and waste-fired CHP plants. Heat networks are also

279 For example the points system used by the London Borough of Lambeth is based on the number of rooms and whether they have direct or indirect heating. Building Research Establishment for DECC, 2012, District heating – heat metering cost benefit analysis

supported by the Renewable Heat Incentive (RHI) if their heat is supplied by an eligible installation. The RHI applies to eligible district heating networks based on the capacity of the installation supplying heat to the network. For example, if a district heat network is supplied by a 600kWth biomass boiler, the RHI treats the district heating network equivalently to if the same capacity biomass boiler was supplying one large consumer rather than a set of smaller dispersed consumers.[280] The government has also announced £9 million of support for local authorities to launch district heating networks and an additional £1 million for Manchester, Nottingham, Sheffield, Newcastle and Leeds to develop heating networks.[281]

11.4 District heating business canvas

We now go on to describe the business canvas for the district heating sector. **Figure 49** illustrates the upstream, network, retail and enabling technology parts of the value chain together, given their close functional integration.

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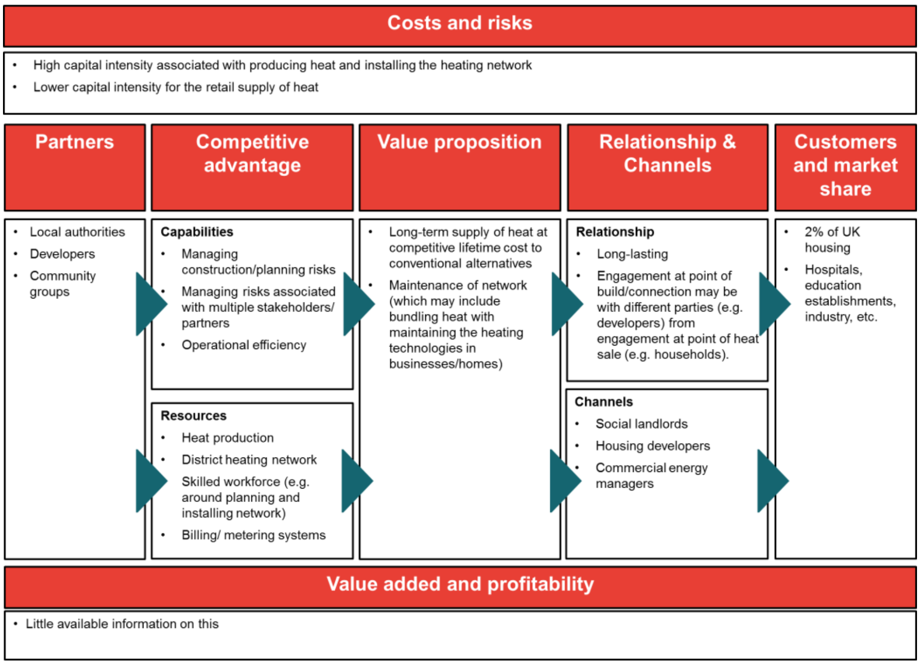
280 Renewable Heat Incentive Ltd. (2013), *FAQs, http://www.rhincentive.co.uk/faqs/item/441/*

281 Cogeneration & On-Site Power Production, 2013, *IDEA applauds UK Department of Energy and Climate Change for heat strategy, http://www.cospp.com/news/2013/03/29/idea-applauds-uk-department-of-energy-climate-change-for-heat-strategy.html*.

Figure 49. District heating business canvas



Source: Frontier Economics, adapted from the Business Model Canvas[282]

11.4.1 Costs and risks

Table 5 shows DECC estimates of the current costs of setting up district heating networks. These costs are highly capital-intensive - based on a 10% discount rate, capital costs represent approximately 60-70% of total costs. In general the costs of building the heat network are the largest component of the capital costs.[283]

282 from BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.

283 Pöyry and Faber Maunsell (2009), *The potential and costs of district heating networks, A report to the Department of Energy and Climate Change*

Table 5. CHP and district heat central domestic cost estimates

Type of district heat	Capital cost (£k/ household)	Operating cost (£k/ household)
Community scale gas CHP	19.16	0.48
Community scale solid-fuel CHP	25.95	1.03
District heating from power stations	An additional £6.5k per household (approx.)	0.09

Source: DECC 2050 Pathways Analysis

Providing cooling in parallel would add to capital costs, but may also increase the economic viability of the network by meeting both heating and cooling demands, and spreading network demand more evenly over the year.

Feasibility analysis of absorption chillers for district cooling in Copenhagen found that they were competitive for cooling capacity above 500kW, where the cooling installations were new or where old CFC or HCFC compressors were being replaced.[284] District cooling may be most viable where there is a local free source of cooling (e.g. the sea) which enables cooling to be provided while reducing electricity demand relative to the alternatives, given that the coefficient of performance of absorption chillers is low relative to electrical chillers.[285] One article on district cooling in Copenhagen estimated that customers saved 45% on their cooling expenses when using district cooling rather than traditional cooling.[286]

The costs of the retail supply of district heating are unclear as the retail offering is often provided by the same organisation that provides the plant and heat network infrastructure. However, retailing is less capital intensive, and key costs for retailers are likely to include billing, collecting payment and, where metering is used, providing the technology and collecting data.[287]

284 Foged, M., and Skov, M. (1999), *District Cooling in Copenhagen*, http://dbdh.dk/images/uploads/pdf-cooling/district-cooling-in-copenhagen.pdf

285 Greater London Authority (2013), *District heating manual for London*

286 With, J., Danfoss (), *Huge Demand for District Cooling in Central Copenhagen*, http://heating.danfoss.com/PCMPDF/VZGEH102_DC-CHP_CaseStory_lores.pdf

287 Building Research Establishment for DECC (2012), *District heating – heat metering cost benefit analysis*

Where heat is metered, the estimated capital costs of installing heat metering and data gathering systems are £447 per dwelling, while annual running costs are £81 per dwelling.[288] Metering is more prevalent for non-domestic consumers.

A key risk in developing a district heating scheme is the risk that consumers may switch to other sources of heat if district heat becomes less competitive, making it more difficult for developers to recover their costs. In practice, this risk may be relatively minor as substitutes are limited (e.g. non-storage electric heating) without costly new installations. District heat retailers also bear the risk that consumers may not pay their bill on time, or they may not pay at all. On the supply side, there is also risk around the wholesale costs of the fuel used to generate heat for the network.

11.4.2 Consumers and market share

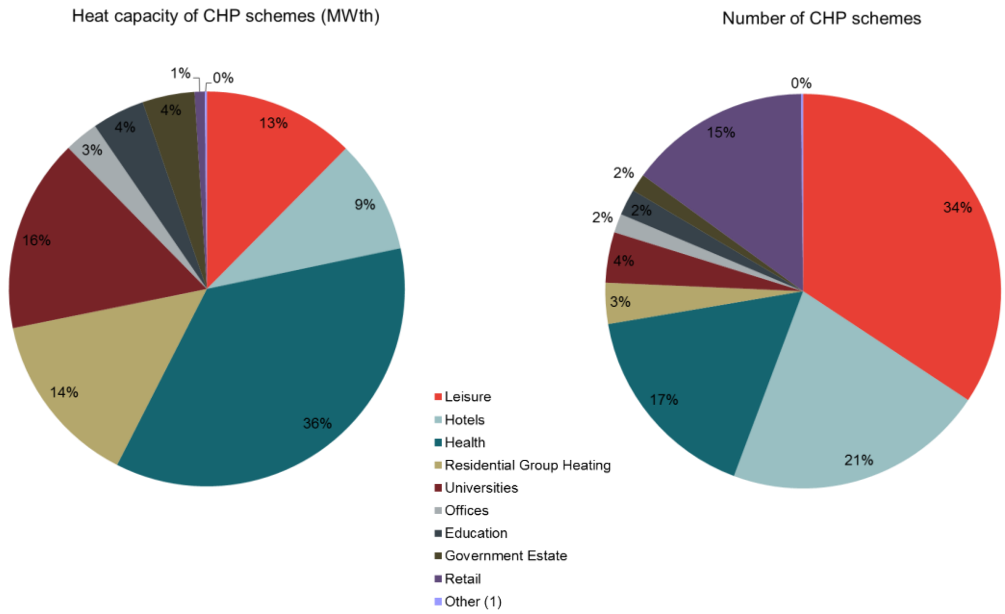
Approximately 2% of the housing stock is connected to district heating systems. District heating is more suited to higher density developments where heating needs can be met within a specific geographical cluster, typically with a limited number of direct connections to the network. This means that district heating is prevalent in higher density dwellings such as high-rise flats. High density of the end-users of heat is also seen in the non-domestic sectors, for example on single multi-use sites such as hospitals, industrial and education establishments.

Market shares of the organisations active in the CHP and district heating value chain are not available. However, within a given location, one organisation will typically have a monopoly over any district heat provision (due to the local monopoly nature of the network).

There are no statistics available on the penetration of district heating by organisation type, though as set out above it is more common in education establishments and hospitals. The charts below illustrate the uses of CHP systems, however not all CHP systems supply a district heating network, and some district heating networks will not use CHP. There are currently 411 MWth of CHP plant installed in the buildings sector (i.e. excluding the industrial sector) by heat capacity. Within the buildings sector, the split between different sub-sectors is shown in **Figure 50** . While all of these supply heat, some will supply through a district heating network, while others will supply a large user without a wider network requirement.

288 Building Research Establishment for DECC (2012), *District heating – heat metering cost benefit analysis*

Figure 50. Heat capacity and number of CHP schemes in the buildings sector, 2011



Source: DECC (2012) *Digest of UK Energy Statistics*

11.4.3 Value proposition, relationships and channels

Some characteristics of the relationship between consumers and district heat retailers can be observed from tariff information for three district heating schemes in the UK we have reviewed (Nottingham, Edinburgh, Thameswey[289,290,291]). These were the only district heating schemes for which this information was publicly available. It should be stressed that information is limited and it is unclear how general these features and value propositions are.

- **Heat metering.** It is estimated that 25% of domestic district heat consumers have heat meters. This is likely to affect the types of tariffs used (e.g. due to apportioning of demand). There is little information on district heat tariffs for commercial consumers. However, one paper notes that the use of metering for non-domestic heat network consumers is a major contributor to recovering investment and operating costs.[292]

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289 Enviro Energy, 2012, *District heating FAQs (Nottingham)*

290 Thameswey Energy (2012), General Information

291 Heat and the City Project (2012), *DH Vanguard Projects*

292 Building Research Establishment for DECC (2012), *District heating – heat metering cost benefit analysis*

- **Consumption versus standing charges.** The domestic tariffs we had information on include a standing charge (often reflecting maintenance costs) and a part that reflects use. Residents in social housing can be charged on a "heat-with-rent" basis (for example observed in Aberdeen), with a fixed annual tariff.[293]

- **Indexed pricing.** We found some evidence of prices being indexed (e.g. in Nottingham where they are indexed to alternative fuel prices, which could include gas). One large UK district heat supplier reported that the variable component of metered domestic heat tariffs was typically indexed at 10-15% below the cost of heat from a gas boiler.[294]

- **Variable versus fixed pricing.** The indexed examples above are evidence of prices varying over time. in addition, a scheme in Edinburgh uses semi-variable charging with residents charged a flat weekly rate, initially set at £1/day, adjusted periodically to reflect individual annual consumption.

- **Bundling.** District heating contracts can be bundled with maintenance contracts. For example, Thameswey's domestic tariff includes a compulsory maintenance charge which covers repair for heat exchangers and an annual inspection. The maintenance charge also includes an annual service, safety inspection and callouts during normal hours but does *not* cover plumbing, pipework and radiators;

- **Method of payment.** Standard credit, direct debit and prepayment are all used as options for domestic consumers to pay their heating bills in district heating schemes.

- **Long-term supply.** Given that district heat networks are natural monopolies, a consumer does not have a choice between different heat suppliers after the heating network is set up (though they can still use outside options such as electric heaters). This characteristic affects competition in the value chain (discussed further in the section below). It may also result in value propositions such as long-term contracts between retailers and consumers, due both to the monopoly nature of the networks and because of the high capital intensity meaning that upfront costs may be recovered slowly. However, we did not find evidence on the length of contracts entered into between district heat retailers and heat consumers.

293 Heat and the City Project (2012), *DH Vanguard Projects*

294 Building Research Establishment for DECC (2012), *District heating – heat metering cost benefit analysis*

It is also worth noting that, in contrast with electricity and gas, the supply of heat to customers of district heat networks is not governed by specific regulations between consumers and retailers. To prevent this lack of regulation becoming a barrier to the uptake of district heat, DECC has announced that it will endorse an industry-led consumer protection scheme for heat network users[295].

11.4.4 Competitive advantage

District heating may often be operated on a not-for-profit basis. Additionally, district heating differs from electricity and gas supply where, despite not having a choice of network to connect to, consumers can choose their retailer. Households and businesses connected to district heating schemes do not have a choice of heat retailer, since the retailer often also owns and/or operates the network and heat generation.

This means that competition takes place at different parts of the value chain, potentially impacting on sources of competitive advantage. Key areas of competition in CHP and district heating include:

- competition to install the district heating network;
- competition to operate and maintain the CHP plant, district heating network and retail; and
- attracting customers to the network at the installation (or extension) stage and competing with other types of heat and power generation. For example at the network level, this may be with final users in the case of large individual heat customers such as hospitals, or with housing associations or building developers in the case of domestic buildings.

The latter stage is where district heating and CHP compete with the rest of the energy market. For CHP, there may be competition with other types of heat generation (e.g. waste incineration) that could be used for a heating network. In addition, CHP plants compete with other types of power generation, whether privately connected to power users (who will assess whether the direct connection is economical relative to distribution connection), or connected to the distribution network. In the case of district heating, competition is with heating providers such as gas and electricity retailers. As set out above, district heating providers may use measures such as indexing heat prices below gas prices to encourage adoption.

The success of businesses competing to install and operate district heating networks may be driven by:

- operational efficiency, e.g. the ability to demonstrate efficiency on past similar projects.

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295 DECC (2013) *The future of heating: meeting the challenge*

- ability to manage operational risks, e.g. through vertical integration;
- ability to partner effectively with a wide range of organisations, for example local authorities and housing associations; and
- marketing and communication to encourage adoption of district heating (this may also be driven by local authorities).

The costs of district heating in the UK are high relative to Europe, so this is likely to be a key driver of district heating adoption in the first place.[296]

District heating is usually vertically integrated in the UK. A range of different ownership structures are seen in the district heating value chain. For example, Nottingham's district heating network is run by EnviroEnergy, which is owned by Nottingham City Council and covers production, supply and billing. Sheffield's district energy network is operated by Veolia Environmental Services for Sheffield City Council on a 35 year contract. Its responsibilities include operating the Eenergy Recovery Facility and developing the District Energy Network.

District heat network developers often set up an Energy Services Company (ESCo) which covers generation, transportation and retail of heat.[297] Sometimes these are "non-profit" companies (such as Aberdeen Heat and Power), joint public-private ventures such as Woking's Thameswey Energy Ltd. (TEL) and private sector ESCos such as Birmingham District Energy Company (BDEC).

Relatively long contracts (e.g. Veolia operates Sheffield's district heating network on a 35 year contract) may also provide incentives for district heating operators to achieve competitive advantage through innovating. Because of the risks around getting consumers to sign up for a long-term heat contract, district heating is more likely to be viable with new build developments or large-scale redevelopments. For vertically integrated district heat networks, risks around recovering the cost of network installation and upkeep may be mitigated by including standing maintenance charges in heat tariffs. This risk also affects how district heating schemes are funded. Schemes are typically funded in partnership with local communities. A range of different funding structures have been employed.[298]

- capital purchase, where consumers fund plant and infrastructure directly;

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296 Pöyry and Faber Maunsell (2009), *The potential and costs of district heating networks, A report to the Department of Energy and Climate Change*

297 Heat and the City project (2011), *Developing district heating in the UK: what works?*

298 Combined Heat and Power Association website (2013)

- long-term contracting where providers fund the plant and infrastructure in return for consumers signing up to long-term, fixed price contracts;
- energy performance contracting where an provider of a measure to improve energy efficiency (typically an ESCO) guarantees the efficiency improvement from the measure and recovers the investment costs with reference to the guarantee;[299] and
- private finance initiatives (PFI) used to create public-private partnerships .

11.4.5 Partners

There is a range of different partnering structures for CHP and district heat networks in the UK. The delivery of district heating projects usually involves collaborations and consortia between various members of the community and firms. Involved parties may include a local authority energy manager, energy service companies, property developers, planners, engineers, architects, and community groups.[300]

The public sector has an important role to play in enabling low-risk district heating business models for developers.[301] This is because of local authorities' planning powers and ability to coordinate between developers and consumers (such as public buildings and social housing groups). The higher prevalence of district heating in social housing than private housing also means that local authorities are likely to be involved in the networks.

11.4.6 Value and profitability

There is little information on the current profitability of CHP and district heating. However, we estimate that the value of the market for district heating in the UK is currently worth around £200m to £400m per year[302]. It is also worth noting that district heating projects are often run on a not-for-profit basis.

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299 For the full definition, see European Federation of Intelligent Energy Efficiency Services, *EPC: Energy Performance Contract Definition.*

300 Combined Heat and Power Association website (2013)

301 Pöyry and Faber Maunsell (2009), *The potential and costs of district heating networks, A report to the Department of Energy and Climate Change*

302 Frontier calculations based on DECC data

12 Annexe 7: Oil value chain map

This annexe presents our analysis of the value chain for providing heating oil to domestic and small business consumers in Great Britain. We follow the same format as in the previous annexes. However, given the lower use of oil as a heating fuel, our analysis is at a higher level than the analysis we presented in the other annexes.

12.1 What is being provided to consumers?

It is estimated that 1-1.5 million UK households have heating oil - or kerosene - fired central heating.[303] Data on penetration among small businesses is not available. Heating oil meets 9% of domestic space and hot water heating demand in the UK, a relatively small proportion which is primarily made up by houses in low-density areas off the gas network.[304] 53% of those rural GB households that are not connected to the gas grid use heating oil as their main heating fuel.[305] This is followed by electric heating, with a smaller proportion of these households using liquefied petroleum gas, bottled gas, or solid fuel.

To allow consumers to meet their space heating and hot water needs, the heating oil value chain must deliver reliably and to a certain safety standard. Reliability requires that customers have a tank with sufficient storage capacity, and that they access oil deliveries when they need the tank to be refilled.

12.2 Overview of the value chain

We divide the value chain into four parts.

- **Upstream.** The upstream oil sector includes crude oil production, refining into heating oil (and other products) and transportation to depots or terminals. Heating oil is a co-product of other oil products so companies involved in its production are necessarily also involved in the production of other distillates. It is therefore part of a wider market for petroleum products.

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303 Richards, P., and Paul Bolton, 2012, Heating oil and other off-gas grid heating - Commons Library Standard Note, available at: http://www.parliament.uk/briefing-papers/Sn05806; and OFT Off-grid energy market study, 2011, http://www.oft.gov.uk/shared_oft/market-studies/off-grid/OFT1380.pdf.

304 DECC, 2012, The Future of Heating: A strategic framework for low carbon heat in the UK, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48574/4805-future-heating-strategic-framework.pdf.

305 OFT Off-grid energy market study, 2011

- **Distribution.** Distributors cover both retail and distribution. They sell heating oil to end consumers and supply these consumers via tankers. Households store the oil in storage tanks at their. Distributors may deliver directly from refineries or from their own depot.

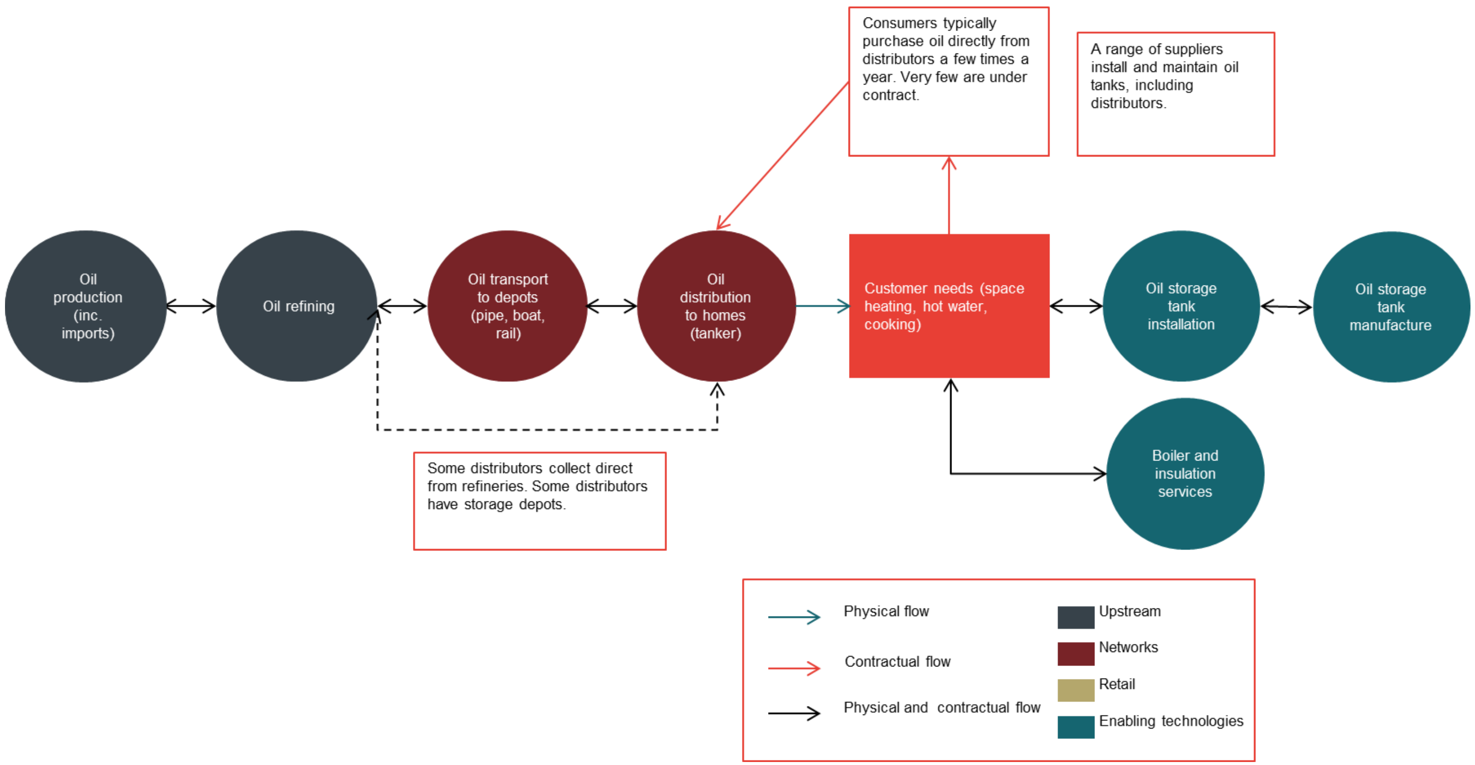
- **Enabling technologies.** The central heating systems that run on heating oil are similar to those that run on gas. As a result, many of the enabling technologies associated with heating oil are similar to those for gas. However, one specific feature of heating oil is that customers must have oil storage tanks on-site. These are described in Box 8.

Each part of the value chain is related to the other parts through physical and contractual flows. **Figure 14** describes the interactions that occur across the value chain.

- **Physical energy flows.** Physical energy flows from left to right across the value chain. Heating oil is refined in the UK or imported. It is then transported to terminals and depots by pipeline or road. Distributors/retailers then transport this to homes and businesses.

- **Contractual relationships and financial flows.** Heating oil distributors/retailers purchase heating oil from terminals, and they may then store it in their own depots. The end-consumers of heating oil purchase heating oil from these distributors.

Figure 51. Overview of the heating oil value chain

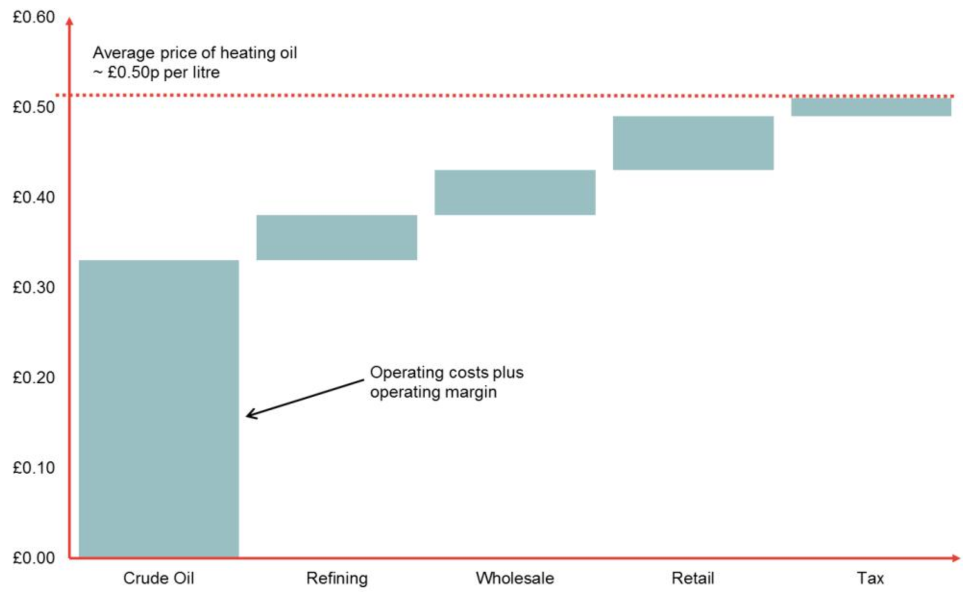


Source: Frontier Economics

The total value added[306] of the domestic heating oil market is currently around £2bn/year. The majority of this value added sits with the producers of crude oil (65%), with the remainder split between refiners, distribution and retail.[307]

A breakdown of the retail price of fuel oil in 2010 is shown in Figure 52. It shows that purchasing heating oil at the wholesale level makes up the bulk of costs (65% for crude oil, plus 10% given that the oil used for heating is refined, and a 10% wholesale margin) for heating oil distributors. This leaves an estimated gross margin of 10% of costs, out of which the distributor's own costs must be met.

Figure 52. Breakdown of price per litre of heating oil



Source: OFT, 2011

12.3 Business environment

To understand how the value chain and its component business models have developed, we must first understand the characteristics of heating oil production and consumption. We consider five main characteristics.

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306 For a given part of a value chain, value added is the revenues less outside purchases of materials and services (e.g. for gas retail this would entail revenues minus fuel costs and network charges).

307 Frontier calculations based on OFT and DECC data. Other financial measures were not available for the heating oil sector.

- **Heating oil meets some of the basic needs of consumers.** The supply of heating oil enables consumers to fulfil their basic needs for space and hot water heating. Fuel poverty acts as a major driver for government intervention to protect vulnerable customers. This driver may be particularly important for customers using heating oil, as it is a relatively expensive heating fuel and could mean more customers using it are fuel poor, particularly in rural areas which are off the gas grid.[308]

- **Heating oil is a co-product.** Heating oil is distilled from crude oil at refineries, and typically represents approximately 16% of the yield from a barrel of crude oil[309]. It cannot be produced in isolation of other oil distillates, and refineries have limited flexibility between the proportions of different products that they make from each unit of raw material.

- **Heating oil is a homogeneous product.** Though EU environmental legislation puts requirements on its sulphur content, fuel oil is a commodity which is not differentiated by different producers or retailers. Because of this, the price distributors pay is based on the international wholesale price (which in turn is closely related to the crude oil price).

- **As a liquid, heating oil is easily transported and stored in the quantities used by consumers for heating.** Crude oil is transported by land (by pipeline) and sea (by pipeline and oil tankers). Heating oil is transported by road in specialised vehicles, with smaller oil tankers for domestic deliveries. Therefore, in contrast to electricity and gas, its transport is not a natural monopoly, and does not require regulation to ensure fair prices for consumers.

- **The market is expected to decline.** Difficulties substituting to alternative fuels (for example high capital costs or a lack of feasibility in connecting to the gas grid) mean that in the medium term demand for heating oil is likely to remain steady. However, some distributors already regard the heating oil market as declining in the medium to long-term.[310] In addition, the high relative costs of heating oil and the move to a low-carbon economy are likely to reduce heating oil demand as households switch to alternative fuels However, demand for heating oil has not fallen over the past decade.[311]

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308 OFT Off-grid energy market study, 2011

309 OFT Off-grid energy market study, 2011

310 OFT Off-grid energy market study, 2011

311 OFT Off-grid energy market study, 2011

- The policy context is also crucial. As in the other energy value chains, a number of policies affect outcomes in the heating oil sector.

- **Government incentives for renewable heat technology adoption** such as the Renewable Heat Incentive and the Renewable Heat Premium Payment are focused on households not connected to the gas grid. This is likely to incentivise consumers to switch away from heating oil towards renewable alternatives over time (which may be exacerbated by rises in the price of heating oil), resulting in declining demand over time.

- **Duty**. Duty is a relatively small part of the retail price of heating oil (see Figure 52). This introduces volatility compared to if duty represented a larger part of the retail price relative to crude oil.[312]

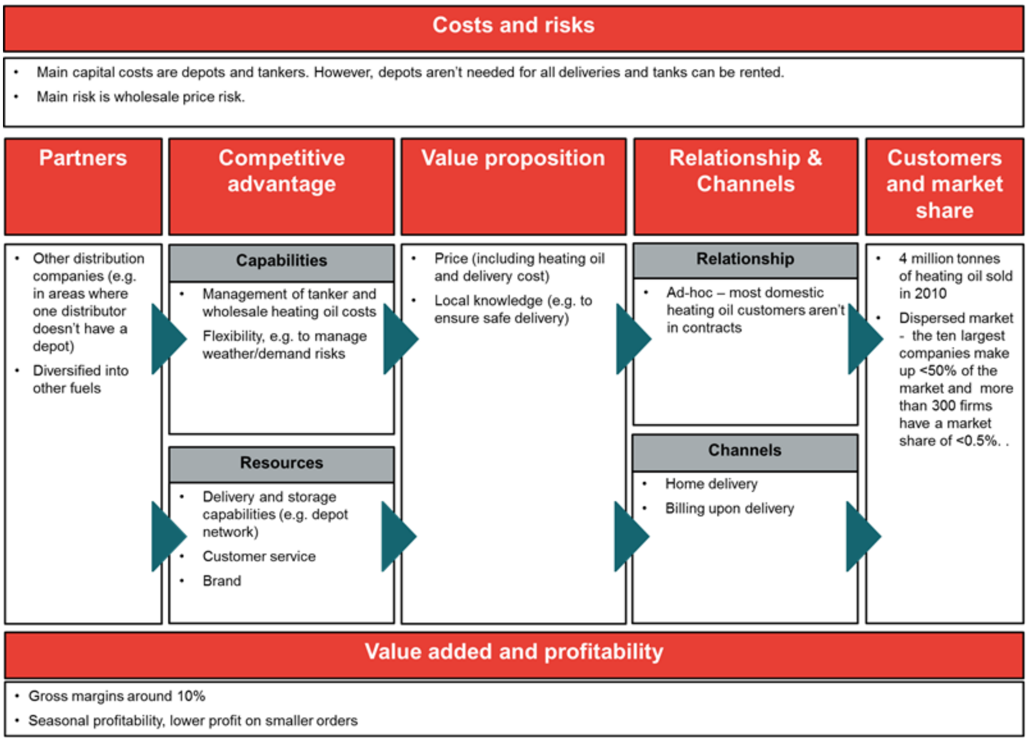
We now go on to describe the business canvas for the heating oil sector. We discuss the upstream and retail/distribution parts of the value chain separately, as they are the two key functionally distinct parts of the chain. We break down the business canvas as follows.

12.4 Heating oil distributors

Heating oil distributors are responsible for the distribution and retail of heating oil. Figure 53 shows the business canvas for this part of the value chain.

312 OFT Off-grid energy market study, 2011

Figure 53. Heating oil distribution/retail business canvas



Source: Adapted from the Business Model Canvas from BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas

12.4.1 Costs and risks

Heating oil distributors run relatively capital-intense businesses.[313]

- **Depots for storing heating oil.** Most businesses require depots for storing oil. However, distributors can sometimes bypass the use of their own depots by distributing directly from upstream depots.

- **Tanker.** Heating oil distributors often serve a large number of small, dispersed customers, often in rural areas. This requires tankers for the transport of oil by road to households. Firms can either buy these or hire them annually.

- **Heating oil.** The price of heating oil per litre that distributors pay is typically based on the traded wholesale price of jet kerosene.

313 OFT Off-grid energy market study, 2011

The other important operational costs for these businesses are likely to be the cost of delivery (affected by distance, weather, customers per route, size of vehicle required, etc.) and staff costs.

These businesses face a number of risks.

- **Wholesale price risk.** The wholesale price of oil can be volatile. This volatility (along with transport cost risk) is typically passed on to customers in variable prices which reflect the cost of heating oil on the day of delivery. Another response could be to hedge against price risk, though we did not find evidence on this.

- **Demand risks.** The demand for oil is strongly linked to weather.[314] This means that demand is likely to be highest when delivery is most difficult (e.g. during cold spells with high snowfall). Distributors can manage this risk through pricing and building capacity (e.g. at depots) to meet demand spikes.

12.4.2 Customers and market share

An estimated four million tonnes of heating oil were sold in the UK in 2010, of which 2.5 million were for domestic use.[315] The amount used by small businesses is not available. Households store oil in tanks with an average capacity of 1,400 litres, and on average they order 800-900 litres of heating oil at a time.[316]

Competition in domestic heating oil supply is local, with typical routes from depots of around 30 miles.[317] Despite this, the OFT estimated that competition was relatively constant across different areas in GB, with 97% of off-grid households able to access four or more heating oil distributors. Overall, the market for supplying heating oil is relatively un-concentrated - the ten largest companies make up less than half of the market and there are more than 300 firms with a market share of less than 0.5%.[318]

Box 8 below describes the key features of the value chain for liquefied petroleum gas, which shares a number of characteristics with the heating oil value chain.

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314 Case study on GB Oils in parent company DCC Energy's 2012 annual report. DCC Energy, Annual Report 2012, available at: http://www.dcc.ie/~/media/Files/D/DCC-Group-Plc/ir/reports/2012/ar-2012/2012-annual-report.pdf.

315 OFT Off-grid energy market study, 2011

316 OFT Off-grid energy market study, 2011

317 OFT Off-grid energy market study, 2011

318 OFT Off-grid energy market study, 2011

Box 8: Liquefied Petroleum Gas (LPG)

A relatively small number of households in the UK use LPG to heat their homes: 150,000 for bulk and 25-50,000 for bottled (OFT, 2011). LPG may also be used for cooking. Similarly to heating oil, bulk LPG is delivered to domestic storage tanks, while bottled LPG is typically bought in 47kg cylinders.

- As with heating oil, short-term substitutability between LPG and other fuels may be low (e.g. it may not be possible to connect households to the gas grid). In the longer-term domestic LPG demand is expected to decline, encouraged by high relative prices and policy.

- The value chain for LPG is similar to the value chain for heating oil (Competition Commission investigation of domestic bulk LPG market, 2006). However, the bulk LPG market is relatively more concentrated and more vertically integrated. The CC's market investigation found that:

  - BP and Shell were active in production, wholesale and retail of bulk LPG while Calor and Flogas were active only in retail; and

  - together these companies supplied around 90% of the domestic bulk LPG market, and this share was around 85% in 2011 (OFT, 2011).

- Similarly to heating oil, bottled LPG customers buy fuel periodically and are not typically in contracts with suppliers. In contrast, bulk LPG customers are typically on a two year exclusive contract with a supplier (OFT, 2011). In both cases, suppliers usually retain ownership of the tank/cylinders.

- Households typically need a different type of boiler to use LPG compared to mains gas. However, like heating oil, the other enabling technologies (e.g. central heating, thermostats) associated with LPG are similar to those for mains gas.

12.4.3 Relationship and channels

Most domestic heating oil customers are not in contracts with distributors and could buy on an ad-hoc basis. In 2011 around 1% of customers were in contracts, while 15% had automatic top-ups and 14% were on a budgeting plan spreading the costs of oil over the year.[319]

Households can order heating oil individually or as part of a group. Individual households place orders directly with the distributor on each purchase, or they may have a contract, automatic top-ups, or a budgeting plan with distributors. In the case of buying groups, which make up 14% of heating oil purchases,[320] a co-ordinator typically places an order a few times a year and collates delivery information. They may charge an administration fee, which is typically annual. Each household is usually then billed directly by the distributor (rather than through the co-ordinator) for the amount their tank is filled by. Oil buying groups can benefit from lower costs per litre by reducing delivery costs.[321]

Households using heating oil can choose between distributors of heating oil, but they are likely to have limited viable alternatives in terms of other heating sources. This means demand for heating oil is likely to be relatively inelastic. The OFT's 2011 market study notes that the costs of moving to a new primary source of heating are high, though more than 80% of GB off-grid households using heating oil also use a secondary fuel (primarily electricity and wood, alternatives which may be costly or unable to sufficiently meet heating needs).[322]

Box 9 sets out some key details on heating oil tanks, which are a key enabling technology for oil heating.

319 OFT Off-grid energy market study, 2011

320 OFT Off-grid energy market study, 2011

321 See Citizens Advice for information on oil clubs: http://www.citizensadvice.org.uk/index/campaigns/current_campaigns/oilclubs/oilclubs-info.htm.

322 OFT Off-grid energy market study, 2011

Box 9. Heating oil tanks

- Domestic oil tanks must be compliant with regional Building Regulations. If installed by someone registered as a "Competent person" (e.g. an Oil Firing Technical Association for the Petroleum Industry (OFTEC) technician), the installer can self-certify that the tank is compliant. Otherwise households must arrange for an inspection for the tank to be certified.

- Tanks can be bought from a wide range of suppliers including specialised local businesses or companies selling a range of other products. Some offer free delivery and installation and remove old tanks. In addition, some heating oil distributors also supply oil tanks.

- The OFTEC guidelines recommend annual inspection of oil tanks to ensure they remain safe and compliant with regulations.

12.5.1 Value propositions

Whether ordering individually or as part of a group, customers are typically quoted a price in pence per litre (often pre-VAT) which is inclusive of delivery costs. Prices vary daily and may also vary hourly. These variations can be driven by demand and transport conditions, as well as by wholesale prices. For example heavy snow in December 2010 made deliveries difficult at the same time as resulting in a 40% increase in demand relative to the year before, which led to a price spike.[323]

Space constraints on domestic oil tanks mean that customers typically order refills a small number of times per year. Distributors usually specify a minimum order per household (typically 500 litres). Households are metered for the amount of oil actually delivered, and may pay the distributor up to 30 days after delivery.[324] Distributors typically buy heating oil from refineries using credit.

Some companies have multiple brands within the heating oil market. This may be due to takeovers and local brand recognition or loyalty.[325]

It is also worth noting that like district heat, but in contrast with electricity and gas, the supply of oil to customers of district heat networks is not governed by specific regulations between consumers and retailers.

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323 OFT Off-grid energy market study, 2011

324 OFT Off-grid energy market study, 2011

325 OFT Off-grid energy market study, 2011

12.5.2 Competitive advantage

The performance of distributors is determined by a number of factors:

- location of depots as competition is local, and transport costs affect the price charged to consumers;
- customer service levels, including flexibility (e.g. ability to prioritise urgent deliveries in winter and scale back summer operations to reduce fixed costs);[326]
- the development of a brand and the promotion of brand loyalty;
- management of the costs of oil tankers; and
- management of wholesale heating oil costs.

Heating oil distributors may manage risks by diversifying into other markets (e.g. non heating oils). For example DCC Energy, which also operates in other market segments and countries, stated in its 2012 annual report that its strategy is to diversify away from reliance on heating related products to generate its margin. Distributors may also gain competitive advantage by maintaining flexible operations to cut back on overheads during off-peak months. Varying prices daily also allows distributors to manage risks around the wholesale price of heating oil and delivery costs.

12.5.3 Partners

Distributors buy heating oil either directly from refiners or intermediate wholesalers.

Distribution companies typically also operate in other markets (e.g. distributing other oil products), and some also operate in other countries.

However, there is little vertical integration in heating oil distribution. Most distributors are independent of 'oil majors' (e.g. Esso and BP) and traders.[327] BP exited oil distribution in 2001 as ROCE (return on capital employed) was viewed as too small. ConocoPhillips, Valero and Shell have also since exited. [328] A further reason for exit could have been the view expressed by some oil majors/traders that heating oil distribution is a declining market.[329]

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326 OFT Off-grid energy market study, 2011

327 Competition Commission, 2012, DCC/Rontec merger inquiry, Final report and appendices.

328 Competition Commission, 2012, DCC/Rontec merger inquiry, Final report and appendices.

329 Competition Commission, 2012, DCC/Rontec merger inquiry, Final report and appendices.

Partners may include other distribution companies, for example in the case of sub-contracting for delivery to consumers in areas where the distributor doesn't have a depot.

12.5.4 Value added and profitability

Gross margins for supplying heating oil to domestic customers are estimated to be around 10%.[330] This calculation is based on a 900 litre delivery, with a lower margin for smaller deliveries. The gross estimate implies a lower margin once distributors' own costs have been taken into account.

Profitability in the sector is seasonal, i.e. distributors make more profit on high volume winter deliveries than from lower demand in the rest of the year.

Return on capital employed (ROCE) for domestic heating oil distribution is not available. However, firms involved in the distribution of heating oil published ROCE across their business in the region of 20% or less in 2010.[331]

12.6 Upstream heating oil business canvas

The upstream part of the oil value chain is responsible for producing crude oil and refining it into heating oil and other products. Crude oil production is a global market composed of large international oil and gas majors. In this section we focus only on the refining section of the value chain based in the UK.

Figure 49 shows the business canvas for upstream heating oil. We now describe what it shows, working from right-to-left.

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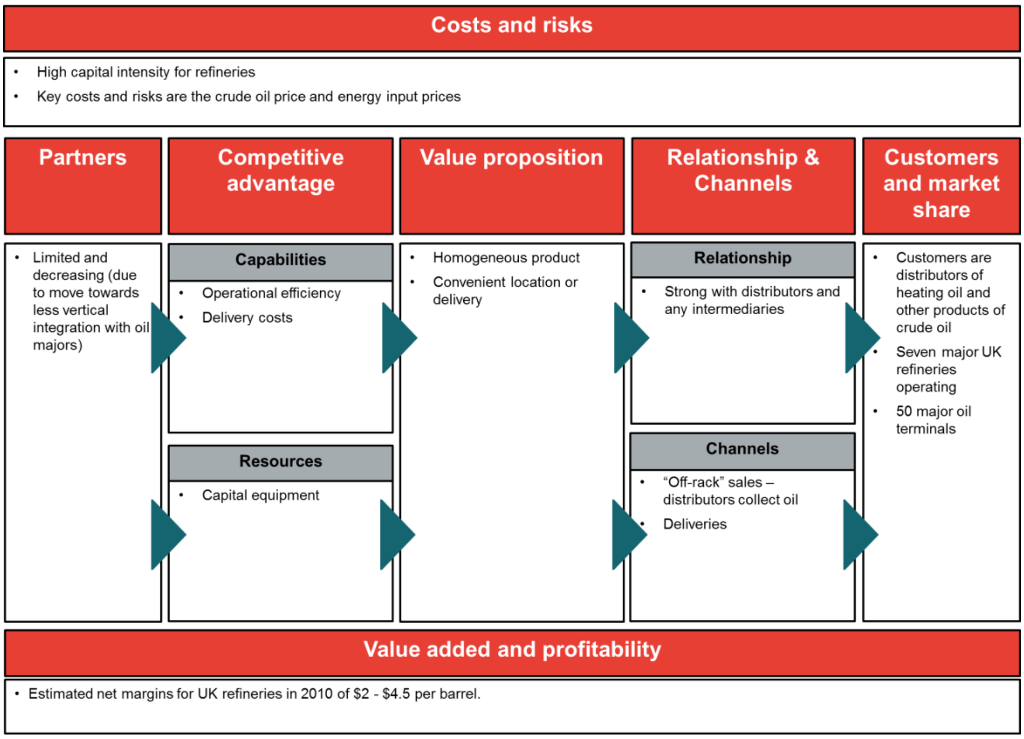
330 OFT Off-grid energy market study, 2011

331 OFT Off-grid energy market study, 2011

Figure 54. Heating oil upstream business canvas



Source: Adapted from the Business Model Canvas from BusinessModelGeneration.com, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas

12.6.1 Costs and risks

Refining crude oil is highly capital and energy intensive. Key costs (and risks) relate to the crude oil price and energy input costs. Energy and environmental policy also impacts on refinery costs and risks. For example, 2008 legislation to reduce the sulphur content of some fuels required investment in plant and increased energy intensity for these fuels.[332]

12.6.2 Customers and market share

The main heating oil customers for refiners are the distributors of heating oil and other products of crude oil.

332 Entec for BERR, 2006, Petroleum Refining, available at: http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file28581.pdf.

Seven major UK refineries were operating in 2012.[333] In addition there were 16 coastal oil terminals (which receive oil from refineries either in the UK or abroad), and 50 major oil terminals in total.[334]

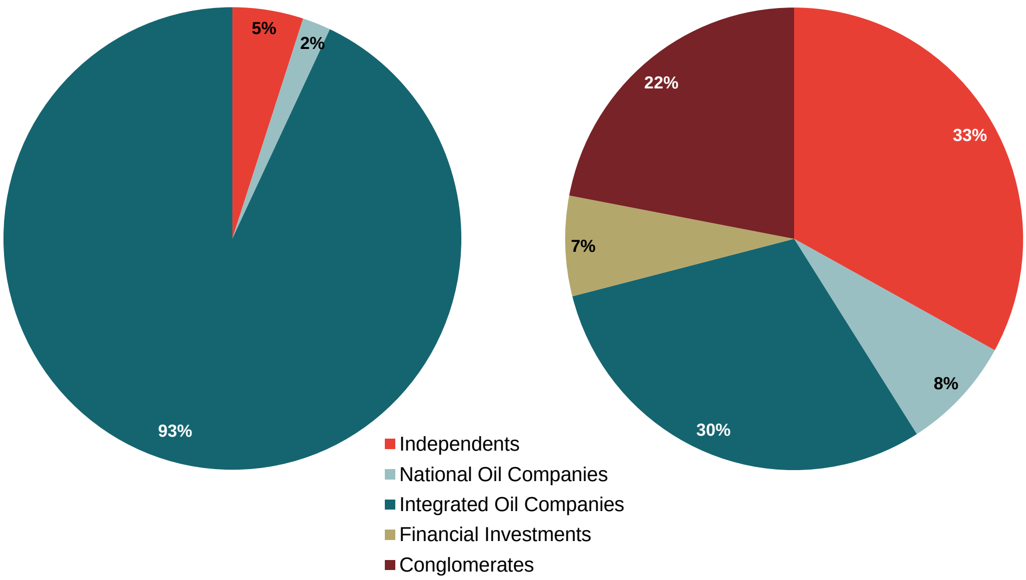
12.6.3 Value proposition, relationships, channels and partners

In recent years some UK refineries have closed as demand for petrol has continued to fall. Most recently Coryton refinery in the South East closed after its owner Petroplus went into administration in 2012. In addition, some existing refineries have been sold by vertically integrated upstream oil companies reducing their presence in UK refining. For example, Chevron sold the Pembroke refinery to Valero in 2012 while Shell sold the Stanlow refinery to Essar. This has formed part of a move away from UK refinery ownership by integrated oil companies, towards a greater range of different owners and increased presence of independents. This is illustrated in Figure 55, which compares the ownership profiles of UK refineries in 1995 with projected ownership profiles in 2013.

333 Competition Commission, 2012, DCC/Rontec merger inquiry, Final report and appendices

334 2010 data from the OFT Off-grid energy market study, 2011.

Figure 55. UK refinery ownership in 1995 and 2013 (projected)



Source: Purvin & Gertz inc. for DECC, 2011

Refineries in the UK differ in their scale, with estimated distillation capacities ranging from 0.7 to 16.2 million tonnes (estimates from 2006).[335] Despite limited production flexibility, the quantity of heating fuel produced by UK refineries has declined over the past 40 years, while the production of transport fuels (e.g. diesel and petrol) increased before stabilising.[336] Competitive advantage

Given the homogeneous nature of the products, competitive advantage in refining is likely to be centred on operational efficiency and the costs associated with delivering crude oil to the refineries and then on to heating oil distributors (including the location of refineries).

12.6.4 Value added and profitability

Profitability in refining oil has fallen in recent years as a result of refinery overcapacity in Europe and declining petrol demand. One response has been for refineries to recover margins when prices spike (e.g. due to temporary reductions in capacity of large refineries). One article estimated that gross margins at

335 Entec for BERR, 2006

336 UKPIA, 2012, Statistical review 2012, available at: http://www.ukpia.com/files/pdf/statsreview2012.pdf.

Stanlow refinery more than doubled to $7.53 a barrel during one such event in 2012.[337] Estimates of net margins for UK refineries in 2010 were around $2 - $4.5 per barrel. This compared to a range of around $2 - $7 per barrel for an international sample of refineries.[338]

337 http://www.independent.co.uk/news/business/analysis-and-features/squeezing-out-the-last-few-drops-out-of-the-uks-oil-industry-8303486.html

338 Purvin & Gertz Inc. for DECC, 2011, Developments in the international downstream oil markets and their drivers: implications for the UK refining sector, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48142/2259-int-downstream-oil-mkts-drivers.pdf.

13 Annexe 8: Current enabling technologies value chain

Enabling technologies such as boilers and insulation are required to transform energy into heating services for consumers.

This Annexe describes the value chain for enabling technologies.

- We begin by explaining what we include in the category of enabling technologies.
- We then present an overview of the value chain.
- We then describe the main policies operating in this area, and the business response to each.
- Finally, we present business canvases for installation and maintenance, and manufacturing.

13.1 Scope of current enabling technologies

We define enabling technologies as technologies that convert energy to heat or cooling, and technologies that increase cooling or heating efficiency.

The set of current enabling technologies are diverse, and detailed information is not available across the board. However, we have tried to build a picture in this annexe, based on the most important technologies and developments in this sector.

13.1.1 Technologies that convert energy to heat or cooling

Enabling technologies include a set of technologies that convert energy to heat and cooling.

- **Boilers.** Over 95% of UK homes are heated by boilers. Most of these (around 23m homes) are gas-fired[339]. The remainder are oil or biomass-fired (Figure 56).
- **Electric storage heating.** Around two million households use electric resistive storage heating[340]. These customers tend to be on Economy 7 type tariffs . The heating technology uses cheaper electricity overnight and stores

339 DECC (2013), *The Future of Heating, Meeting the Challenge*

340 Sustainability First (2012) *GB Electricity Demand, Paper 3,*

the heat for output during the day time. These technologies are associated with a low degree of flexibility for the consumer.

- **Other resistive electric heating.** A wide range of other restive electric heaters exist, ranging from low-cost free standing radiators, to more expensive "electric fires". Around half of electricity used for household space heating is estimated to be consumed in peak periods. This proportion is growing over time[341].

- **Heat pumps (air source and ground source).** Heat pumps are a relatively new technology and penetration is currently low. Between 2008-2011, an estimated 13 thousand ground source heat pumps were installed, along with 35 thousand air source heat pumps[342].

- **Other low-carbon heating systems.** These include biomass systems (either boilers running on pellets or woodchips, or wood stoves), solar thermal devices for heating water and micro-CHP units.

- **Air conditioners.** Active cooling, using air conditioning units, mechanical cooling or heat pumps, currently has relatively low penetration in the UK. The proportion of residential buildings using air conditioning units stood at 3% in 2012[343]. Further detail on air conditioners is in Box 10.

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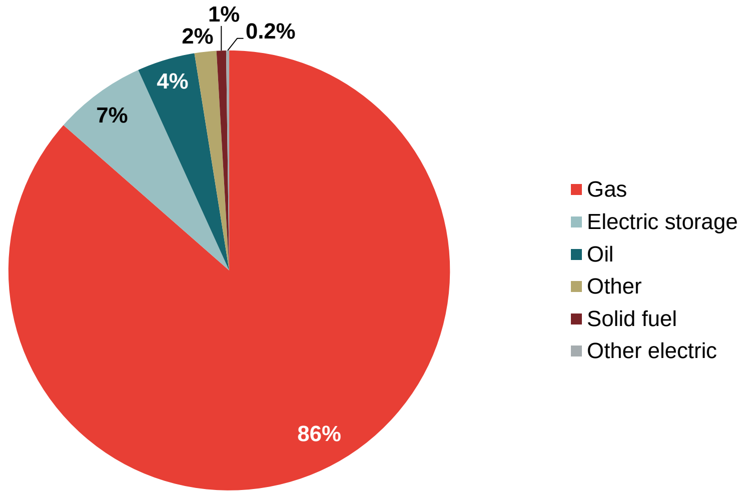
341 Sustainability First (2012), *GB Electricity Demand, Paper 2,*

342 AEA (2012), *Renewable Energy production in 2011 from heat pumps in the UK - Abstract*

343 Defra (2012), *The Economics of Climate Resilience Buildings and Infrastructure Theme*

Figure 56. Installed central heating by type in 2010



Source: DECC, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65955/4186-ecuk-domestic-2010.xls

Box 10. Air conditioning

Active cooling, using air conditioning units, mechanical cooling or heat pumps, currently has relatively low penetration in the UK domestic housing stock; the proportion of residential buildings using air conditioning units stood at 3% in 2012. This is significantly lower than in other countries. In 2009 87% of US households had an air conditioning unit and in Greece it is estimated to be between 45-50%. Mechanical cooling is estimated to use around 15TWh per year in the UK, just over 4% of total electricity demand, with domestic demand for cooling accounting for less than 1% of household energy use[344].

Domestic penetration in the UK may be relatively low due to the high upfront costs involved in purchasing an installed air conditioning unit. Estimated capital outlays are in the region of £10,000-£16,000, with an approximately even split between capital and installation costs. Demand has, unsurprisingly, proved to be highly responsive to weather patterns with retailers reporting growth in sales above 150% during the heat-wave of 2003. However, with the increasing availability of heat pumps, some of which can also perform cooling functions, the demand for active cooling may stabilise year round increasing utilisation and helping to overcome high capital costs. Giles (2012) projects that by 2020, the number of new builds with heat pumps will have increased by a factor of 10[345].

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344 Defra (2012), *The Economics of Climate Resilience Buildings and Infrastructure Theme*

345 Defra (2012), *The Economics of Climate Resilience Buildings and Infrastructure Theme*

The installation market for air conditioning and heat pumps is mainly dominated by independent contractors. Some of these contractors also install gas boilers.

13.2.1 Technologies that increase heating or cooling efficiency

Enabling technologies also include technologies that increase heating and cooling efficiency.

- **Insulation[346].** Take up of insulation has been increasing over time. In 2010 around 99% of homes had some insulation, while 25% had what was described as 'full insulation (Figure 57).[347] The potential market for further insulation is large however, with around 5.7 million empty cavity walls left to be filled and 12.8 million lofts that still need more insulation[348].

- **Double glazing.** Moving from single to double glazing can reduce a building's heat demand by over 10%[349]. 83% of homes had some form of double glazing by 2004[350] (Figure 57), though modern A-rated double glazing is substantially more efficient than earlier versions, so there is scope for further improvements.

- **Storage.** At present, storage using hot water tanks is common in households with electric heating. Use of the storage allows occupants to take advantage of off-peak electricity tariffs[351]. In addition, around two million households use electric resistive storage heating[352]., which stores heat from off-peak electricity in bricks and releases the heat at peak times.

- **Thermostats.** Thermostats are control systems which help regulate the supply of heat to the required temperature when needed. 97% of homes have thermostats, though only a minority of these meet the standards of 2010 Building Regulations (a timer, a room thermostat and thermostatic radiator valves).[353]

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346 Where we refer to insulation in this report, we mean loft and cavity wall insulation, unless otherwise specified.

347 DECC (2013), *The Future of Heating: Meeting the Challenge*

348 Energy Savings Trust, cited in Consumer Focus (2012), *What's in it for me? Using the benefits of energy efficiency to overcome the barriers*

349 DECC (2013), *The Future of Heating: Meeting the Challenge*

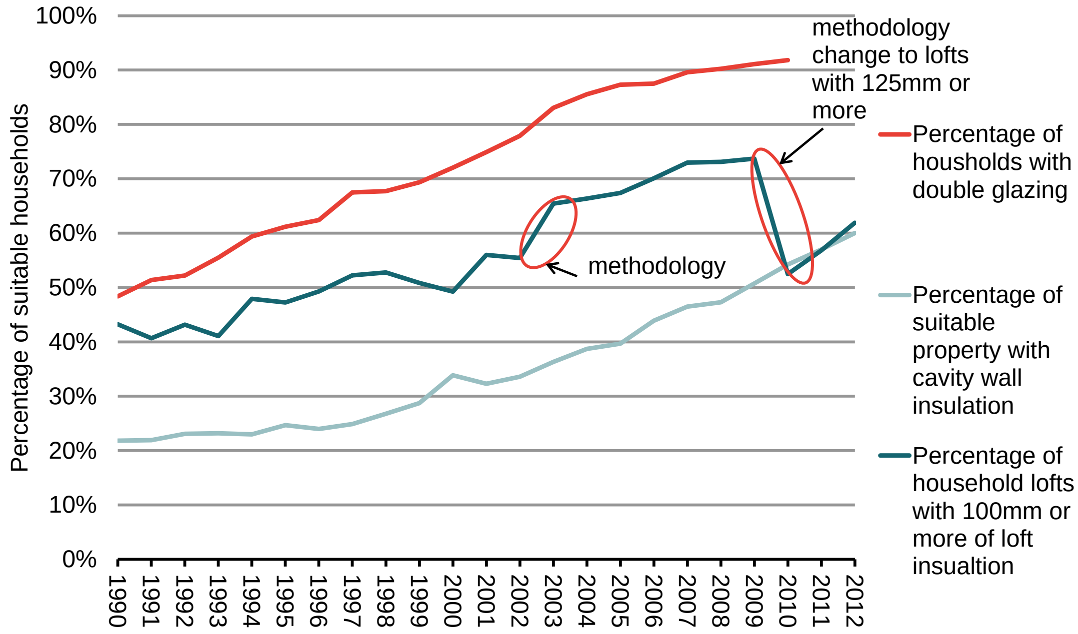
350 Element Energy (2009), *Uptake of energy efficiency in buildings.*

351 DECC (2013), *The Future of Heating: Meeting the Challenge*

352 Sustainability First (2012) *GB Electricity Demand, Paper 3*

353 DCLG (2010) Housing Survey, cited in DECC (2013), *The Future of Heating: Meeting the Challenge*

Figure 57. Household penetration of insulation and double glazing



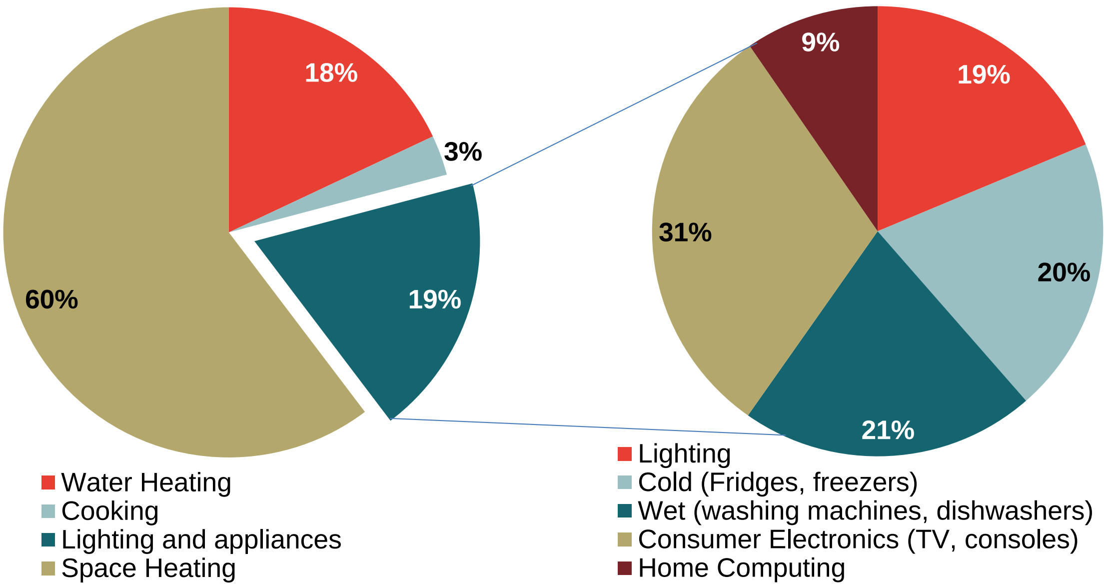
Source: DECC, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65955/4186-ecuk-domestic-2010.xls

13.2.2 How important is energy use from other appliances?

In this annexe, we focus on enabling technologies relating to heating and cooling. However, for context, we compare energy use to other appliances.

Figure 58 shows the relative domestic energy use on lighting and appliances. This shows that heating and water heating together account for more than three quarters of household energy use.

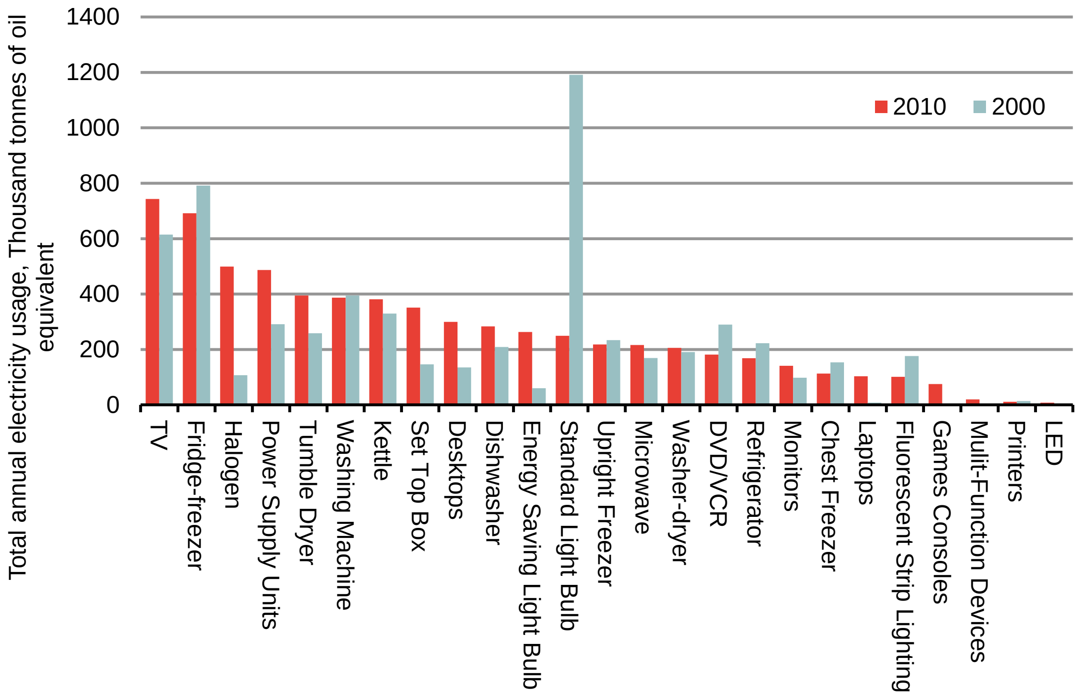
Figure 58. Space heating and other domestic uses of energy



Source: DECC Energy Consumption in the UK Domestic Data Tables
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65955/4186-ecuk-domestic-2010.xls

Figure 59 shows the total domestic electricity usage of each of the major groups of appliances. Despite some increases in the last decade, the largest of these, TVs, still uses less than 4% of the total energy usage on space heating. It is notable from the figure that standard light bulbs, the appliance with the largest consumption in 2000, now consume less than 20% of the energy they did in 2000. Furthermore, this saving is considerably larger than the increases in consumption from TVs, halogen lights and laptops put together.

Figure 59. Electricity usage by common non-heat enabling technology appliances



Note: the total energy consumption for space heating totalled 23 million tonnes of oil equivalent over the same period, and thus the boiler or other domestic heating system is by far the largest consuming technology in domestic homes.

Source: DECC Energy Consumption in the UK Domestic Data Tables

13.3 Overview of the enabling technology value chain

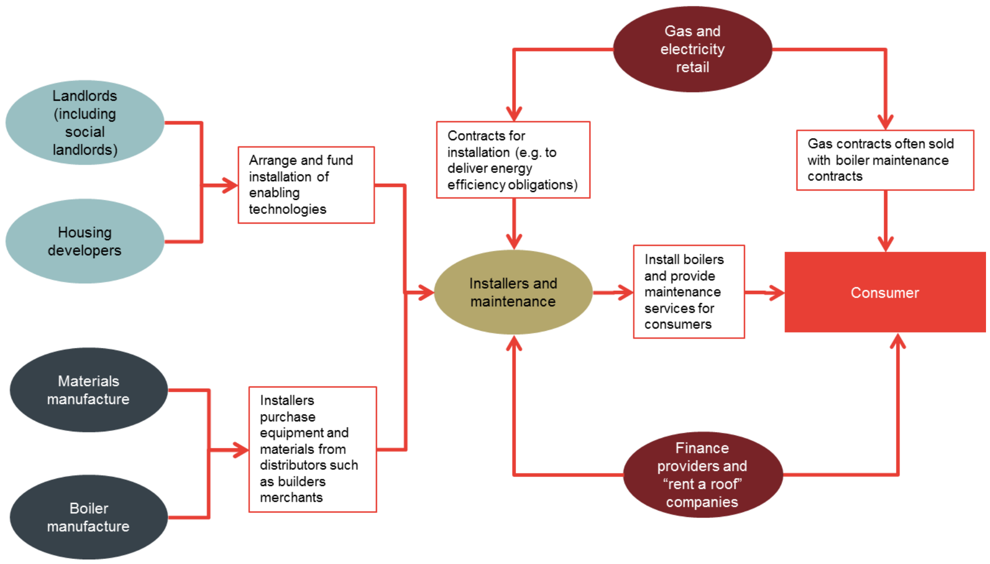
The value chain for enabling technologies is described at a high level in Figure 70.

Consumers interact with the enabling value chain at the **installation and maintenance** stages. Installation and maintenance can be contracted directly by the consumer, by landlords (including social landlords) and by housing developers. Installation can also be contracted via energy retailers, to meet their obligations. In addition, some electricity and gas retailers, and other companies offer insurance-type maintenance contracts. Finally, in response to Government incentives, companies have entered the market that provide finance to consumers, or purchase the enabling technologies on their behalf.

Manufacturers usually sell to installers via distributors such as builders' merchants.

In the next section, we present business model canvases for each of installation, maintenance and manufacturers.

Figure 60. Stylised overview of contractual arrangements in enabling technologies



Source: Frontier

13.4 Business environment

The enabling technologies market has been heavily shaped by policies and obligations on the large energy retailers. In this section, we first provide an overview of policies and regulations. We then discuss responses to the most important of these polices in more detail[354].

13.4.1 Overview of legislative framework

Supplier obligations place an obligation on energy retailers to meet carbon emission reduction targets by delivering energy efficiency measures to households. More specifically:

- The **Carbon Emissions Reduction Target** (CERT) is designed to reduce household carbon emissions through uptake of cost-effective energy efficiency measures such as insulation, heating and lighting.

- The **Community Energy Savings Programme** (CESP) is designed on an area-basis, with the objectives of reducing carbon emissions and fuel bills specifically for low income households.

354 These are described in more detail in Annexe 2.

These policies are now being replaced by the **Energy Companies Obligation** (ECO) which entails three separate obligations on the large energy retailers:

- **Carbon Emissions Reduction Obligation** where companies must deliver 20.9 million lifetime tonnes of carbon dioxide savings by 2015.
- **Carbon Saving Community Obligation** where companies must deliver 6.8 million lifetime tonnes of carbon dioxide savings by 2015. This focuses on consumers in low income areas.
- A **Home Heating Cost Reduction Obligation** (£4.2bn of lifetime cost savings). This requires energy companies to provide measures which improve the ability of low income households to heat their homes.

There are also a number of other policies encouraging domestic installations of enabling technologies.

- **Barriers to consumer financing of enabling technologies are starting to be addressed through the Green Deal**. Under the Green Deal, launched this year, private firms offer energy efficiency improvements to their homes with the upfront costs recovered through an increment to consumers' bills.
- **Domestic-scale renewable electricity generation technologies are encouraged through the Feed-in Tariff (FiT) scheme.** The FiT provides a payment for generation from small-scale renewable technologies (<5 MW) such as solar PV.
- **Renewable heat generation is encouraged through the Renewable Heat Incentive (RHI) and the Renewable Heat Payment Scheme.** At present it is only open the non-domestic consumers. It is expected to open to domestic consumers in 2014.
- **Permitted Development Rights have eased the planning barriers to domestic microgeneration**. These allow certain limited developments on home to take place without requiring planning permission.

Finally the sector is influenced by safety regulations on installers and manufacturers.

We now discuss business response to the following policies:

- CERT, CESP and ECO;
- Green Deal;
- Feed-in tariffs; and

- RHI.

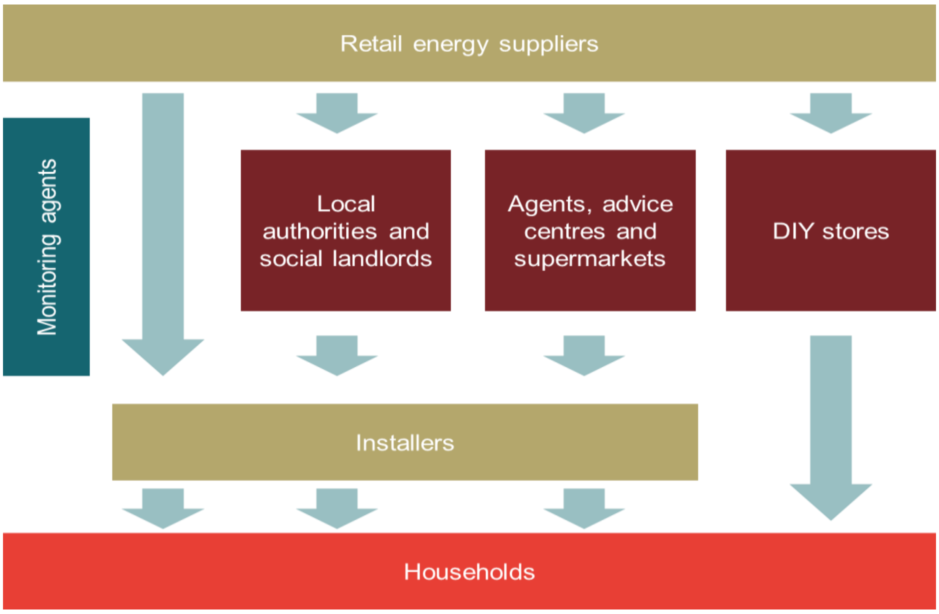
13.4.2 CERT, CESP and ECO

CERT and CESP ran from 2008/2009 to December 2012, with ECO taking over in 2013. We describe how these obligations have been met by energy retailers and the consumer value propositions that have resulted.

Under **CERT,** enabling technologies worth £1.5bn/year have been delivered. Around 60% of the energy efficiency savings have been insulation (2 million households between 2008 and 2011) with lighting representing around 20%[355]. Energy retailers have generally contracted with insulation installers, local authorities, social landlords and retail stores (e.g. for marketing of services and direct sales of insulation). Contracts have been set on the basis of a price per tonne of carbon saved by the enabling technologies (as measured by the standard CERT values). In this way the market has become 'commoditised'.

The channels for delivering are illustrated in Figure 70.

Figure 61. Channels for delivering CERT measures



Source: Adapted from DECC (2011), *Evaluation of energy supplier obligation policies*

Around 70% of CERT measures were delivered to private households. The offers for energy efficiency installation are made through a variety of channels including:

355 DECC (2011)

- direct from installers, including via managing agents and advice centres;
- via the local authority (e.g. mail-outs);
- via supermarkets and DIY retailers (with the latter often selling materials directly without installation); and
- direct from energy retailers (both to their own customers and more widely).

The remainder of measures have been delivered via social landlords (25%) and in conjunction with national Government schemes such as Warm Front (5%-10%)[356].

CESP differs from CERT in that it is area-based, and primarily focussed on low-income consumers. The area-based projects have been directly managed by energy retailers and their local partners (including energy service firms). This has included installation of 'harder' and more costly measures such as solid wall insulation. DECC identify two categories of delivery models:

- 'energy-company managed' where schemes are funded and managed by retailers, often using the retailer's own installation business; and
- 'third-party managed' where schemes are managed on behalf on the retailer by the local authority or housing developer, with management of projects often delegated to agents.

Similar delivery channels are expected to develop under **ECO**.

A notable innovation under ECO is the brokerage scheme. This is a fortnightly auction which allows delivery agents to sell commitments to deliver units of ECO obligations 'anonymously'. It is hoped this scheme will promote competition in the market, allow smaller providers to compete more effectively with larger providers and with the retailers own subsidiaries and increase transparency over costs. The brokerage mechanism has been trading since the start of 2013 and by the end of February, £26.9 million had been traded through it. Retailers can either contract for ECO services through this brokerage mechanism or contract bilaterally with third party Green Deal Providers, or provide the services in-house.

In addition, Green Deal providers will be able to access ECO funds (see below).

Expenditure to deliver ECO is expected to be around £1.3bn/year with 75% related to the carbon savings target and 25% on the home heating cost reduction target[357].

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356 DECC (2011), *Evaluation of energy supplier obligation policies*

13.4.3 Green Deal

The Green Deal is a mechanism for financing energy efficiency and microgeneration measures for households. Under the Green Deal, the upfront costs of measures are initially covered by providers and are repaid by consumers through an increment to consumer bills. There are three key stages to delivery of energy efficiency under the Green Deal.

- The homeowner gets an **assessment** of their property to find the most cost-effective energy savings options.

- The homeowner chooses a Green Deal **provider** to undertake the work. The Green Deal provider is the body that offers a Green Deal plan to customers, which enables them to finance work recommended by an accredited adviser and undertaken by an accredited installer. These functions might be done in-house by the provider, or sub-contracted to other organisations, but the customer's contractual relationship is with provider. These services can qualify for those required under ECO (see above) and therefore may be subsidised.

- Once the work is completed repayments are made via the consumer's energy bill.

Since it launched last year over 40 companies have registered as Green Deal providers. These include the installation arms of the six largest energy retailers, major construction support service companies such as Carillion plc. and organisations that have emerged in response to these Government schemes such as the Big Green Company. There are also over 100 registered Green Deal assessors[358].

It is as yet unclear how large the take-up will be for Green Deal financing.

13.4.4 Feed in Tariffs

On 1 April 2010 the Government introduced the Feed-in Tariffs (FITs) scheme. The scheme is intended to encourage the uptake of small scale renewable and low-carbon technologies up to a total installed capacity of 5 MW. The scheme creates an obligation for retailers to make tariff payments to eligible installations for the generation and export of renewable and low carbon electricity.

As of the end of December 2012, almost 360,000 installations had been registered under the Feed-in Tariff scheme since its introduction.

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357 DECC (2012), *Energy Companies Obligation Brokerage Mechanism*. Some industry observers believe this is an under-estimate of the cost of delivering this scheme.

358 http://www.greendealorb.co.uk/consumersearch, Accessed 13/03/13

To apply for accreditation under the FIT scheme participants must install one of the following eligible sources of low carbon energy or technology[359]:

- anaerobic digestion;
- hydro generating station;
- micro combined heat and power (micro-CHP) with an electrical capacity of 2kW or less (up to a maximum of 30,000 eligible installations);
- solar photovoltaic (PV); or
- wind.

Of the 1.7 GW of total capacity installed under the FIT scheme, roughly 90% is attributed to solar PV installations, highlighting the clear dominance of this technology, while wind consists of approximately 6% of the total. Other technologies make up the remaining 4% of capacity. Approximately 70% of installations are domestic, 26% commercial, 3% industrial and 1% are community schemes.

The cost of the scheme is currently approximately £600m per year. This includes generation payments, deemed export payments claimed by generators, the qualifying (administration) costs incurred by FIT Licensees, minus the value of deemed export to Licensed Electricity Suppliers. Typically, the support scheme offers returns to consumers of around 5-8% on capital investment.[360]

There are over 4000 registered installers of eligible generation equipment, ranging from large national brands (such as British Gas and Anglian Homes) through to small local ones where existing electricians took up the opportunity that the FiTs scheme offered for diversification. At the national end of the spectrum, British Gas aimed for a turnover of approximately £60 million per year from this market by 2012. However, the c2,000 installations a week being undertaken is not sufficient to support the number of accredited companies currently operating in the UK and there is expected to be a rationalisation of the industry.

A survey for Consumer Focus in 2011[361] found that how knowledgeable an installer appears to be and the amount of information provided were the main factors which determine consumers' choice of company. When asked why they chose one installer over another, over half of consumers (58%) stated that they

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359 The specified maximum capacity of eligible installations under the FIT scheme is set at 5MW Total Installed Capacity (2kW for Micro CHP). It is permissible to install up to 5MW of Total Installed Capacity generation from the same low-carbon energy source on any defined site.

360 DECC (2012) *Feed in Tariffs: Government Response to consultation on Comprehensive Review phase 2A: Solar PV Cost Control*

361 Consumer Focus (2011), Keeping FiT – Consumers' attitudes and experiences of microgeneration

chose an installer who seemed more knowledgeable about the products. Just under half of consumers (47%) chose their installer at least partly because they provided more information about the products and installation process. Other factors which had a big impact on choice of installer were value for money (43%), perceived experience in installing the product (41%), and also simply how friendly the installer seemed at the quotation stage (41%).

A significant development since the start of the FITs scheme that contributed to uptake levels was the emergence of arrangements where a single individual or organisation owns, or receives the FITs payments from, multiple PV installations. DECC estimated that nearly 20% of PV installations registered for FITs in 2011 were associated with generators who had more than one PV installation registered for FITs. Multi-installation schemes that have emerged since the FITs scheme started include situations where a single organisation owns multiple properties on which they then install solar PV as well as "rent a roof" arrangements. Companies that offer this service include Homesun, A Shade Greener, Freesource Energy and Isis Solar. In general a third party owns generating equipment which is then hosted by a number of houses or other buildings. The hosts benefit from the electricity generated by the PV panels (and associated energy bill savings) and potentially a rent payment, while the third party benefits from the FITs income.

13.4.5 Renewable Heat Incentives

The Renewable Heat Incentive scheme was launched in November 2012. At present it only covers non-domestic users, but it will be extended to domestic systems in 2014[362]. The scheme subsidies renewable heat generation to equalise the financial cost of renewable and conventional generation. The support scheme lasts for 20 years, and is open to heat generation plants installed since mid-June 2009, subject to accreditation by Ofgem. This accreditation covers only plant used for the purposes of space, water or process heating. Furthermore, for generation with a capacity below 45kW, the installation must be accredited by the Microgeneration Certification Scheme (MCS), an industry-led, quality assurance group consisting of installers and manufacturers.

The large majority of accredited non-domestic systems are solid biomass boilers[363]. As of March 2013, biomass boilers made up 99% of the total

362 https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi, Accessed 03/04/13

363 Other eligible systems are biogas; bio-Methane; municipal Solid Waste; deep Geothermal; ground Source Heat Pump (GSHP); water Source Heat Pump (WSHP); solar Thermal- if less than 200kW generating capacity; and CHP- if using geothermal, biogas, municipal solid waste or solid biomass.

accredited installed capacity, with 268MW.[364] Accredited licensees are required to submit meter readings and are then paid a fixed price per kWh which varies between 1 and 9 pence depending on the installation. The tariffs are designed such that they provide a 12% rate of return on the additional capital investment required[365]. This is notably higher than the 5-8% return from FiTs, reflecting the relatively unproven nature of many renewable heat systems. From scheme commencement to the end of March 2013 £7.6m had been paid out[366]. However, DECC report that the total cost of the scheme in 2012-13 (including administrative accreditation processes) will total £24m.[367]

For relatively small scale systems, installations must be accredited by the MCS. This organisation was formed in 2008, and certifies installers and products complying with their standards partly set by DECC. Additionally, installers must be accredited by Renewable Energy Assurance Ltd (REAL). DECC also offer funding of either £500 or 75 per cent of the cost of the training for installers to attend renewable heating kit installation training. In 2013, there were around 1,650 heating installation companies registered under the Microgeneration Certification Scheme, representing around 16,500 installers[368].

As in the case of the FiT, the subsidies have led to business opportunities providing the high up-front investment required for a renewable heat system, and then renting this to consumers in return for the associated RHI income. For example, Strategic Energy began offering free biomass boilers to landlords in June 2012.[369] This helps to overcome the capital barrier to renewable heat systems for consumers. It is not clear whether these "rent-a-roof" type arrangements will be open when the scheme is extended to domestic users, as DECC proposals for the domestic scheme suggest that the RHI payment will have to go to the owner of the technology who "as a rule of thumb" will be the owner of the property[370] The same DECC document also states that the market is expected to respond to the incentive by creating specific financing packages around the RHI.

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364 Ofgem Live RHI Data available at https://rhi.ofgem.gov.uk/Public/ExternalReportDetail.aspx?RP=RHIPublicReport Figures correct at time of publishing. Accessed 03/04/13.

365 DECC (2011) *Renewable Heat Incentive*

366 ibid

367 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/153669/standby_budget_management_graph.pdf , accessed 04/04/13

368 DECC (2013) *The Future of Heating: Meeting the Challenge*

369 Strategic Energy news item June 27th 2012 available at http://www.snrgy.co.uk/index.php?mact=News,cntnt01,detail,0&cntnt01articleid=14&cntnt01returnid=59 , Accessed 03/04/13

370 DECC (2012), *Renewable Heat Incentive, Consultation on proposals for a domestic scheme*

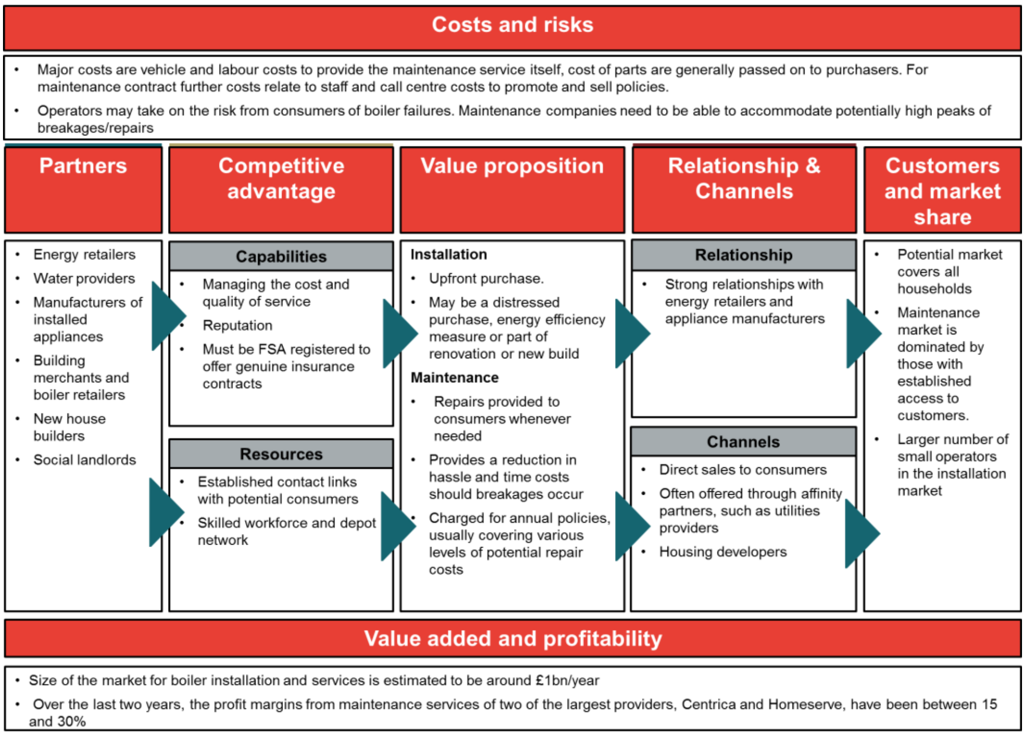
13.5 Business model canvases

We now present the business model canvases for installation, maintenance and manufacture of enabling technologies.

13.5.1 Installation and maintenance

Figure 62 shows the business model canvas for installation of enabling technologies.

Figure 62. Enabling technologies installation and maintenance business model canvas



Source: Frontier Economics adapted from the Business Model Canvas from BusinessModelGeneration.com[371]

Costs and risks

The most important costs and risks for installers are:

- **marketing, sales and customer service -** employment of sales staff, call centre costs, marketing and maintaining ties with other utilities providers;

[371] **Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at:** http://www.businessmodelgeneration.com/canvas.

- **maintenance workforce**- employment, training, depots and equipping of engineers to ensure that all potential repair obligations can be met, and;
- **direct technology costs -** costs of technology parts and replacement technologies – although these are generally passed on to consumers.

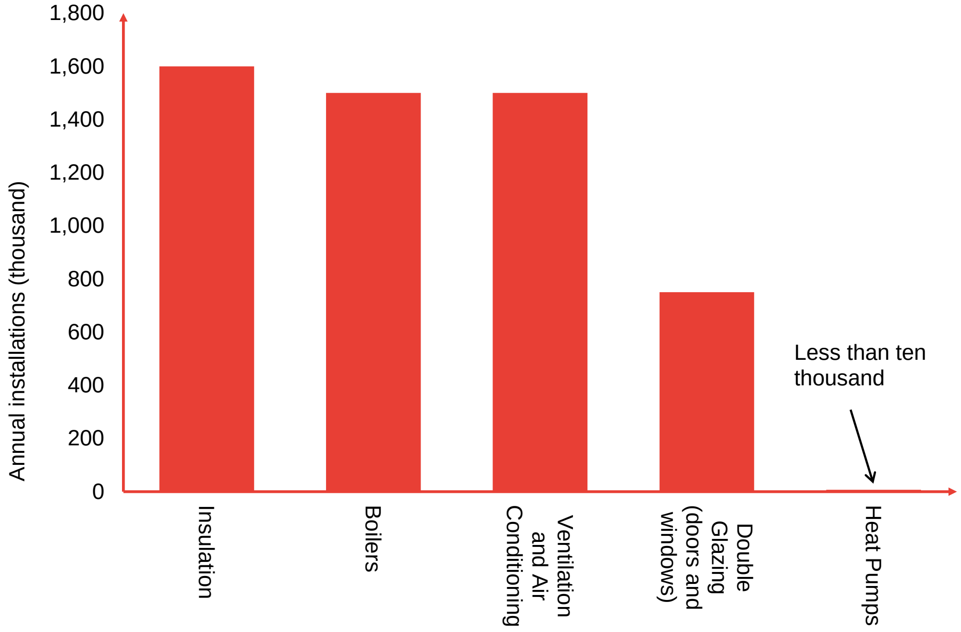
Installers often take on risks around technology performance on behalf of the consumer (e.g. through explicit guarantees or implicitly as part of their need to maintain their reputation). They must also takes on risks and provide guarantees around safety, in particular gas safety in the case of boilers. This includes compliance with regulatory Health and Safety standards.

Maintenance contract providers must also bear the risk of breakdowns and the need to repair or replace. To fulfil their obligation, providers must either be sufficiently staffed, or have enough subcontractor capacity to deal with the quantity of repairs necessary.

Customers and market shares

The installation market is large, with millions of households taking up new technologies each year. Figure 63 shows estimated annual installations for key enabling technologies.

Figure 63. Total annual installations for enabling technologies[372]



Source: DECC (2012) *Final Stage Impact Assessment for the Green Deal and Energy Company Obligation* and http://www.netmagmedia.eu/home/pe/solus/fensa_2013-02-05/

There are currently 23.5 million boilers installed in UK households[373], each of which is a potential insurance contract. Furthermore 1.5m new domestic gas boilers were installed in domestic properties in 2011[374]. It is possible to bundle the installation of a boiler with a maintenance contract, thus tapping directly into this market. In addition, it is possible to contract for maintenance of wet household equipment such as hot water systems or drains, with a potential market of any of the 26.6 million households in the UK connected to the water grid. Around one in five boilers suffers a breakdown during the winter[375]. This suggests a maximum potential market of approximately 4.7 million customers for one-off repairs. In addition, maintenance contracts are also available to business customers.

372 This gives the market value for 2010 where available. In the cases of double glazing and ventilation and air conditioning the value is from 2009. For Insulation the data covers the financial year running from 2010 to 2011.

373 DECC (2012), *Energy Consumption in the UK: Domestic Data tables*

374 DECC (2012), *Final Stage Impact Assessment for the Green Deal and Energy Company Obligation*

375 uSwitch, http://www.moneywise.co.uk/insurance/home-insurance/does-it-make-sense-to-insure-your-boiler, Accessed 01/04/13

The market for installations of other heating technologies is much smaller. For example, around 90,000 solar thermal heating systems were installed in 2011[376]. This market should grow once the Renewable Heat Incentive is implemented for domestic households.

New house builders and social landlords (including bulk installations) also create demand for energy efficiency: a recent OfT investigation estimated that 20-30% of demand for insulation installation come from new build whilst the large majority of retrofit installations are associated with energy efficiency obligations[377].

A diverse set of players are involved in installation and maintenance.

- The market for installation, maintenance and one-off repairs of boilers is characterised by many small, independent providers, but also includes the six major retailers of gas and a large number of plumbing and home service firms (large players include Homeserve and Pimlico Plumbers).

- The market for insurance-type maintenance contracts for boilers is more highly concentrated, as a result of the need to operate at a scale at which the inherent risks are reduced. All six of the major energy retailers (SSE, Scottish Power, E.On, EDF, RWE and Centrica) operate in this market, along with larger independents such as The AA, and Homeserve and boiler manufacturers such as Worcester-Bosch. Centrica are the largest in the domestic maintenance and installation market, with 8.9million contact holdings in total.[378] Homeserve had 2.7 million customers in 2012, with approximately 3 policies per customer[379]. The operations of other providers are somewhat smaller, with E-On covering 126,000 customers in 2011.[380]

- For insulation, the market for installers ranges from single installers specialising in small jobs to large companies that may carry out large projects (e.g. an entire housing estate)[381]. Key players include Mark Group, Dyson SIG Energy Management and Carillion.

- There are fewer installers of new heating technologies, such as heat pumps. In 2013, there were around 1,650 heating installation companies registered

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376 Heating and Hotwater Industry Council (2011), *Market Update*

377 OFT (2012), *Home insulation: A report on the Call for Evidence carried out by the OfT*

378 Centrica (2012) *Annual Report 2011*

379 Homeserve (2012) *Annual Report 2012*

380 E-on (2012) *Annual Report 2011*

381 OFT (2012*), Home Insulation: A Report on the Call for Evidence carried out by the OFT.*

under the Microgeneration Certification Scheme, representing around 16,500 installers, compared to over 100,000 registered Gas Safe engineers[382]

Relationships and channels

Consumers purchasing maintenance and repairs do so through differing channels depending on the type of maintenance purchased.

- Those purchasing as a one-off repair tend to do so as a "distress purchase". While replacements are generally characterised as distress purchases, DECC cite industry reports that in only 30% of cases, the boiler cannot be serviced and it is often replaced because it is more economic to do so (due to the greater efficiency of newer boilers[383]). A Consumer Focus study found that these relationships with installers are often characterised by low levels of trust. Brands appear to be less important in this market, with consumers preferring to use information gained from positive word of mouth and respected messengers to try and establish relationships of trust[384].

- In contrast, maintenance contracts are purchased annually, and often from an existing provider of other services. Brands are much more important in this market, with customers drawing on existing relationships (for example with their energy retailers) to provide themselves with assurance that their repairs and maintenance will be covered. Providers of maintenance contracts usually offer maintenance contract as a bundle with existing products. For example, energy retailers offer additional maintenance services for households at the point of sale of energy.

A large proportion of insulation is installed under retail suppliers' energy efficiency obligations. As described above, under these obligations energy retailers pay a subsidy to installers to carry out insulation jobs. 20% to 30% of the insulation market currently relates to new build – largely driven by building regulations - with the remaining 70%-80% being retrofit[385] - largely driven by energy efficiency obligations.

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382 DECC (2013) *The Future of Heating: Meeting the Challenge*

383 DECC (2013), *The Future of Heating: Meeting the Challenge*

384 Consumer Focus (2012), *What's in it for me? Using the benefits of energy efficiency to overcome the barriers*

385 According to an OFT investigation into home insulation 20%-30% of demand comes from new build, whilst the large majority of retrofit installation is associated with retailer obligations on energy efficiency (ECO, CERT, CESP). OFT (2012*), Home Insulation: A Report on the Call for Evidence carried out by the OFT.*

Value propositions

The consumer value propositions for **installation** of enabling technologies vary. The follow describes some of the main propositions.

- Gas boilers are often purchased outright by the consumer from the installer either through upfront purchase or finance packages, with the boiler itself and the installation typically purchased together.[386] Most energy retailers offer finance plans to help cover the cost of a new boiler or upgrades to the central heating system.

- A large proportion of domestic consumers purchase energy efficiency installations on a subsidised basis as part of retailers' energy efficiency obligations (as described above). Others receive these as bulk installations via their social landlords or as part of the purchase of a new build home. Under the Green Deal consumers are also now able to purchase energy efficiency measures with the cost repaid via their energy bill. Many consumers will purchase energy efficiency technologies as part of a package including installation but direct purchase from DIY stores is also common.

- For small businesses, enabling technologies may be installed as part of a facilities management contract. As small amount of enabling technologies for small businesses are provided as part of an energy services contract (ESCo). Contract terms vary but often include a fixed fee for heating services which covers both the commodity (gas) and the installation and servicing of the enabling technologies.

Value propositions for **maintenance** products and services vary.

- One-off repairs to enabling technologies are usually distressed purchases after faults with boilers, and as such the service offered focuses on speed of repair and prices are set by the value of the labour needed and any parts used in the repair.

- For domestic enabling technologies insurance, customers sign contracts (usually annual) to receive repairs and replacements of up to a specified value in the event of a fault or failure of the boiler in return for monthly payments. The precise level of cover varies. At the cheaper end, there may be an excess payable for repairs and a relatively low maximum value of repair. In contrast, more expensive policies may have no limit to the value of repairs included.

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386 New boiler prices range from £400 and rise to above £1200. There is typically a trade-off between boiler costs and efficiency. By comparison, the costs of installation are typically around £600. However, if pipes relating to the gas supply or the flue need to be moved or introduced, installation costs can increase substantially.

As discussed above, for small businesses, enabling technologies may be purchased upfront or accessed as part of a facilities management contract. These contracts typically include servicing of the enabling technologies

Competitive advantage

For installers and companies providing one-off repairs, competitive advantage is driven by the following factors:

- management of the costs and quality of installation, including developing a skilled and certified workforce;
- development of a brand, reputation and customer loyalty, including developing relationships with energy retailers, housing developers and social landlords as channels for winning business; and
- efficient purchasing of materials and equipment.

For those providing maintenance insurance contracts, there are further competitive advantages which result in the greater success of the established, larger providers. There is a significant advantage to being able to bundle boiler maintenance cover with other related products. This is illustrated by **Table 6** below, which shows the other energy sectors in which the major providers operate. In the case of HomeServe, a considerable focus is placed on maintaining relationships with "affinity partners"[387] providing complementary products which can then be bundled with Homeserve insurance at the point of sale. Homeserve's affinity partners include several operating in water utility provision, boiler manufacturer Vaillant, shower manufacturer Mira and heating oil providers such as Total Butler and NWF Fuels.[388]

387 Homeserve affinity partners cover 24million households in the UK, roughly 90% of the total number of households. http://www.homeserveplc.com/download/ar2012.pdf

388 Homeserve Annual Reports and online literature available at http://annualreport2011.homeserveplc.com/strong-partnerships-and-brands and http://www.homeserveplc.com/about-us/case-studies-uk

Table 6. Activities of boiler maintenance contract providers

Company	Energy retail	Boiler Manufacture	Boiler installation	Boiler maintenance	One off repairs
Six largest energy retailers	x		x	x	x[389]
HomeServe			x	x	x
Worcester Bosch		x	x[390]	x	

Source: Company annual reports, online services

We note that there are also clear minimum standards for boiler installers, in particular in relation to meeting safety regulations and standards. Products such as boilers must meet gas safety standards. Installers must also be trained and registered as "gas safe". This includes British Standards (BS), European Standards (EN) and the former Council for Registered Gas Installers (CORGI), now known as the Gas Safe Register. All maintenance or installation businesses performing gas work must be on the Gas Safe register, and are subject to inspections to remain so. Furthermore, for insurance providers, the policies must be approved by the Financial Services Authority.

Partners

Installers and maintenance providers depend on a wide range of partners to deliver their services. Of particular importance are:

- merchants who connect installers to manufacturers;
- retail energy providers who can offer bundles of utilities and maintenance, and who are often the first point of contact for customers and purchase services under their energy efficiency obligations;
- providers of other utilities such as water, for which there are also plumbing insurance contracts available to be bundled with, and;
- housing developers who install enabling technologies as part of their housing developments; and
- social landlords who finance and control the choice of enabling technologies in social housing.

389 British Gas offer a one-off repair service, but this is not offered across the board by the other largest energy retilares. SSE do not offer one-off repairs, for example.

390 Installation provided through Worcester-Bosch accredited engineers only.

Value added and profitability

The value added[391] of the markets for boiler installation and services is estimated to be £1.1bn/year while the market for insulation is estimated at £0.8bn/year[392]

The size of the market for boiler maintenance services, not including manufacture, installation or one-off repairs, is estimated to be approximately £353m/year[393]. Over the last two years, profit margins of Centrica and Homeserve on maintenance services have been between 15% and 30%. Furthermore, the return on capital employed was roughly 100% for Centrica in 2012. [394] This is a sector in which relatively large returns appear possible. This may reflect consumers' high willingness to pay for security and simplicity of maintenance of their energy systems.

13.5.2 Business canvas – manufacture

Heating and cooling enabling technologies are typically manufactured by companies who have global presence and do not generally have a direct presence elsewhere in the value chain. Manufacturers of electric heating technologies such as heat pumps, storage heating and air conditioning are also often active in producing electric heat technologies across the range. Others produce gas heating technologies such as boilers.

Figure 64 shows the business model canvas for enabling technology manufacture.

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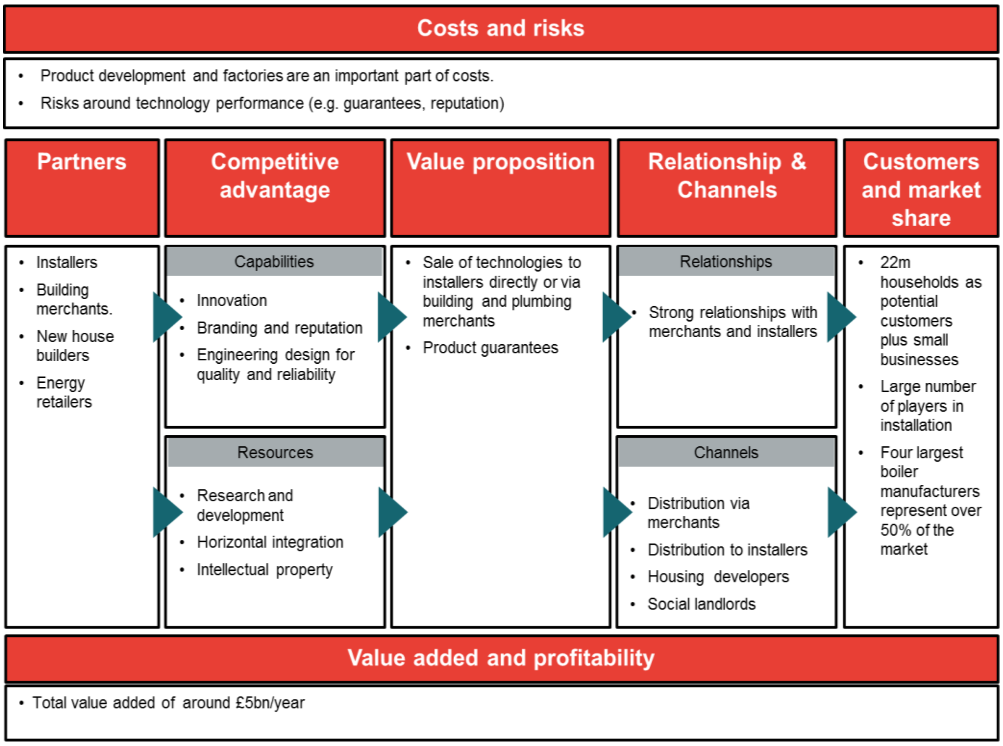
391 For a given part of a value chain, value added is the revenues less outside purchases of materials and services (e.g. for gas retail this would entail revenues minus fuel costs and network charges).

392 OFT (2012), *Home Insulation: A Report on the Call for Evidence carried out by the OFT*

393 This estimate is based upon the number of boilers in the UK, 23.46million according to DECC figures available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65955/4186-ecuk-domestic-2010.xls , an estimated average boiler maintenance cost of £75 according to Which (http://www.which.co.uk/home-and-garden/heating-water-and-electricity/guides/installing-a-boiler/) and an estimated proportion of 20% of boiler owners who take boiler cover. This is a conservative estimate given both the customers numbers of Homeserve and Centrica, and the Which finding that 33% of its readers have a maintenance contract.

394 Centrica Annual Report 2011 available at http://www.centrica.com/files/reports/2011ar/files/pdf/centrica_annual_report_2011.pdf and Homeserve Annual Report 2012 available at http://www.homeserveplc.com/download/ar2012.pdf

Figure 64. Enabling technologies manufacture business model canvas



Source: Frontier Economics, adapted from the Business Model Canvas from BusinessModelGeneration.com[395]

13.5.3 Costs and risks

For manufacturers, capital intensity can be high with product development and factories an important part of costs.

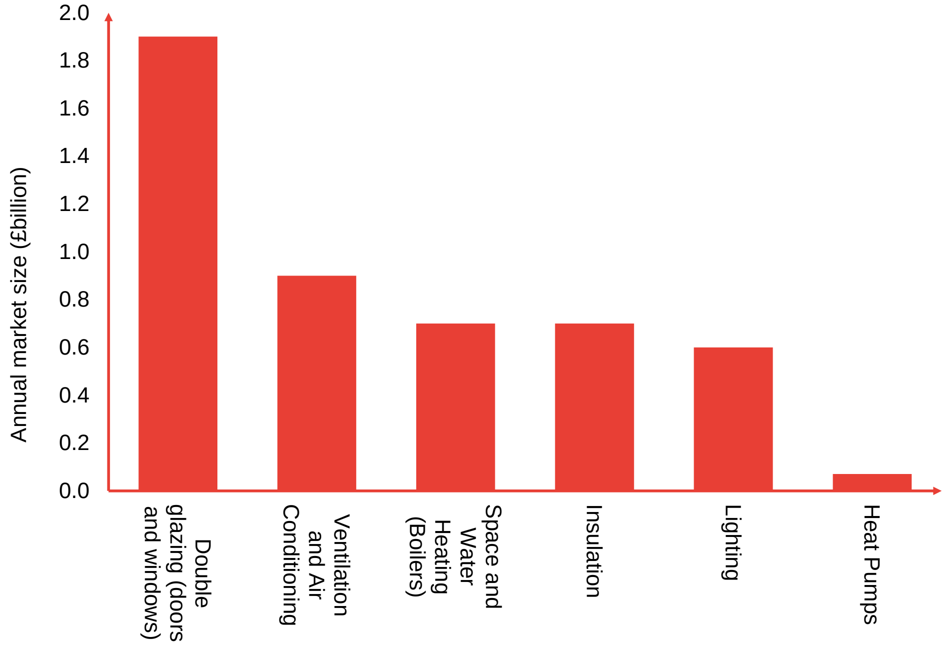
Manufacturers take on risk around the technology performance and reliability (e.g. through explicit guarantees or implicitly as part of their need to maintain their reputation). They must also takes on risks and provide guarantees around gas safety. This includes compliance with regulatory Health and Safety standards.

Customers and market share

Figure 65 shows the market size of enabling technologies.

395 **Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. Available at: http://www.businessmodelgeneration.com/canvas.**

Figure 65. Market size of enabling technologies manufacture[396]



Source: DECC "Final Stage Impact Assessment for the Green Deal and Energy Company Obligation" https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42984/5533-final-stage-impact-assessment-for-the-green-deal-a.pdf

Markets shares differ across technologies.

- **Heating technologies.** Over 100 manufacturers supply gas boilers to the UK market. The gas boiler manufacturing industry has a medium concentration of ownership. The four largest players (Baxi, Worcester Bosch, Valliant and Idea) contribute approximately 54% of the industry's annual revenue and the seven largest firms contribute approximately two-thirds of annual industry revenue. These firms are also active in the production of other heating technologies. **Table 7** below shows evidence of integration between the oil, gas and electric space and water heating technologies market, with traditional gas boiler manufacturers investing in launching heat pump technologies. Successful companies in the market place including Worcester Bosch and Baxi and are owned by European wide engineering groups. The industry also comprises many small companies

396 This gives the market value for 2010 where available. In the cases of Double glazing and Ventilation and Air conditioning the value is from 2009. For Insulation the data covers the financial year running from 2010 to 2011.

(over 100 manufacturers).[397] Around 70% of boilers sold in the UK are manufactured outside the UK[398].

- **Insulation.** There are eight major manufacturers of insulation in the UK — Knauf, Rockwool, Superglass, Isover, Kingspan, Celotex, Recticel and Xtratherm. Insulation is largely supplied from UK manufacturers – due to the high transport costs. Imports are estimated to account for only about 10% of the UK insulation market (including insulation of commercial and industrial buildings)[399].

Table 7. Activities of boiler manufacturers

Company	Gas boilers	Oil boilers	Heating controls	Heat pumps	Storage heaters	Air conditioning
Worcester Bosch	x	x		x		
Valliant	x	x	x	x	x	x
Baxi	x	x	x	x		
Ideal	x		x	x		
Dimplex	x			x	x	x

Relationships and channels and value propositions

The channels for marketing enabling technologies vary widely (for example, they can be marketed directly by installer, via energy retailers or other bodies such as DIY stores and supermarkets).

For manufacturers, the relationship with installers is very important. Installers have the main link with consumers. In addition, performance, reliability and practicality of enabling technologies are heavily influenced by how the technologies are installed. Installers are incentivised by manufacturers to recommend their products, often indirectly, through special promotions, rather than directly through cash incentives. The relationship between installers and manufacturers of the enabling technologies is also typically via a merchant who deals direct with the installer. For example:

- Builders and plumbing merchants have a very strong relationship with manufacturers of boilers. There is also anecdotal evidence that

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397 AMA Research (2013), *Space and Water Heating Market Report - UK 2013-2017 Analysis*

398 DECC (2013) Future of Heating: Meeting the Challenge

399 OFT (2012) *Home insulation: A report on the Call for Evidence carried out by the OFT*

manufacturers offer boilers at a discount to builders and renovators, on the basis that consumers are likely to replace the boiler with the same model.

- Manufacturers of insulation materials sell via specialist distributors such as SIG and Encon or builder's merchants (e.g. Travis Perkins, Jewson) and DIY stores (e.g. B&Q, Wickes).

Some manufacturers will also offer product guarantees which can be passed onto the consumer via the installer.

Competitive advantage

Important sources of competitive advantage for manufacturers include:

- Engineering and design of quality products. A skilled workforce, funding of product development and intellectual property can all contribute to this;
- developing brand, reputation and customer loyalty; and
- high levels of exposure at the points of sale for boilers and other energy related services.
- efficient procurement of material and equipment needed for manufacture.

Partners

Manufacturers of enabling technologies depend on a wide range of partners to deliver their services. Of particular importance are:

- merchants who connect installers to manufacturers;
- retail energy suppliers who are often the first point of contact for customers;
- housing developers who install enabling technologies as part of their housing developments; and
- social landlords who finance and control the choice of enabling technologies in social housing.

13.5.4 Value added and profitability

The total market size for the manufacture of enabling technologies is estimated to be around £5bn per year (covering boilers, air-conditioners, double glazing, heat pumps and lighting)[400].

400 DECC (2012), *Final Stage Impact Assessment for the Green Deal and Energy Company Obligation*

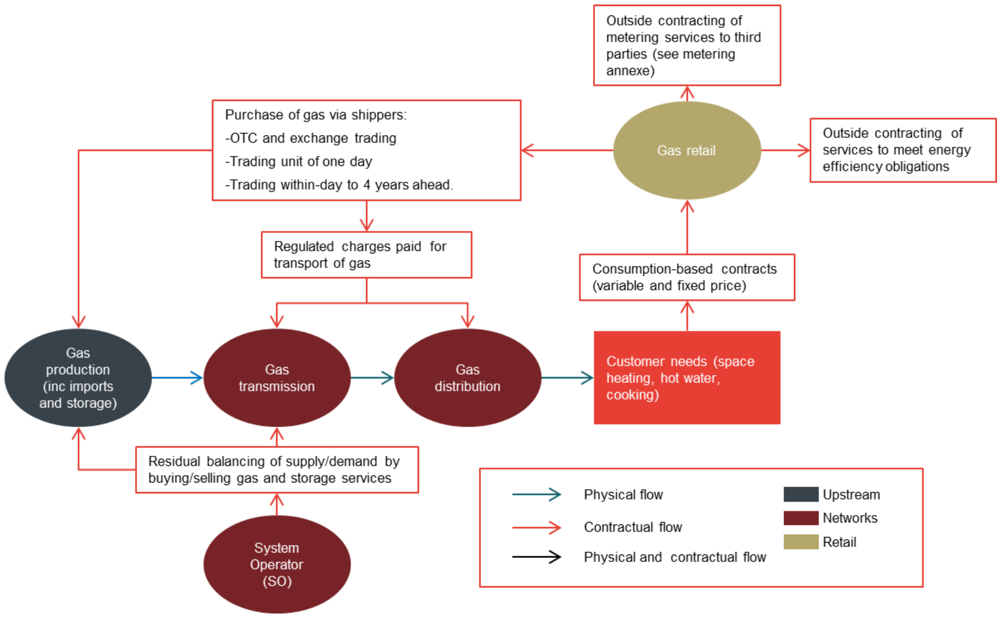
14 Annexe 9: Contractual arrangements

This annexe focuses on the contractual arrangements between parts of the value chain, excluding the consumer value propositions which are covered in the main gas, electricity, district heating and oil annexes (Annexes 4-8).

14.1 Gas and electricity

Figure 66 and Figure 67 provide an overview of the key contractual arrangements in the gas and electricity value chains[401].

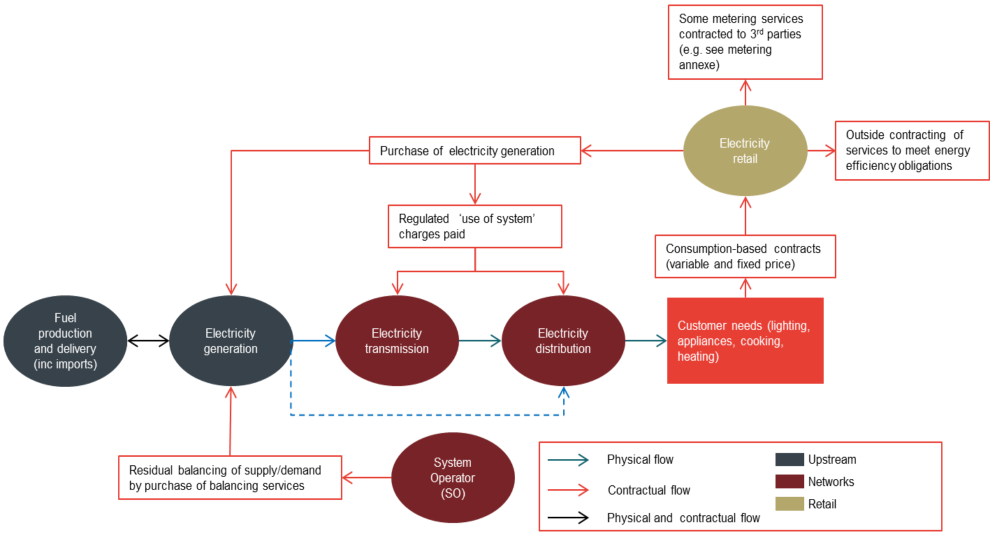
Figure 66. Key contractual arrangements in the gas value chain



Source: Frontier Economics

401 In this section, we cover these in the section relevant to the part of the value chain which is *receiving* the revenue (e.g. we cover wholesale gas trading in the upstream section).

Figure 67. Overview of contractual arrangements in the electricity value chain



Source: Frontier Economics

14.1.1 Retail

Retails have important relationships with the upstream fuel producers. These are described below, in the upstream section. In addition retailers have the following relationships with other parties.

- **Retailers contract with installers of energy efficiency measures as part of meeting retailers' energy efficiency obligations**. We cover this in the enabling technologies section.

- **Retailers contract for metering services**. Retailers have different contracting strategies for provision of retailing services. Most retailers contract with parties that own metering assets and often with providers of metering installation, maintenance and reading services where they do not have the customer density to justify undertaking the activities in house[402].

- **Retailers contract for billing systems and the associated IT**. Many retailers contract out for billing systems, including for the associated software and support. For example, Utiligroup provides an "end-to-end" billing systems solution to the UK energy retail market. This includes registering customers, billing, trading, demand-forecasting and settlements.

402 Further detail is provided in Annexe 10: Metering of gas and electricity

- **Retailers contract with technology suppliers to provide smart home offerings**. As retailers offer more innovative propositions, they are using various delivery partners for equipment and systems. In particular retailers such as British Gas and SSE have developed partnerships with suppliers of energy management hardware (e.g. meters) and software (e.g. for analysing the data). This includes companies such as Alert Me, Onzo, Trilliant and Opower. Retailers have also been directly investing in some of these firms[403].

14.1.2 Networks

Networks collect the revenues they are allowed under their price controls through charges on networks users (e.g. retailers, generators, shippers). These are applied for use-of-system (on an on-going basis) and for connection.

- **Electricity transmission.** 73% of the use-of-system charges are levied on retailers (i.e. demand) and 23% of generators. 20% of the charges are based on location (i.e. where demand and generation is different area zones are charge according to the estimated costs of serving that zone). The other 80% of charges are in effect socialised.

- **Electricity distribution.** Prior to 2010, network companies could establish their own charging mechanisms. Since 2010, these have started to be harmonised through the Common Distribution Charging Methodology. There are a wide variety of charging structures and they vary depending on the type of customer (e.g. whether they are half-hourly metered or not). Charges are typically a mixture of consumption charge (p/kWh) and a standing charge (e.g. £/kW/year). In some cases where commercial customers have half-hourly meters, charges can vary by time of day and they can also be locational for high-voltage customers.

- **Gas transmission**. Charges are made to shippers on the basis of a mixture of consumption (p/kWh), exit capacity (p/kWh/day), entry capacity (p/kWh/day) and a standing charge (p/day). The prices for entry and exit capacity at different points are determined by auction and therefore are locational.

- **Gas distribution.** Charges are based on a mixture of consumption (p/kWh) capacity (p/peak day kWh) and standing charges (p/day). These are charged at defined entry and exit points for the gas network.

As regards connection charges, there are a variety of arrangements.

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403 http://www.greentechmedia.com/articles/read/onzo-sells-hardware-to-sse-focuses-on-analytics

- In electricity transmission connection charges (mainly for generators) are based on "the costs of assets installed solely for and only capable of use by an individual user". These paid for through upfront and annual charges.

- In electricity distribution the charges for exclusive connection to the network are charging in full to the user whereas the costs of any reinforcements of the existing network needed are typically shared between the user and the network operator.

- For gas distribution there are standard charges for connecting individual properties range from around £100 to £1000.

Network firms also contract out for services related to their operations, including for construction, maintenance and equipment purchase.

14.1.3 Upstream gas

Gas producers, importers and storage operators trade with retailers via gas shippers (who are often part of the retail businesses). This trading is underpinned by the gas trading arrangements which provide incentives on producers and retailers to ensure the gas they physically demand and supply matches what they have contracted for. The following features characterise the trade of gas in the GB market at present. Further detail is provided in Box 11.

- **The majority of trading is 'over-the-counter' (OTC)**. Channels for trading may be OTC where two companies contract bilaterally (including via brokers), or exchange based where parties trade anonymously. The OTC market currently accounts for the majority of gas traded. There is also some contracting with the System Operator where gas is brought/sold to ensure system balancing.

- **Gas producers trade gas with shippers and retailers through a variety of contract types**. These allocate price and volume risks between these parties in different ways and over different durations (e.g. fixed versus floating price contracts; fixed versus floating volume contracts). Seasonal products are very common (i.e. a contract for an amount of gas to be delivered over a season).

- **Gas can be purchased up to four years ahead and beyond to allow retailers to hedge price risks**. Most of the liquidity in the market is concentrated between two and 12 months ahead and is limited beyond two years ahead. The majority of trading volume is concentrated in seasonal products.

Aside from trading gas, gas producers, importers and storage operators will also contract out for many other services related to their operations, including for construction services, maintenance services and equipment.

14.1.4 Generation

In GB, electricity is traded between generators and retailers in half-hourly "settlement periods". Up to one hour in advance of the settlement period, electricity generators can trade with retailers and large business users (who may buy electricity directly on the wholesale market). This is done through bilateral contracts (OTC) or on exchanges. Parties must notify Elexon, the Balancing and Settlement Code Company, of these contracts (see Box 11).

Short-term trading is aimed at optimising the purchase and sale of shorter duration quantities of power and helps parties to adjust their positions to take account of unpredictable incidents.

After gate closure, fluctuations in production and generation can no longer be balanced by trades between market participants. Instead, the complexity of managing the electricity system in real time and ensuring that demand and supply balance on a second-by-second basis requires the (transmission) system operator to take over the running of the system. This is done by targeted activation of control or balancing reserve, which allows the System Operator to alter the intended running patterns of particular generators or load facilities to ensure that the demand supply/balance occurs in real time.

The following features characterise trading of electricity between generators and retailers.

- **The majority of trading is 'over-the-counter' (OTC)**. As with gas, the OTC market currently accounts for the majority of electricity traded. However the levels of exchange trading are growing, especially at day-ahead stage[404]. There is also a high level of vertical integration between electricity generators and retailers meaning large volumes can be "self-supplied".

- **A wide range of products are traded**. Aside from contracts for delivery in a given half-hour, other common contracts include 'baseload' (i.e. round-the-clock generation), 'peak' and 'off-peak'.

- **Electricity is traded from one hour to 3 years ahead**. The majority of the trading volumes occur on the forwards and future markets. However, most of the liquidity is concentrated within-year. Independent generators also sign long-term off take contracts for power generation with portfolio generators

404 Ofgem (2012), *GB wholesale electricity market liquidity: summer 2011 assessment*

and retailers (Power Purchase Agreements). These typically transfer short-term market risks (including those around balancing) away from generators. They can be an important part of financing independent power projects[405].

- **The wholesale electricity market is currently an 'energy-only' market** with wholesale trading based on generation (MWh). However, Government are concerned that this may not be able to deliver sufficient incentives for investment in capacity (MW) in a low-carbon system. DECC are proposing to introduce a capacity market where this is rewarded separately to generation according to its contribution to the reliability of the system.

As regards other contractual arrangements in electricity generation, firms in GB typically "build, operate and own" the power stations. However, some services and technologies associated with the construction and operation of these facilities are often contracted out to third parties (e.g. construction, maintenance, equipment).

Box 11. Managing price and liquidity risks

For retailers, generators and gas producers in electricity and gas, managing risks around price and liquidity is very important to their financial sustainability.

For retailers the key issue is that wholesale electricity and gas prices can be volatile and only part of this risk is passed onto customers (i.e. tariffs can only be changed periodically and some customers are on fixed price tariffs). Related to this there is liquidity risk, which in this context means the risk that a company cannot obtain the funding needed to fulfil its contracts with other market participants.

Typically retailers, generators and gas producers will trade under a risk management model. This will include controls of trades to ensure a firm's exposures to price and liquidity risk is limited. This includes hedging medium and long-term price risks through wholesale market contracts and ensuring the firm has sufficient cash and working capital to manage periods of low market liquidity.

A number of small retailers have gone out of business due to difficulties managing these risks during periods when the market has become short, prices have spiked and liquidity has dropped. This is a particular issue in electricity where prices can be very volatile when the market is short of generation. Retailers that are vertically integrated with generation may have advantages in these situations as they do not have to completely rely on purchasing from the market.

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405 DECC (2012), *A call for evidence on barriers to securing long-term contracts for independent renewable generation investment*

Box 12. Brokers, traders and exchanges

Brokers act as intermediaries in the energy market, bringing together parties to buy and sell. Brokers do not take a financial position themselves, and therefore do not take on the risk of transactions. Instead, they charge commission, which varies depending on the broker and the size of the transaction.

There are a large number of broker firms active in the UK market. Some specialise in energy or environmental markets. Others are also active as brokers in financial markets more generally[406]. **Table 8** describes the size of the market.

Table 8. Trading by brokers in the energy market – year to July 2012

	Size of market	Change over previous year	Notional value
Gas	518 billion therms	-8%	£276 billion
Electricity	998 TWh	+9%	£58 billion
Coal	2.4 billion tonnes	+9%	$281 billion
Emissions	3.6 billion tonnes	+40%	€36 billion

Source: Data collected from UK energy market brokers by the FSA[407]

Unlike brokers, **energy traders** take physical positions in the market. A range of parties are active in energy trading. Each of the six main energy retailers has a trading arm. In addition, financial institutions and boutique energy trading companies are involved.

Exchanges offer anonymous market places for trading, clearing and notification.

APX was established in 2000 as the UK's first independent power exchange. It deals with the majority of within-day balancing in electricity and also covers gas[408]. A second power exchange, N2EX was launched in 2010. N2EX is owned by Nordpool, who are active in continental markets.

Most of the smaller players (such as independent energy retailers) are not active on exchanges, due to the high credit and collateral costs[409].

406 See for example: http://www.leba.org.uk/pages/index.cfm?page_id=3&title=members_directory Accessed 04/04/13.

407 FSA (2012), *Analysis of activity in the energy markets 2012*

408 http://www.apxgroup.com/trading-clearing/apx-power-uk/, Accessed 04/04/13

409 Ofgem (2001) *GB wholesale electricity market liquidity: summer 2011 assessment*

Box 13. ELEXON and Xoserve

ELEXON delivers the Balancing and Settlement Code (BSC) in the electricity sector. It handles almost £1.5 billion of customers' funds each year and interacts with over 240 companies in the electricity industry[410]. Turnover for the year to 31 March 2012 was £30.4m[411].

ELEXON (and its subsidiaries[412]) form a not-for-profit group. The group's costs are recouped from licenced electricity generator and retailers, all of whom are obliged to become signatories of the BSC.

ELEXON is wholly owned but not controlled by National Grid.

Some of ELEXON's work has been outsourced to Logica – including the design, build and operation of the central services supporting the New Electricity Trading Arrangements (NETA) and the business process outsourcing, hosting and communications aspects of the BSC Systems.[413]

Xoserve provides data services to support the gas market. One of its key roles is to manage all the information relating to the 22m gas supply points in Great Britain.

Previously, Xoserve was run as a private profit-making company, jointly owned by the five major gas distribution network companies and National Grid's gas transmission business. It was regulated by Ofgem with fixed allowed revenues set on an ex-ante basis.

Following a review in 2011, Ofgem decided that Xoserve should be run as a non-profit business, following a similar model to ELEXON's. The new arrangements will be implemented in mid-2013[414] and from then on market participants will be charged for the cost of its services. This reform aims to give more control to the users of Xoserve's services and provide more flexible funding arrangements for new services.

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410 www.elexon.co.uk, accessed 29/03/13

411 ELEXON (2012), *2012 Financial Report*

412 ELEXON is the parent company of four wholly-owned subsidiaries: ELEXON Clear Limited, Poolserco Limited, Poolit Limited and BSC Co. Limited.

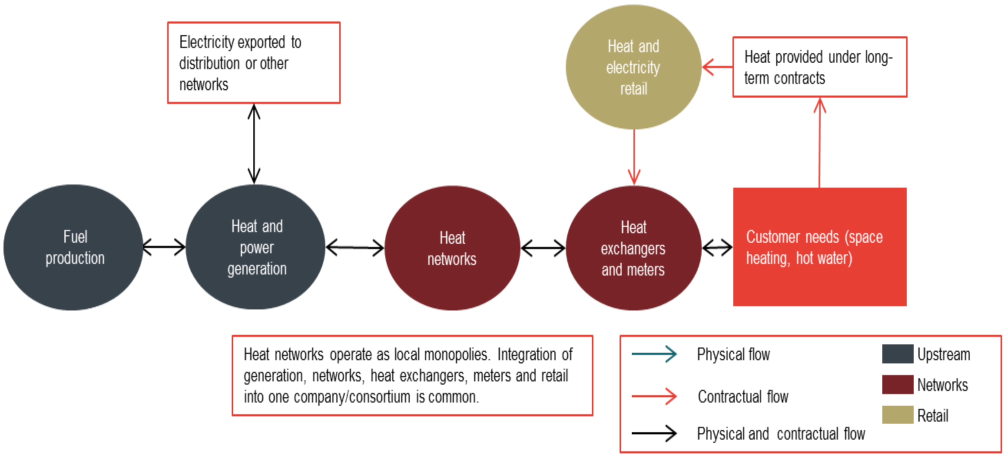
413 http://www.logica.co.uk/we-are-logica/media-centre/case-studies/elexon%20firms%20up%20relationships%20with%20transparency%20and%20trust/, accessed 29/03/13

414 Ofgem (2012), *Open letter: Review of Xoserve – Ofgem's conclusions*

14.5 District heating and CHP

Figure 68 shows the structure of a typical district heating project.

Figure 68. The structure of a district heating project



Source: Frontier Economics

In a given district heating project there is typically a high level of integration between generation, networks and retail. Project developers often set up an Energy Services Company (ESCo) which covers generation, transportation and retail of heat, and in some cases electricity. Ownership or long-term contracting of the scheme by local authorities is also observed. Similarly an owner of social housing (or other heating network owner) may contract out the construction, operation and maintenance of a heating network while retaining ownership of the network and responsibility for supplying heat.

Various contracts are required to deliver and run a district heating scheme. These can be complex and usually cover the following areas[415].

- **Construction**. This includes contracts for design and construction of the CHP plant (or other heat supply), the heat network and the connections within the premises. This will also include contracts for equipment.

- **Services**. This includes generation of heat (and electricity if relevant), operation and maintenance of the plant and network, connecting additional customers to the network, and metering and billing services.

- **Property agreements**. This includes purchase and leasing of required land, street works licenses and access rights to private land and buildings.

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415 These are adapted from ARUP (2013), *District Heating Manual for London*

All of the above can be contracted individually or as part of service bundles. Moreover ESCos will undertake many of these services themselves.

The types of contractual structure used for district heating vary, and this was identified as a barrier to development of heating networks by both public and private sector developers in recent research.[416]

ESCOs have been used for a number of district heating developments in the UK. Box 14 shows the key contracts required for ESCO district heating.[417]

Box 14. ESCO contracts

This box describes the contracts required for district heating delivered by ESCOs.

- **Master agreement** with the project sponsor to ensure the ESCO earns a sufficient return on its investment. This will typically require a long-term agreement.
- **Connection.** This contract will typically set out the connections required by the sponsor and the cost at which these will be delivered.
- **Heat supply contracts** are with domestic and business consumers. They typically specify prices and the quality of service.
- **Service level agreements (SLAs)** at every level – for example between the ESCO and housing developer to agree connection timings.
- **Property leases** may also be agreed at the same time as the master agreement. These will typically provide the energy centre buildings to the ESCO on a long-term lease.

The main types of ESCO include the following, and each may be associated with different contract structures:[418]

- public sector with limited or no private sector role;
- public sector with private sector involvement in design and construction;

416 BRE, University of Edinburgh and the Centre for Sustainable Energy (2013), *Research into barriers to deployment of district heating networks*

417 These are adapted from ARUP (2013), *District Heating Manual for London*

418 Adapted from Brodies LLP (2007), *Making ESCOs work: guidance and advice on setting up and delivering an ESCO*

- public sector driven but with private sector procuring and operating the scheme;
- public or private sector, operated on energy performance contracting principles; and
- private sector driven.

We now describe two contrasting examples of contractual structures used by ESCOs in the context of CHP and heating networks in the UK.

- A CHP scheme in Aberdeen to deliver heat and power to domestic customers was introduced using a **not-for-profit ESCO at arm's length from the local authority**, regulated by a Framework Agreement setting out the ESCO's obligations and an Installation Agreement with provisions for installation. In turn, this ESCO contracted out functions such as the design and build of the scheme. The ESCO operates and maintains the system itself. For non-council-tenanted properties it supplies, the ESCO enters Heat Supply Agreements. Electricity is supplied to an electricity consolidator, who then supplies tenants and owner-occupiers with power as agreed with the ESCO, and sells surplus electricity locally.[419]

- A CHP and network heating system in Tower Hamlets was delivered through PFI. This involved the Barkantine Heat and Power Company (BHPC) being set up as a **wholly owned subsidiary of London Electricity Services (now part of EDF Energy) who were appointed by the London Borough of Tower Hamlets through a tender process.** BHCP is contracted to be involved in the scheme for 25 years, and the Borough receives 40% of unanticipated profits every two years. It installed a CHP unit and household meters, and supplies heat and power to domestic customers.[420]

Where contractual arrangements also include supply of electricity, this element may be supplied indirectly to domestic and small business consumers. This is because electricity generated by CHP units may be intermittent (e.g. supplied only when heating is also supplied), so may not be able to fully meet domestic and small business needs. However, there are also examples of CHP providing domestic and small business electricity supply through private wires.[421] Woking's CHP scheme found that selling electricity generated by the CHP directly to

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419 Brodies LLP (2007), *Making ESCOs work: guidance and advice on setting up and delivering an ESCO*

420 Adapted from Brodies LLP (2007), *Making ESCOs work: guidance and advice on setting up and delivering an ESCO*

421 See survey evidence in BRE, University of Edinburgh and the Centre for Sustainable Energy (2013), *Research into barriers to deployment of district heating networks*

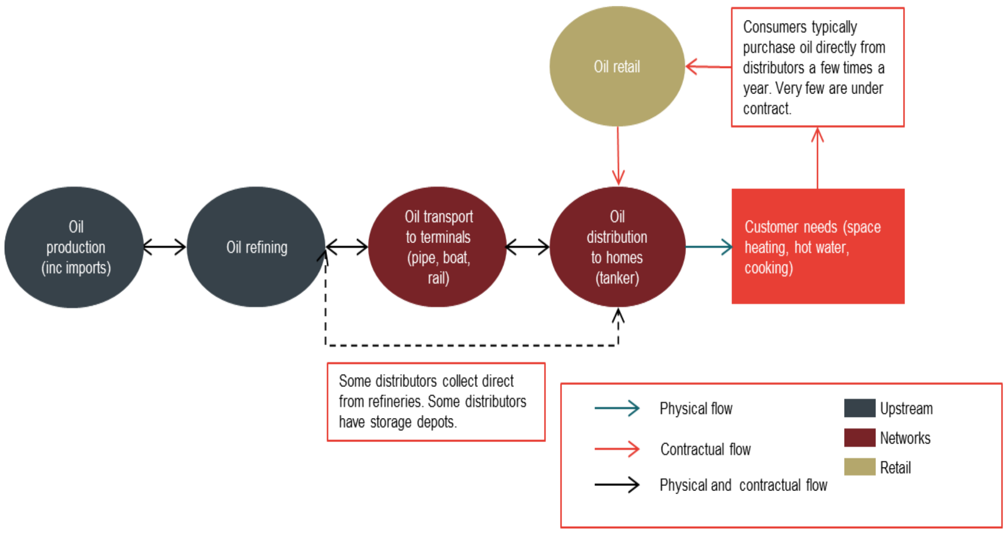
customers was more profitable than selling it to electricity supply companies,[422] though regulatory changes continue to affect the relative incentives to use private wires instead of distribution network connection.

Given that heating networks entail large sunk costs; long-term contracting with end-consumers is often used to mitigate the risk of not recovering these costs. This contracting is often between an ESCO and the heat users, or may be indirect. For example, in the Aberdeen CHP and network heating example above, the ESCO is required under its contracts with the local authority to provide heat to the Council, which is ultimately supplied to tenants on a heat with rent basis. Alternative ways to mitigate the risk of not recovering network costs are local authorities agreeing to require all new developments within the network area to connect to the heating network, or local authorities guaranteeing that their buildings will connect to the network.

14.7 Heating oil

Figure 69 provides an overview of the key contractual arrangements in the heating oil value chain.

Figure 69. Key contractual arrangements in the heating oil value chain



Source: Frontier

There are two key contractual arrangements within the heating oil value chain:

422 Brodies LLP (2007), *Making ESCOs work: guidance and advice on setting up and delivering an ESCO*

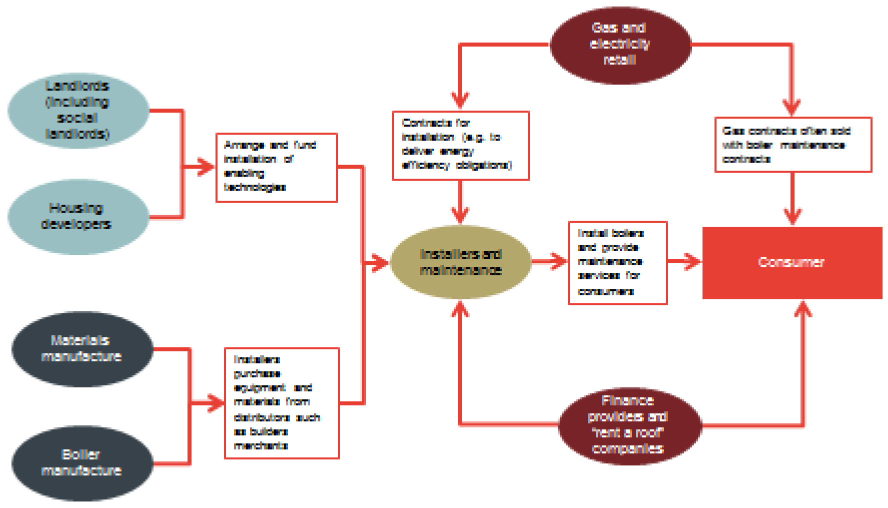
- **Crude oil producers selling to refiners**. Many of the large global oil producers are involved in refining and therefore crude oil can often be "self-supplied".

- **Refiners selling to distributors**. In contrast to wholesale markets for gas and electricity, markets for refineries selling to heating oil to distributors are more localised due to the required physical connection. In heating oil, retail and distribution are typically integrated together.

14.8 Enabling technologies

The contractual arrangements in enabling technologies are extremely diverse. Figure 70 provides a stylised overview of some of the important contractual arrangements in gas enabling technologies.

Figure 70. Stylised overview of contractual arrangements in enabling technologies



Source: Frontier

14.8.1 Energy efficiency technologies

There are a wide variety of contractual arrangements for manufacture and installation of energy efficiency technologies. Installers of energy efficiency technologies such as insulation typically contract for materials and equipment via builders merchants.

A very important channel for delivery of insulation technologies is via retailers energy efficiency obligations (CERT, CESP and now ECO). To deliver their obligations, retailers have developed multiple channels including contracting directly with installers and retailer of energy efficiency technologies and also through partnerships with social landlords and local authorities.

The nature of contracts vary but under CERT energy retailers have typically contracted with delivery partners based on a price per tonne of carbon saved (typically for insulation and lighting installations). Under ECO a brokerage service has been set up with retailers able to purchase energy saving measure anonymously via fortnightly auctions. One of the main objectives of this service was to ensure open access to energy retailers' ECO spending for all Green Deal Providers, regardless of their size or existing relationship with retailers.

In turn the delivery agents offer measures to households which are subsidised by the payment from retailers[423]. More detail on these offerings can be found in the enabling technologies annexe.

14.8.2 Boilers

The manufacturers of boilers are not typically active in the installation of boilers. Installers generally purchase boilers via building and plumbing merchants. There is also some evidence that for installers working on housing developments, boilers are offered at a discount by manufacturers on the basis that consumers are likely to replace the boiler with the same model.

While most of the contracts for installation come directly from the consumer, social landlords and housing developers also contract for installation on behalf of the final consumer. For small business there may be a facilities manager who contracts with installers.

423 DECC (2011), *Evaluation of the delivery and uptake of the Carbon Emissions Reduction Target (CERT)*

15 Annexe 10: Investment and financing in the energy value chains

This annexe describes the current investments in the energy value chains and how these are financed. It covers the main investment players and the expected levels of return.

15.1 Current investment levels

Investment rates in the electricity gas sectors are currently high, and will need to rise further. In 2011 there was more than £10bn of investment in the electricity and gas sectors in the UK, equivalent to around 12% of the total turnover of the sector[424]. This is around double the rate of investment seen a decade ago.

The majority of this recent investment has been in power generation assets (57% in 2011) as aging plant has been replaced and as build of renewable generation has expanded (particularly wind). In 2011, 20% of the investment has been in distribution networks and 20% in transmission networks with the remainder in gas storage and import infrastructure[425]. Investments in enabling technologies are not included in these figures[426].

15.2 Investment players

The main players involved in investment in the energy sector are as follows.

- **Brokers of capital**. These are the investment banks, capital markets, credit rating agencies that facilitate access to capital markets and provide information on projects.

- **Providers of debt**. These are commercial banks, European Investment Bank, European Bank for Reconstruction and Development that provide debt finance to projects.

- **Agents of long term capital**. These are the private equity companies and infrastructure funds.

- **Principle holders of long term capital**. These are the sovereign wealth funds, pension funds, endowments, investment funds and insurance

424 E&Y (2012), *Powering the UK: Investing for the future of the Energy Sector and the UK*

425 E&Y (2012), *Powering the UK: Investing for the future of the Energy Sector and the UK*

426 Figures for these are difficult to disentangle from the wider investment spend by manufacturers.

companies. This group are bound by fiduciary duties, which dictate clear risk-return requirements. This means that they have typically invested in the sector through listed equity, rather than directly financing projects[427]. Given their importance to providing finance for the energy sector, further detail of their requirements is provided in Box 15.

427 Exceptions to this have been seen in Europe. For example, the arrangement between Dong and PGGM (a Dutch pension fund) saw it take a 24.8% stake in a 367 MW offshore wind farm under construction. The contractual arrangements had to be packaged in such a way that it was a viable proposition for the pension fund and DONG remained responsible for all operational activities. This model is seen to be one that could become increasingly important in future, given the scale of investment required in the sector.

Box 15. Pension fund requirements

Given the importance of this type of funding for the energy sector, and the expected increased reliance on it in future, it is useful to understand the characteristics of energy sector investments that correspond with the needs of the pension fund investor[428].

- **Asset diversification benefits:** Investing in certain energy sector assets can act as a risk reduction strategy for a pension plan due to the low correlation to the traditional public market asset classes. This can serve to reduce the volatility of returns and unsystematic risk of the overall plan.

- **Consistency and reliability of returns:** Another benefit may be the fixed income nature of the return stream. For many energy investments, a large part of the return is generated as income rather than investment appreciation (see **Figure 71**). This provides reliability of the returns over time. Also, the returns for many of these investments can be partially hedged for inflation.

Figure 71. Illustrative infrastructure returns

Asset segment	Risk	Avg. cash yield % (years 1–5)1	Avg. leveraged IRR (%)2	Capital appreciation potential
Private Finance Initiatives (PFI)	Low — Medium	4–5	6–9 3	Extremely limited
Toll roads (Operating)	Low — Medium	4–6	8–12	Limited
Contracted power generation	Low — Medium	4–7	10–13	Limited
Regulated assets	Low — Medium	5–8	10–15	Limited
Rail	Medium	8–12	14–18	Yes
Airports/Seaports	Medium	4–7	14–18	Yes
Toll roads (Development)	Medium — High	3–5	12–20	Yes
Communications networks	Medium — High	4–7	15–20	Yes
Merchant power generation	High	4–12	15–25	Yes

(1) Cash distribution to equity holders as a percentage of equity investment
(2) Assumes debt of 50% to 85% and investment periods of not less than five (5) to seven (7) years
(3) PFIs generally finance social infrastructure. New development of PFIs may return as much as 10–12%, to compensate for greater risk
Source: JP Morgan Asset Management

- **Investment Time Horizon:** The long-term lives of many of the investments are an important characteristic for pension funds. Pension funds are long-term investors due to the long-term nature of their liabilities,

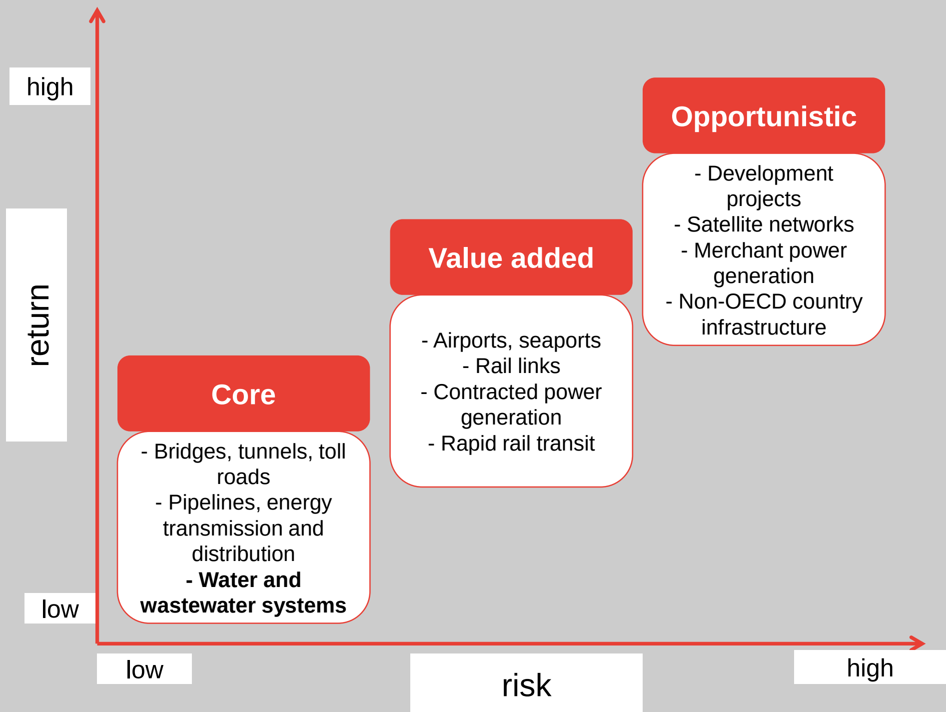
428 See JP Morgan – Infrastructure investments : Key benefits and risks (January 2010)

investing in assets that generate cash flow over the long term aligns with the pension fund's primary goal of meeting its cash flow obligations.

- **Variety of Investment Options:** There are many options for investment in the energy sector. This provides flexibility in attempting to match asset cash flow to liability cash flow. Investments will have varying maturities based on the specific investments.

- **Alternative risk/return profiles.** Not all energy sector assets have the same risk-return profile: there is a range to choose from (see **Figure 72** below): from *core assets* with a low risk-low return profile including, for example, network businesses subject to economic regulation to *opportunistic assets* that may yield returns higher than the core asset type but those returns are exposed to a higher risk such as merchant generation opportunities.

Figure 72. Risk-return profile of alternative infrastructure assets



Source: Adapted from JP Morgan – Infrastructure investments : Key benefits and risks (January 2010)

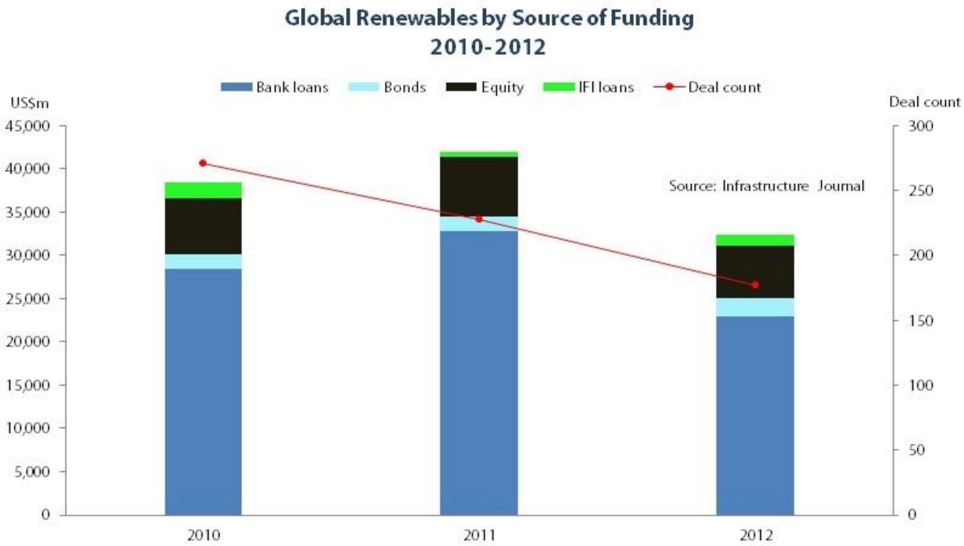
15.4 How investment is financed in the energy value chains

In general there are two main options for financing energy investments:

- **on balance sheet funding,** where energy companies (or consortia) raise new debt and/or equity against their whole asset base; and
- **project financing** (including asset finance), where debt is borrowed (for example, through bond issues) for a specific project, and where debt is linked to the revenue generated from the project.

The former model is the most common in the energy sector. Typically, the immediate funders for new projects are energy companies who use retained earnings as well as raising new capital. External capital is usually in the form of debt, mostly bond issues as this is usually cheaper than new equity. Credit ratings are therefore important and need to be maintained so they can access low-cost capital from the capital markets. For example, maintenance of a single A range credit rating is stated as being central to Centrica's core strategy. For very large investments, companies issue new shares. For example, in 2008 Centrica raised over £2,251 million from a rights issue to fund investment in generation assets while SSE raised £479 million to fund a capex programme in 2009. As an example of the source of funding in the energy sector, Figure 73 provides a split of the source of funding for the global renewables sector.

Figure 73. Global renewables by source of financing



Source: Infrastructure Journal

There is growing interest in the role that **asset finance** could have in the renewables and energy efficiency (Box 16).

Box 16: Asset finance

Asset finance involves an arrangement between a leasing company, who buys and owns the equipment, and a customer, who hires the equipment, paying rent over a fixed term. It can be obtained directly from specialist providers, or indirectly through equipment suppliers or finance brokers.

This type of financing is widely used across business sectors in the UK, particularly by SMEs. In 2011, asset finance funded about 25% of all fixed capital investment in the UK. It is particularly suited for assets which are relatively homogenous, and are not sunk (i.e. have a value outside their immediate use). In 2011, asset finance was used for business cars (30% of total asset finance provided), commercial vehicles (21%), plant and machinery (18%) and business and IT equipment (16%)[429].

Asset finance currently plays a small role in funding renewable and energy efficiency investments. However, interest in this area is growing. The Financial Leasing Association estimates that the potential size of the market for CHP systems, biomass boilers and small wind turbines could be £6billion over three years[430]. For example, in 2011, Carbon Trust and Siemens launched a £550m asset financing programme for business energy efficiency investments in the UK[431]. Several companies now offer specialist asset financing in the renewable sector, offering finance to cover assets ranging from microgeneration and heat pumps to offshore wind-farm maintenance vessels[432]. Asset finance is also used to fund electricity and gas meters[433].

he precise way investment in the energy sector it financed depends on the scale of investment required and the risks involved. Scale can vary from small community-based projects through to large national assets (for example, the price

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429 Finance and Leasing Association (2012), *Promoting energy efficiency measures: the role of asset finance*

430 Finance and Leasing Association (2012), *Promoting energy efficiency measures: the role of asset finance*

431 http://finance.siemens.com/financialservices/global/en/press/press_releases/pages/the-carbon-trust-and-siemens-launch-new-green-finance-deal-worth-550-million-to-green-businesses-in-the-uk.aspx

432 For example: Lombard, Assured Asset Finance,

433 For example: Macquarie Energy Leasing.

for each reactor at Hinkley Point C is expected to be £7 billion[434]) while risks vary across a range of characteristics.

- **Revenue risk** where there is a high upfront cost and investors need confidence that future prices (e.g. for power) will be sufficient to ensure a return on their investment.

- **Policy risk** that can impact on the profitability of a project. For example, changes that affect future carbon prices or support mechanisms. Policy risk can often be hardest to risk to manage.

- **Construction risk** where there are risks of delays and cost overruns. This can be a particular issue for new technologies and nuclear investments.

- **Technology risk** can vary extensively between projects where the technology is tried and tested (such as CCGT plants) through to technology that is still very much in the development stage (such as CCS).

It is important to recognise that infrastructure finance is a global business. The UK energy sector therefore competes in the capital markets for finance with both other sectors and countries. Indeed, there is evidence that investors see Europe as a fragmented series of policy regimes that can limit the activities of investors to a subset of those countries and can lead to "country-hoping" behaviour.[435] Policy developments drive this behaviour. Further, many of the energy companies that operate in the UK are part of larger global utilities (e.g. EdF, RWE, E.ON, Iberdrola) and therefore the competition for finance between countries is also driven by internal factors. Ensuring that the UK energy sector remains competitive in its ability to secure finance is one of the challenges facing the sector and policy makers.

There is a relatively risk-averse approach to lending from commercial banks. This is a particular issue for securing finance for projects with a significant new technology or novel process element. Where there is insufficient track record for the technology or process, lenders often require increased equity contribution (which affects the affordability of the project). There have also been a number of government schemes to help address this issue. An overview of these schemes is set out in Box 17.

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434 "Building New Nuclear: the challenges ahead", Energy an Climate Change Select Committee (26 February 2013).

435 "Roadmap 2050 - Financing for a zero-carbon power sector in Europe - a financial sector's view on the decarbonisation of the European power sector", European Climate Foundation (2011).

Box 17. Attracting private finance to infrastructure

- **UK Guarantees Scheme** – The Government hopes this scheme will help encourage private sector investment in infrastructure projects, in part by reducing construction risk. The aim is to give investors confidence that the Government will step in if projects go wrong by providing expensiture and liabilities on financial assistance of up to £50 billion to priority projects in the infrastructure pipeline. These projects could be in transport, utilities, energy and communications. Eligible projects will be subject to charges, due diligence by HM Treasury and must meet eligibility criteria such as national significance, degree of preparedness, credit quality, committed equity finance, and contribution to economic growth.

- **Pension Infrastructure Platform –** The Government signed a Memorandum of Understanding with two groups of UK pension funds (including the National Association of Pension Funds and the Pension Protection Fund, and a separate group representing pension plans and infrastructure fund managers) to unlock additional investment in UK infrastructure. The Government will target up to £20 billion of investment from these initiatives.

- **Green Investment Bank – GIB** became operational in October 2012, funded with £3 billion to commit before April 2015, £180 million of which is already committed to waste and energy efficiency projects. Its mission is to provide financial solutions to accelerate private sector investment in the green economy, addressing market failures affecting green infrastructure projects in order to stimulate a step up in private investment. It has commenced funding. For example it will be providing £18 million towards a new energy innovation centre for Cambridge University Hospitals NHS Trust, with a further £18m being provided by Aviva. The funds provided for the energy centre are part of a commitment of £50 million to the Aviva Investors REaLM Energy Centres Fund (Fund), a fund that specialises in investment in non-domestic UK energy centres. The new energy innovation centre will house a combined heat and power unit, biomass boiler, efficient dual fuel boilers and heat recovery from medical incineration.

- **Export credit agencies:** ECAs provide guarantees as to debt repayment up to the level of the value of exports of key technologies and equipment to be integrated into the project. There has been heavy reliance on ECA support in the renewables and commodities sectors in recent years.

- **Local authorities** - Local authorities' involvement to date in financially supporting such projects has been relatively limited, given procurement, state aid and internal governance rules. However, the Localism Act 2011 has given greater contracting freedom to local authorities' available options for partnerships.

- **Local agencies** – An example of a local agency is the London Waste and Recycling Board (LWaRB) which has a fund of £26.3 million from

Government to distribute including to showcase technologies such as hydrogen fuel cells, gas to grid, and waste derived transport fuels. This programme will include brokering partnerships with various parties such as technology providers, off-takers and fuel suppliers.

As well as utilising bank loans and raising equity, smaller schemes rely often rely on organisations that specialise in providing finance for community groups and good causes. This may be through Government grants (for example through Grassroots Grants, the £130million programme run by the Community Development Foundation), local government funding (such as grants for environmental projects), European funding (if the project can be shown to improve local economic opportunities it may be eligible for funding from the European Social Fund) or via specialise lender such as Adventure Capital Fund, Charity Bank or Triodos Bank.

15.7 Investment within the energy value chains

We now describe how investments are financed in individual parts of the energy value chain.

- **Upstream gas**. Investment in gas production assets in the UK (typically in the North Sea) is associated with high risks around construction, operations and revenues. Gas production projects are complex, and require specialist technical skills. As a result projects are typically financed by large international firms, often oil and gas majors, with costs of capital in excess of 10%.

- **Electricity generation**. Electricity generation investments are funded from a variety of sources depending on the type and size of plant. Most large-scale power projects (e.g. gas CCGTs and wind farms) are financed by large utilities. Over half of generation is owned by the largest six retailers who, are international firms. Other major generators (e.g. GdF Suez/IP, ESBI) are independent of retail but also international in scale. The prevalence of large international players reflects the scale, long lead times and risks associated with developing power stations. These firms often finance projects together in joint ventures to allow them to diversify their capital over more projects and share expertise.

  For smaller generators, direct financing can be secured from capital markets but having an agreed long-term power purchase agreement (PPA) is often crucial to this.

  Support schemes for renewable generation (such as ROCs) have provided a policy framework to reward renewable investments which has been fundamental in securing equity for these projects.

The costs of capital for generation vary by technology, particularly in relation to the level of construction, technology and operational risk. For a new gas CCGT the cost of capital is typically estimated at 7% -8% and onshore wind at around 8% to 9%. More complex investments such an offshore wind and nuclear can have costs of capital in excess of 10%[436].

- **Gas and electricity networks**. Because gas and electricity networks are subject to revenue regulation they are viewed as relatively low-risk businesses. The estimated costs of capital for network firms are typically between 4% to 6%. Due to the low risk profile and the long-lived nature of the assets, they attract long-term investors, such as pension and infrastructure funds, through both debt and equity financing[437].

- **Metering.** There is an activity to fund the capital cost of meters and (sometimes) the meter installation costs. Meter funding is essentially no different to other types of high unit volume, low asset based financing (such as financing IT equipment or mobile phones).[438] Meter assets tend to be long life and generate predictable cash flows from energy companies (who are themselves deemed to be high quality clients in an essential industry) which means that they are attractive assets to finance and own[439].

- **CHP and district heating schemes**. District heating may be financed by a combination of the project sponsor (e.g. property developer, local authority) and the energy service company delivering the project. If the ESCO is funding the majority of the project this must be underpinned by a long-term demand guarantee provided by the project sponsor. The project sponsor may also provide further financing support through outright capital contributions or loan guarantees[440].

- **Enabling technologies**. When looking at investments in energy efficiency there are two main dimensions to consider.

  - **Investment by the enabling technology manufacturers.** Enabling technologies such as boilers and insulation materials are manufactured by a diverse range of firms. Manufacturers of boilers and other heating

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436 Mott Macdonald (2011), *Costs of low-carbon generation technologies*

437 For example, Scotia Gas Networks is 25% owned by the Ontario Teacher's Pension Plan Board.

438 "Completed acquisition by Macquarie Bank Limited (London branch) of Utility Metering Services Limited", OFT (24 January 2012) p7.

439 OFT (2012) para 83.

440 ARUP (2011), *District heating manual for London*

technologies must invest in research, product development and factories. These firms are typically part of large European-wide engineering groups (e.g. Bosch, BDR Thermea).

- **Investment by the consumer**. Enabling technologies involve an upfront cost to the consumer which must be financed. While many consumers finance these investments themselves a number of other finance options are available. This includes financing plans offered by installers, bank loans[441] (including remortgages for renovations) and now financing under the Green Deal (where load repayments are made via the household energy bills). The upfront cost of energy efficiency technologies is also subsidised via the energy company obligations (see Annexe 8) and via housing developers and social landlords.

441 Nationwide offer specific loans for energy efficiency investments.

16 Annexe 11: Metering of gas and electricity

This annexe covers metering of gas and electricity. We cover the following:

- background;
- roles and responsibilities;
- contractual arrangements;
- the main players and funding; and
- learning from this sector.

16.1.1 Background

Legislation requires that a gas and electricity meter must be installed at every customer point to measure energy usage. **There are around 53 million active gas and electricity meters in the UK.**[442] There is no such requirement for district heating to be metered at present, and survey work carried out for DECC in 2012 estimated that only 25% of existing residential led district heating schemes have heat meters installed[443].

Metering plays an important role in determining customer service and is an important enabler of competition. It impacts on the accuracy of billing, provides a source of information, determines the availability of energy services and affects the change of retailer process.

Retailers recover the cost of metering services from customers through supply tariffs (rather than a one-off charge). Since metering costs are largely fixed for each customer and do not vary by consumption, they are often taken into account by retailers when determining the level of standing charge in the tariff. Meter asset and maintenance costs represent approximately 2.5% of the current domestic electricity bill and 3.4% of the gas bill while meter reading make up 1.6% of an electricity bill and 1.4% of a gas bill.[444]

Ofgem introduced competition in to gas and electricity metering services in 2000. Prior to this it had been the monopoly responsibility of National Grid (in gas) and the DNOs (in electricity). Ofgem's objectives in facilitating competition were to promote lower costs, better service and more innovation in a period of rapid

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442 There are around 27 million domestic electricity meters, 22 million domestic gas meters, 2.3 million I&C electricity meters and 1.5 million I&C gas meters in the UK ("Completed acquisition by Macquarie Bank Limited (London branch) of Utility Metering Services Limited", OFT (24 January 2012)). Approximately 14% of domestic customers have prepayment meters.

443 "District Heating – Heat Metering Cost Benefit Analysis" Databuild (2 May 2012).

444 Calculated from data provided in "Energy Supply Margins: Update January 2012, Commissioned by Energy UK", NERA (23 January 2012).

technological innovation. **It is therefore an interesting case study to the effectiveness of new entrants being able to challenge incumbent providers where technological innovation was possible.**

16.1.2 Roles and responsibilities

The contractual framework Ofgem designed to introduce metering competition is complex and is not seen anywhere else in the world. **The retailer is responsible for procuring metering services for its customers from a number of different agents.** The precise specification of roles and responsibilities of these agents differs slightly between the electricity and gas sectors, but the basic activities of interest can be grouped as follows.

- **Meter Asset Provision:** There is an activity to fund the capital cost of meters and (sometimes) the meter installation costs[445]. These funders then charge retailers a daily meter rental charge based on amortising the asset and (if applicable) the installation costs over the expected life of the meter. Meter funding is essentially no different to other types of high unit volume, low asset based financing (such as financing IT equipment or mobile phones).[446] Meter assets tend to be long life and generate predictable cash flows from energy companies (who are themselves deemed to be high quality clients in an essential industry) which means that they are attractive assets to finance and own[447]. It is expected that the smart meter roll out will be financed in this way.

- **Meter Asset Management**[448]: There are then a set of activities associated with the installation, commissioning, testing, repair, maintenance, removal and replacement of metering equipment.

- **Data Collection Services:** Finally there is a requirement for collection and validation of the meter readings. The data is collected manually by pedestrian meter readers for dumb meters and remotely for smart meters. There are also responsibilities for aggregation of consumption data and submission of it into the settlement process.

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445 Installation costs are often comparable in size with the cost of the meter.

446 "Completed acquisition by Macquarie Bank Limited (London branch) of Utility Metering Services Limited", OFT (24 January 2012) p7.

447 OFT (2012) paragraph 83.

448 The term Meter Operator Provider (MOP) is used to refer to an electricity Meter Asset Manager (MAM).

16.1.3 Contractual framework

Retailers will either contract with parties to provide these services, or undertake the services in-house. If the retailer contracts with third parties, this may be through contracting separately for each service through independent companies; or by contracting with one party who may either be a vertically integrated company or who will sub-contract or partner with the other agents. All of these possible arrangements have been seen in the industry and there is no single model that is applied.

It is the retailer that decides on the choice of meter, from a large number of meter manufactures. The most common industry model is for the retailer to retain both the technology risk (associated with reliability of the meter) and churn risk (associated with customers switching retailer) associated with the meter.

Contract choice and design is commercially confidential. However, information on British Gas' initial meter contracts was made available as part of the investigation into National Grid's metering contracts. The contracts British Gas entered into in 2002 with commercial providers generally lasted 20 years, broken down into two periods. In the initial period, typically five years, the provider typically had the exclusive right to install meters for British Gas in a specific geographic area[449]. After the expiry of the initial period that exclusivity no longer applied but the contract remained in place to govern the continued rental of the meters which had been installed in the initial period.

16.1.4 The main players

The incumbent meter providers still play an important role in this market. This is particularly in terms of ownership of the legacy meters (i.e. the ones that were installed prior to the introduction of competition). Therefore National Grid on the gas meter side and the DNOs on the electricity side still own a large proportion of the meters currently in place. A smaller number of the legacy providers, notably Northern Powergrid and Western Power Distribution, appear to be actively seeking opportunities to continue to be players in this market for new metering assets.

The Big Six retailers also tend to have legacy meter reading businesses in the areas they were incumbent retailers and still have sufficient density to make it cost efficient to have this as an in-house capability. There is also some evidence that **retailers are bringing other metering activities back in-house as part of their strategy for managing the smart meter roll-out**. The main objective of this is to control the installation field force as a means of brand management during the customer engagement process. This is largely determined by where

449 British Gas ended up signing contracts with three different commercial meter providers to gain full geographic coverage across GB.

they still have sufficient geographic density of customer base to make it cost effective. Where they do not have this they are likely to sub-contract the activity.

However, **there have been a number of new entrants into the market**. The financing of metering assets has been an attractive activity for a number of global financing players such as Macquarie and Calvin Asset Management. By its nature, maintenance and installation have been more UK focussed, being provided by companies with experience of managing large field forces. For example, both G4S Utility Services and Lowri Beck cover the full range of metering services, including meter reading activities, across the water sector as well. There are also businesses that have specialised in the SME market, such as Bglobal plc.

Meter manufacturing is a global market although specific meter design tends to be country specific[450]. There are lots of players including Landis & Gyr, GE, Samsung, EDMI, ITron, Secure George Wilson and Elster. The largest provider in the UK in the electricity sector is currently Landis & Gyr.

A brief overview of some of the main players in this market is provided below.

Macquarie Group Limited is an Australian financial services company that provides (among other services) banking, investment and fund management services. It invests and manages a wide range of energy-related infrastructure assets, including gas distribution networks, wind farms, and electric and natural gas utilities internationally[451]. Macquarie has focussed on the MAP business, although it has a small presence in the MAM activity for historic reasons[452]. It established its meter leasing business in 2003, in conjunction with Siemens Metering Services, to provide 1 million traditional domestic gas and electricity meters to British Gas in London and East Anglia in the UK. It has since broadened its offering to fund smart electricity and gas meters to British Gas, RWE NPower and Scottish Power. In 2011, Macquarie bought Onstream from National Grid[453] for £274 million. At the time of acquisition, Onstream had some 2.6 million domestic electricity meters and 1.6 million gas meters and had a turnover of £70 million.

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450 For example, given requirements for prepayment meter functionality, the current favoured design for the smart meter specification is richer than most international smart meters and is therefore likely to be a bespoke solution.

451 In the UK it has a shareholding in Wales & West Utilities Limited (a regulated gas distribution business), Energy Power Resources (a renewable generation company) and CLP Envirogas (developer of landfill gas power generation projects).

452 British Gas (with whom Macquarie had significant MAM contracts) provided its own MAM services from 2009. However, where customers switched supplier away from British Gas, the MAM responsibilities remained with Macquarie.

453 Onstream was set up in 2001 by National Grid to compete in the new commercial marketplace, and was separate from the group's regulated metering business.

Calvin Asset Management Limited is a Meter Asset Provider with a focus in the domestic metering market. It finances both the procurement and installation of gas and electricity meters and has in excess of 4 million meters across the country. It offers funding solutions and partners with energy retailers to provide them with off-balance sheet funding arrangements. It manages the Meter Fit companies and is wholly-owned by Infracapital Partners LP. The funding is comprised of shareholder equity (from Infracapital Partners LP) and debt from a syndicate of banks. While its core market is domestic metering it has said publically that it is also exploring opportunities for investment in other energy related assets.

G4S Utility and Outsourcing Services (UK) Ltd is the largest independent multi-utility metering services company operating in the UK and provides services across MAP, MAM and Data Collection in both the gas and electricity sectors. Its metering business was started before competition through entering a joint venture with British Gas in 1996 to provide meter-reading services in the UK when it established AccuRead. It is part of G4S, the largest secure outsourcing company in the UK and Ireland, with a turnover of more than £1.7 billion and over 55,000 employees managed from over 100 offices. It is currently bidding to become the Data Communications Company for the smart meter roll-out.

Lowri Beck Services Ltd also works across the metering value chain. It has been providing metering and data services based around its nationwide meter reading and data collection services to utilities and businesses since 1996. Metering Services are provided for Gas, Electricity, Water, Heat, Oil & LPG covering residential, commercial & industrial customers. Both manual and automated meter reading services are available as part of the metering solutions capability.

Siemens Metering, Communications & Services is part of Siemens, a global engineering company. Working throughout the UK and in selected international markets, it offers meter-to-cash and energy measurement and management services to many public as well as private organisations. Through contracts with energy and water suppliers, it provides metering services to over 14 million homes and businesses in the UK, with its field staff making over 40 million visits annually. Siemens Metering, Communications & Services also owns and operates the UK's gas prepayment system on behalf of all the UK's gas retailers.

Bglobal plc. is a Meter Operator specialising in the SME Market for the installation of AMR Electricity Meters with over 190,000 meters. It also provides an end to end energy management service to provide businesses with the tools they need to measure and analyse their energy consumption and expenditure, identify potential efficiency improvements and deliver sustained energy savings throughout the business. Utiligroup (part of Bglobal) also provides an end-to-end offering to small supply companies that covers the whole spectrum of services that an energy retailer needs to operate in the UK market from winning and registering a new customer, to making the necessary Agent Appointments and communicating with the central market systems; to CRM and Billing, Demand Forecasting, Energy Trading and Settlements. It has undertaken this service for new entrant retailers such as the Co-operative Energy and OVO Energy.

Landys & Gyr is one of the largest manufacturers of meters both in the UK and internationally. It covers metering solutions for electricity, gas, heat/cold and water for energy measurement solutions for utilities. It covers a complete portfolio of energy meters and integrated smart metering solutions. It was bought by Toshiba Corporation in 2011.

16.1.5 Learning

There are a number of interesting lessons that emerge from this sector.

- **Breaking a legacy position takes time.** Competition in metering services was introduced in 2000. It took until 2007 for competition in the electricity metering sector to be sufficient to remove the electricity metering price controls and the obligations for DNOs to provide meters at a regulated tariff. A number of DNOs exited the market at this point although by the end of 2010, DNOs still owned over 90% of domestic electricity meters[454]. Retailer decisions play an important role in determining the pace at which competition develops in metering. The continued existence of regulated services reduces the incentive for retailers to seek alternative metering service providers. Indeed, it was British Gas' decision to procure meter service competitively that largely drove competition in the market.

- **Legacy providers can stall the market for competition.** Competition has been even slower to develop in the gas sector. Shortly after the domestic gas metering market was opened to competition, National Grid struck long-term contracts with five of the six major energy retailers to supply and maintain gas meters. These contracts included financial penalties that applied if retailers replaced more than the small number of meters allowed under contract by National Grid. These contracts restricted the rate at which retailers could procure meters from rival competing meter operators. This led to Ofgem finding that National Grid acted uncompetitively in the domestic gas metering market. This decision was upheld by the Competition Appeal Tribunal and the Court of Appeal. The penalty of £15 million imposed by the Court of Appeal in 2012 on National Grid was the highest financial penalty for abuse of dominance imposed in the UK to date. The investigation process took considerable time and competition has been

454 "Review of Metering Arrangments", Ofgem (17 December 2010), paragraph 1.3.

slower to emerge as a result. Indeed, National Grid still has a national obligation for domestic meter services to be provided on request prior to roll-out of smart meters and the charges remain regulated by price control.

- **Supply businesses were attracted to off balance sheet financing for assets.** The retailer business model is as an asset-light business. Therefore there has been a consistent push to ensure financing of meter assets (and often installation costs) in undertaken off-balance sheet through external financing institutions.

- **The smart meter roll-out has been an important opportunity for new entry (see Box 18).** The roll-out of smart meters over the rest of the decade will provide substantial tender opportunities amounting to an estimated £11 billion[455]. It is this value that has driven much of the entry and activity in this market. Without the opportunities delivered by technological change, metering competition would not have developed to the extent it has.

455 OFT (2012) paragraph 82.

Box 18. Roll-out of gas and electricity smart meters

Rollout of smart meters

Retailers have begun to roll out smart meters. By the end of September 2012, 623,200 smart meters had already been installed in domestic properties and 365,000 advanced and smart meters in non-domestic properties. The mandated mass rollout will begin in 2014 and is due to be complete across domestic and small business consumers by 2019. Widespread rollout of smart meters will make near real time information on energy use available and will facilitate a range of new tariffs and business models across the sector.

Data collection and handling under smart meters

DECC is establishing a **Data and Communications Company (DCC)** which is due to be live by then end of 2014. DCC will be appointed through a competitive process and will be responsible for contract managing the services which it needs to communicate with smart meters at domestic gas and electricity consumer premises. Once appointed, the DCC will be licenced and regulated by Ofgem. There are two groups currently bidding for this licence: these are headed up by Capita Group and G4S. A decision is expected in July.

Separately the Government is procuring a **Data Service Provider (DSP)**, a contract the DCC will take on once it has been appointed. The DSP will be responsible for managing the industry processes associated with the smart meter network such as change of retailer and delivering the end to end security of the model. Again the tender is in process with a decision expected in July. There are three groups still bidding being led by CGI, HP and IBM.

The final large tender currently being procured is for **three regional franchises for the smart communications network**. Arqiva, Cable and Wireless, and Telefonica are bidding for licences in each of the northern, central, and southern regions, while Airwave has made a bid for the northern region licence.

17 Annexe 12: Glossary of financial terms

Insulation	Refers to loft and cavity wall insulation, unless specified.
Operating Margin	The difference between operating revenue and operating costs. This therefore does not take into account the capital expenditure required by a firm, but provides an estimate of the proportion of an additional sale which would accrue to the company as operating profit. As above, the operating profit is defined as the EBIT, the value before interest and taxation.
Profit	EBIT, unless specified. This is the operating profit before interest and tax are included.
Return on capital	This gives the operating profit as a proportion of the average capital employed over the same period.
Value Added	The difference between the value of output from a business or industry and the cost of inputs which are purchased from external suppliers. For example, a retailer of energy has value added which represents the difference between the wholesale energy it purchases and the price it sells energy to consumers at. This will therefore contain the cost of maintaining call centres and billing functions, but not the network, production or generation costs of energy.
C5	C5 ratios refer to the market share held by the largest 5 businesses in the market. A higher C5 percentage therefore corresponds to a more concentrated market, where fewer companies hold a larger share.

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