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PROJECT REDMAST: OVERVIEW OF THE CURRENT GB ENERGY MARKET STRUCTURE

Research and Development of Market Structure report WP1

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1 INTRODUCTION

The current domestic energy market, both for electricity and gas, is based on a "supplier hub" model whereby suppliers act as the primary interface between energy customers and the energy system. The supplier hub model emerged following privatisation of the energy sector and suppliers' roles and responsibilities have continued to evolve to reflect new policy objectives. This has been supported by the legal frameworks, licencing arrangements and industry rules in place today.

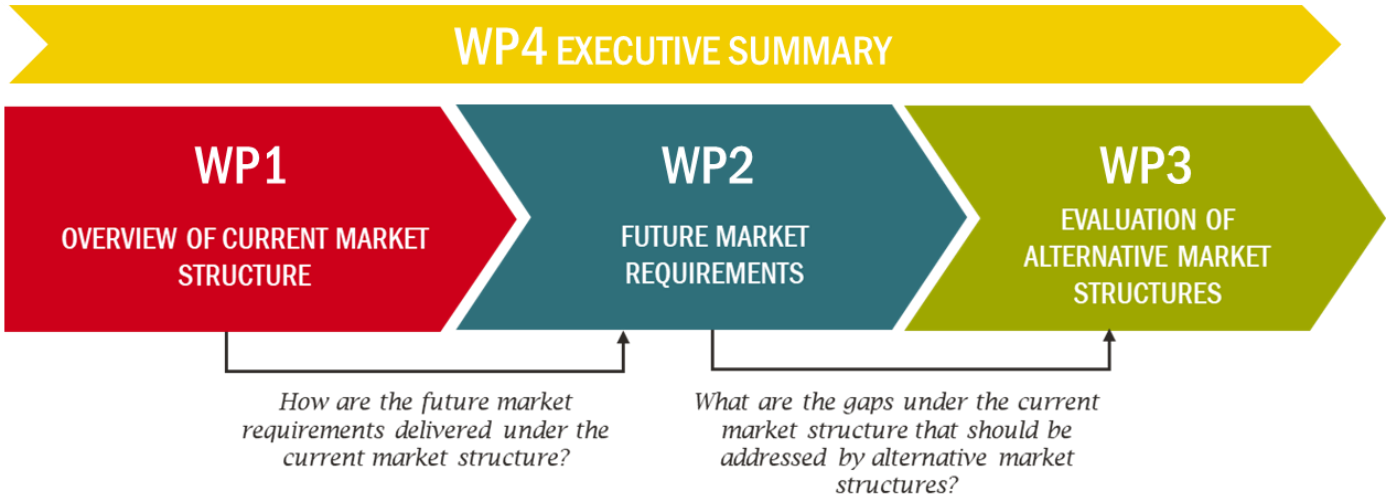
However, the energy sector is currently undergoing a period of significant change. The UK has committed to achieving net-zero by 2050 and this relies on the decarbonisation of our energy supply. At the same time, there have been steadily increasing concerns around affordability and equity in the bills that customers face. In order to achieve a secure, green, and affordable energy network for the future, the energy system will need to undergo significant changes. This includes provision of flexibility from customers, greater investment into energy efficiency and heating technology, and integration of data from smart meters and smart devices to manage whole system costs.

In this context, it is time to review whether the current market structure and supplier hub model can meet these challenges, or whether the role of entities will need to change. Whilst questions around whether the supplier hub model were raised by Ofgem in 2017, limited progress has been made on the topic since.

1.1 PURPOSE OF THIS WORK

Western Power Distribution (WPD) has asked Frontier Economics to review the current structure of the market and evaluate this against future market requirements. This project, referred to as project REDMAST (Research and Development of Market Structure) will inform an evaluation of potential future market structures to understand whether the current structure needs to be adapted going forward.

FIGURE 1 INTEGRATION OF WORK PACKAGES



Source: Frontier Economics

This report is the first stage of this analysis (WP1) and describes the current structure of the GB energy industry, a brief timeline of how it has evolved over the years, and an overview of the recent supplier crisis. It will also provide a description of the relationships between different parts of the industry, focusing on flows of services, data and communications, and costs.

1.2 STRUCTURE OF THIS DOCUMENT

The remainder of this document is set out as follows:

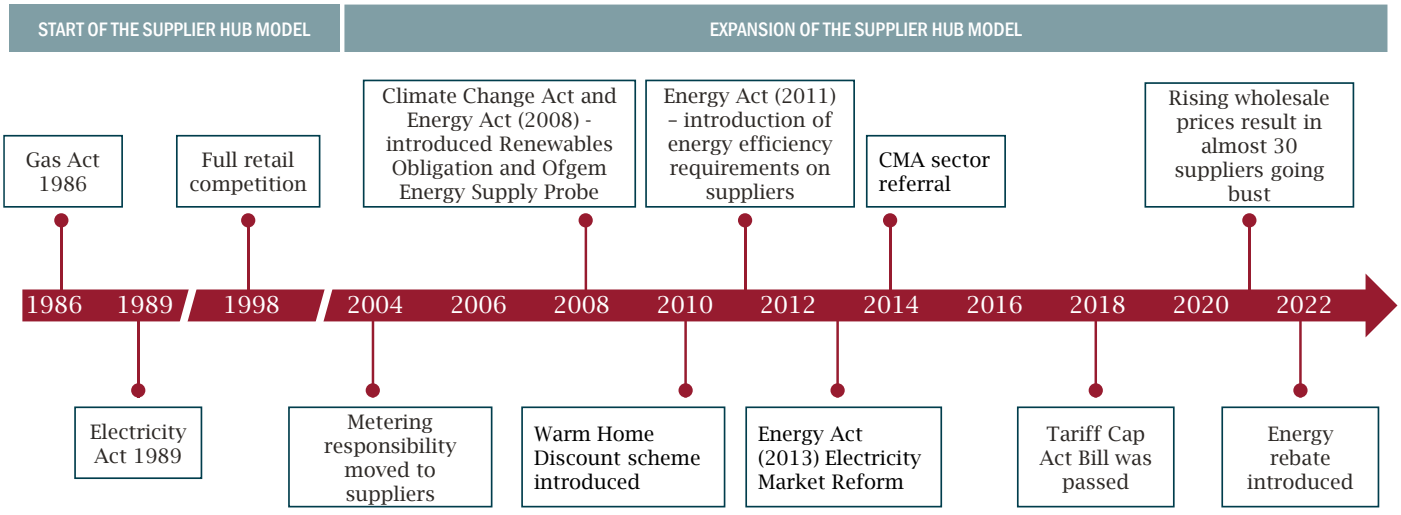
- **Section 2** provides a brief overview of the development of the market to date.
- **Section 3** gives a more detailed overview into the recent GB supplier exits.
- **Section 4** sets out a more detailed description of the various entities in the GB electricity and gas market and the market flow diagrams.

This report also includes two annexes which provide a more detailed breakdown into the various flows between entities in addition to a supporting glossary.

2 TIMELINE OF THE MARKET

This section provides a brief overview of key developments that have shaped the current energy market structure, focusing on events that affected retailers and the supplier-hub model.

FIGURE 2 TIMELINE OF KEY DEVELOPMENTS



Source: Frontier Economics

2.1 ORIGINS OF THE SUPPLIER HUB MODEL AND MARKET OPENING

The British gas and electricity markets were privatised via the Gas Act 1986 and Electricity Act 1989 respectively. Until these privatisations, energy retail had been provided by state-owned entities as monopoly activities. The transformation into a privately owned and formally liberalised market was a process that took place over a 12 year period, with retail competition for all customers in both sectors only completing in May 1998.

As part of the industry re-structuring that accompanied privatisation, the supplier became the main interface between customers and their energy supply. This is referred to as “the supplier hub model”, in which the supplier is both the single point of contact for the consumer and is responsible for collecting all

payments owed to the network companies, generators (electricity) and gas shippers (gas) and Ofgem, as well as meeting industry codes. This design choice (where the supplier is at the centre of arrangements for the market) was part of a much larger set of market structure arrangements that were made at the time of the privatisations to meet multiple objectives (for example, introducing competition into the generation markets).[1]

2.2 EXPANSION OF SUPPLIER ROLE

One of the features of the market is that, over time, the role played by suppliers has increased. Since the early 2000s, suppliers have taken on responsibilities for:

- co-ordinating the provision of metering services, including the smart meter rollout;
- collecting funding for and delivering certain environmental programmes; and
- collecting funding for and delivering social programmes.

We briefly discuss each of these developments below.

We note that there have been several recent social and environmental obligations introduced onto entities other than suppliers. These include the boiler upgrade scheme which provides central government grants to households installing low carbon heating technologies and the market based mechanism for low-carbon heat which introduces obligations on manufacturers of gas and oil boilers to sell a proportional number of heat pumps.

2.2.1 METERING

The responsibility for metering services was transferred from DNOs to suppliers in 2003/04. The change was predominantly driven by a view that the DNOs were not best placed to deliver a consumer-centric approach to the provision of metering assets. Instead, the relationship between suppliers and their end customers (where metering assets are located) and the competitive nature of the retail activity was felt to provide the potential for competition to drive efficiency and improve customer service.

As well as transferring metering responsibility to suppliers, metering services themselves were opened up to competition by Ofgem to "encourage innovation and competition within metering services".[2] 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. 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.

[1] See Littlechild (June 2010), *The Creation of a Market for Retail Electricity Supply*, for more detail including the fact that the design of the retail market was only one element of a complex set of industry arrangements that were being designed at the same time.

[2] Ofgem (2011). *ROMA final document*, Appendix 2.

- Meter operation / asset management: 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 for traditional meters and remotely for smart meters. There are also responsibilities for aggregation of consumption data and submission of it into the settlement process.

In 2008, the Labour government announced its intention to mandate energy suppliers to install smart meters across Great Britain. This followed European Union (EU) legislation in 2006 to encourage all EU countries to roll out smart meters. The 2010 Coalition Agreement included a commitment to roll out smart meters and, in 2012, the Department modified energy suppliers' licences to impose an obligation on them to take 'all reasonable steps' to install smart meters in all homes and small businesses by the end of 2019[3].

By the end of 2019, the rollout was not complete: 29% of domestic meters had been upgraded to smart meters and were operating in smart mode.[4] As a response, the Government has introduced a new 4-year smart meter rollout framework that targets 100% coverage by 2025 and requires suppliers to install smart meters to 66.9% of their domestic customers by December 2023.[5]

As of September 2021, 38% of domestic meters had been upgraded to smart meters and operating in smart model, with a further 9% operating in traditional mode.

2.2.2 ENVIRONMENTAL RESPONSIBILITIES

Climate change considerations grew during the 2000s and the Climate Change Act 2008 was introduced, committing the UK to reduce its emissions by at least 80% by 2050 compared to 1990 levels and requiring legally binding 'carbon budgets' to ensure that policy goals remained on track to meet this target.

This then led to a number of environmental responsibilities being placed on suppliers. Examples include the following:

- The Energy Act 2008 established the Renewables Obligation which required suppliers to buy a proportion of their electricity from renewable sources via purchasing Renewable Obligation Certifications (ROCs) from accredited renewable generators.

- The Energy Act 2011 required energy suppliers to promote energy efficiency among its customers. CERT and CESP were the two main initiatives put in place to improve energy efficiency within domestic households in Great Britain. CESP was designed to improve domestic energy efficiency in the most deprived geographical areas across Great Britain, while CERT made energy efficiency measures available to all consumers.

- The Energy Act 2013 established a legislative framework for delivering low carbon energy and introduced the Electricity Market Reform to incentivise investment in secure, low-carbon

[3] DCLG, DWP, DECC & Ofgem (2015). *Policy paper*: *2010 to 2015 government policy: household energy*, Appendix 7: 'Smart meters'

[4] BEIS (2020), *Smart Meter Statistics in* Great Britain: Quarterly Report *to end December 2019*. This figure excludes smart meters operating in "traditional mode" – i.e. not connecting to the data network, and requiring manual reads.

[5] BEIS (2021), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/990525/smart-meter-policy-framework-post-2020-govt-response-minimum-annual-targets.pdf

technology and improve the security of energy supply. These changes were largely focussed on the wholesale markets, with few changes to the way the retail markets operated although one change replaced CERT and CESP with the Energy Companies Obligations (ECO). Under the ECO, energy suppliers which supplied above a threshold number of domestic customers were legally obligated to install energy efficiency measures in eligible households (primarily vulnerable customers).

Policymakers chose to add the delivery of environmental and social (see below) obligations to the role of suppliers for several reasons including:[6]

- energy retailers were mainly large companies and therefore capable of undertaking the required functions;
- they were already licensed, and therefore there was an existing legal framework for placing obligations upon them; and
- the alternative (of direct Government funding for policies) was problematic due to constraints on public expenditure.

2.2.3 SOCIAL RESPONSIBILITIES

Energy is an essential public good. Households that must spend a high proportion of their household income to keep their home at a reasonable temperature are defined to be in fuel poverty. As energy prices have risen relative to incomes, for example because of environmental policy cost or wholesale cost increases, policymakers have become increasingly concerned about affordability of energy.

These issues are not new, but there was a switch from instituting direct payment support from taxation (for example, the Winter Fuel Allowance for all pensioners which was introduced in 1997) to energy bills. This followed the financial crisis, which increased levels of fuel poverty (since wages stagnated and benefits were cut) while austerity constrained policy options. This led to the introduction of the Warm Homes Discount (WHD) in the Energy Act 2010.[7] It has since gone through a number of iterations, to broaden the eligibility requirements and ensure that it didn't become a barrier to customers from changing supplier[8]. Those eligible for the WHD receive an annual discount on their electricity bills, currently £140. This is funded by other energy customers through their bills.

In addition to social tariffs, energy suppliers are also subject to wider consumer vulnerability protections. For example, Ofgem has an expectation that all energy suppliers take reasonable steps to ensure their customers can meet their debt repayment arrangements and they have to offer customers a range of payment options and any repayment plan has to be based on a consumer' ability to pay.

[6] UK Energy Research Centre (2016), *The governance of retail energy market services in the UK: A framework for the future*

[7] This built on rebates that some suppliers already offered to customers on certain benefits.

[8] The original incarnation of the scheme meant that suppliers only had to provide a WHD payment for a capped number of customers (where the cap was set below the number of eligible customers). This made customers reluctant to change supplier in case their new supplier did not offer them the WHD payment.

2.3 EFFECTIVE COMPETITION IN THE ENERGY MARKET (AND ITS RE-REGULATION)

Following energy retail sector liberalisation in 1998, there were fourteen incumbent electricity suppliers[9] and one incumbent gas supplier (British Gas). There was a period of consolidation occurring in the early 2000's, which involved overseas investment from utility companies. In 2001, the French utility EDF entered the market, German utilities RWE and E.ON followed in 2002.[10] Ofgem deemed competition was sufficient by 2002 to phase out its initial transitional price caps for domestic customers.

By this point, the successors of the regional electricity companies, together with British Gas, had consolidated to form six suppliers – the so-called "Big 6". Between them, these companies accounted to close to 100% of the GB domestic supply market.

Ofgem carried out a periodic reviews of the market during this period, which concluded that competition was working well. For example, its 2007 report found "*vigorous price competition between the big six suppliers for all customers.*"[11] It also noted innovations in tariff structure and payment methods.

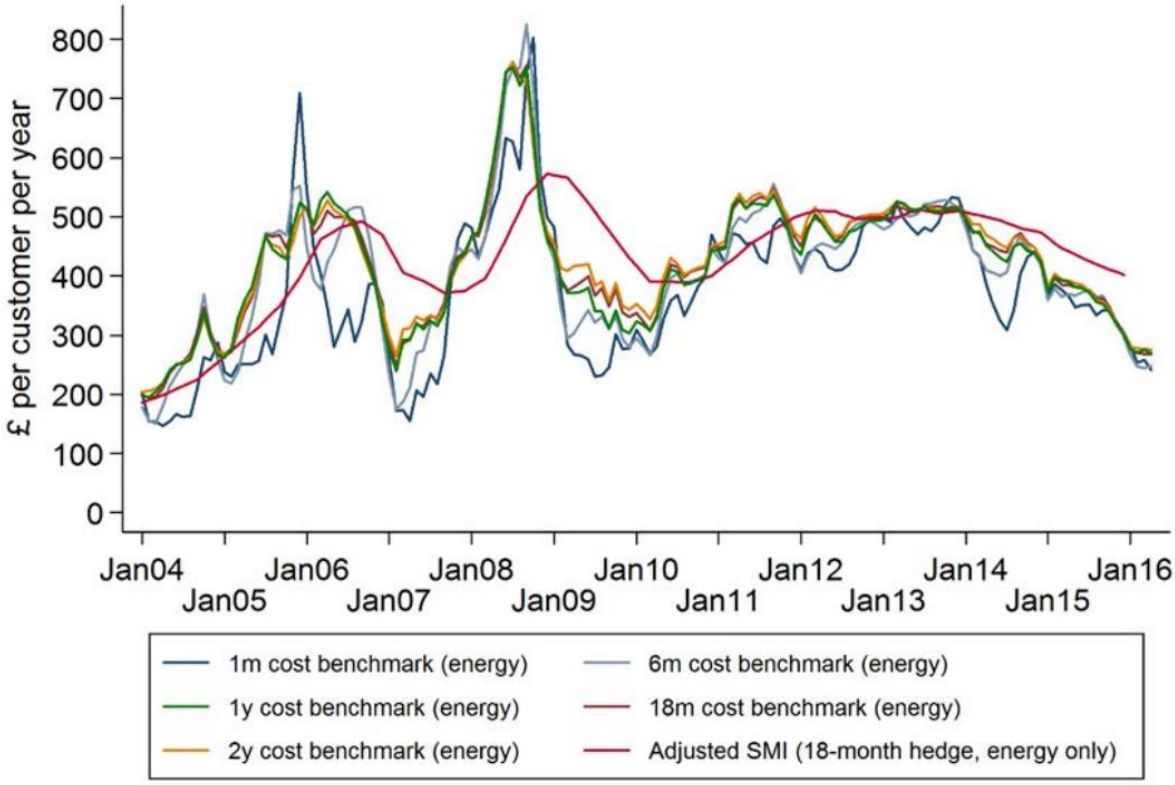
However, following this period, the energy sector became much more politicised, driven by rising prices, which were themselves largely driven by increasing wholesale prices. Figure 3 below, taken from the CMA's market investigation, shows the cost of energy for a dual fuel customer over time. The different lines represent whether energy is bought for delivery in the month ahead, six months ahead, or other longer duration contracts. Typically a supplier would purchase a proportion of its energy far in advance, and a proportion closer to delivery. The smooth pink line shows the cost of such a strategy (based on the approach Ofgem assumed in its supply market indicators). This clearly shows the overall increase in wholesale prices that occurred after 2004.

[9] These came out of the 14 electricity distribution networks (also known as the regional electricity companies) that had previously had a monopoly on electricity retail activities.

[10] Ibedrola, the Spanish utility, went on to acquire Scottish Power in 2008.

[11] Ofgem (2007), *Domestic Retail Market Report*

FIGURE 3 EVOLUTION OF WHOLESALE ENERGY PRICES IN THE UK



Source: CMA (2016). Energy market investigation. Final Report.
Note: Forward looking energy costs benchmarks for a dual fuel, typical consumption customer

While suppliers were not in control of wholesale prices, the additional pressure on bills led both the regulator and the government to become increasingly concerned that a significant number of customers were not actively participating in the market, and were therefore paying excessive amounts for their energy. A series of investigations led to various attempts to mitigate this.

- Ofgem's 2008 Energy Supply Probe highlighted differential pricing as an issue – for example electricity suppliers offering higher prices to customers within their former monopoly area. It put in place a package of reforms including a prohibition on suppliers charging unjustified price differentials, and a requirement for suppliers to include key information in bills and annual statements.[12]

- Ofgem's Retail Market Review (RMR) was launched in late 2010. Additional interventions were made with the intention of increasing consumer engagement by simplifying the choices available to customers. In particular, the RMR required suppliers to offer customers a maximum of four tariffs per fuel, which had to conform to a set structure (e.g. only one unit rate).[13]

Despite these interventions, concerns remained around increasing prices and price differentials, along with falling switching rates. Customer switching in 2013 was less than half the level it was in 2008 and still

[12] Ofgem (2009), *Ofgem's probe gives energy customers more muscle*

[13] Ofgem (2012), *The Retail Market Review – Updated domestic proposals*

declining.[14] Political pressure continued to grow and in 2013 the Government requested that Ofgem and the Competition and Markets Authority (CMA) undertake a co-ordinated review, which led to referral for a full market investigation conducted by the CMA from 2014. Its final report was published 2016 and concluded that the following features of the retail market led to an adverse effect upon competition:[15]

- weak customer response and lack of engagement with domestic retail energy markets;
- barriers to entry and expansion in the prepayment segment; and
- the regulatory framework – notably problems associated with the RMR reforms that Ofgem had instigated, as described above.

The CMA recommended a series of remedies including a transitional price cap for prepayment customers only, as well as removing some of the RMR interventions that Ofgem had previously introduced.

Although the CMA's price cap only covered the prepayment market, the perceived need for a wider tariff cap gathered political support, and the introduction of such a cap was in both Labour and Conservative manifestos in 2017.[16] This led to the introduction of the Domestic Gas and Electricity (Tariff Cap) Bill into Parliament in 2018. In accordance with the Tariff Cap Act 2018, Ofgem implemented the default tariff cap in January 2019. This restricts the tariffs which suppliers are able to charge customers on standard variable tariffs (i.e. tariffs without a fixed end date).

2.4 NEW ENTRIES TO THE SUPPLY MARKET

At the same time that the concerns described above were being raised, the market share of the "Big 6" former incumbent suppliers was being eroded by new and expanding entrants. The combined electricity market share of these suppliers fell from 94% at the start of 2014 to 70% by the end of 2019 (gas market shares fell similarly, from 94% to 72%).[17]

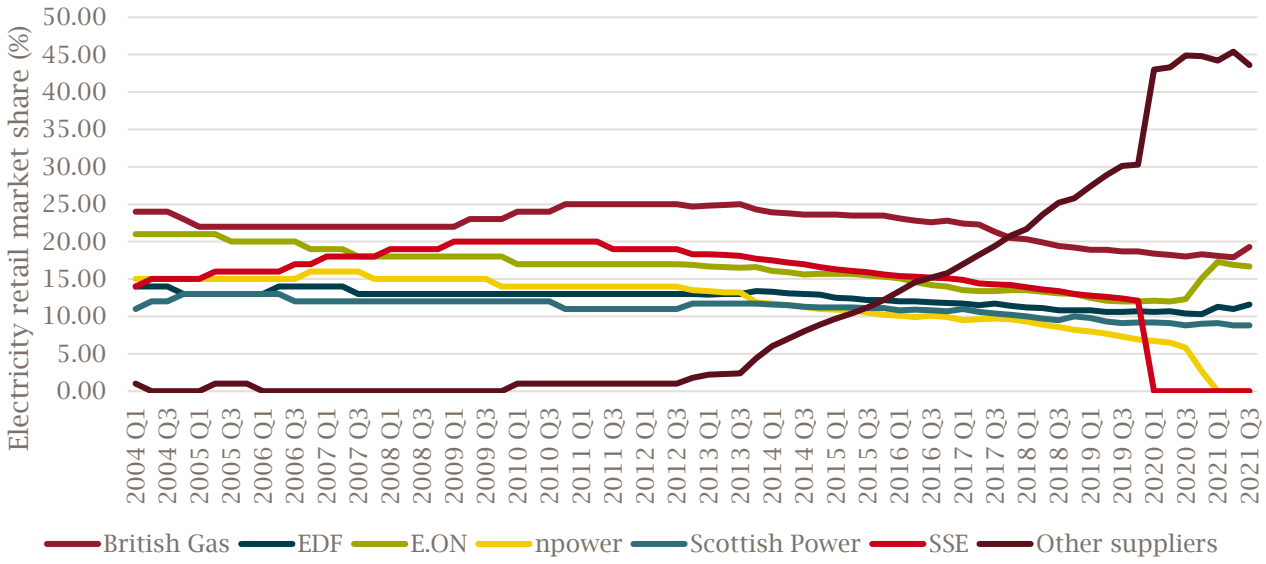
[14] Stephen Littlechild (2019). Promoting competition and protecting customers? Regulation of the GB retail energy market 2008–2016, pg. 123

[15] CMA (2016), *Energy market investigation: Summary of final report*

[16] House of Commons (2021), *Energy bills and tariff caps*

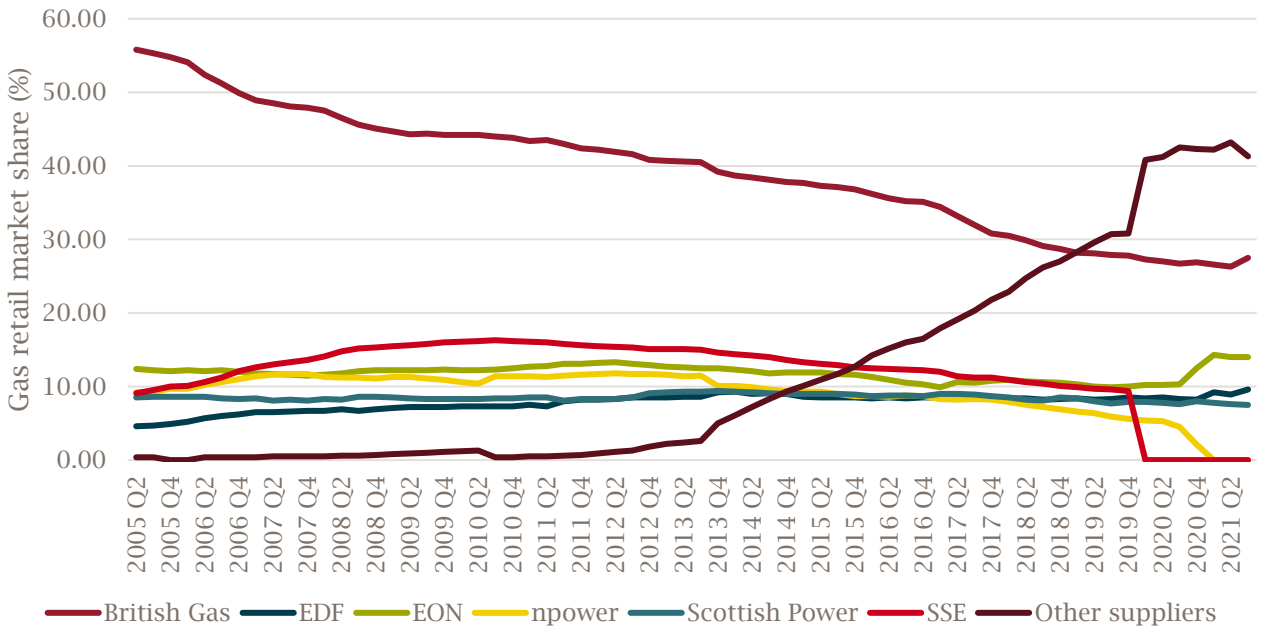
[17] Ofgem Retail Market Indicators

FIGURE 4 ELECTRICITY MARKET SHARES BY SUPPLIER



Source: Ofgem

FIGURE 5 GAS MARKET SHARES BY SUPPLIER



Source: Ofgem

The new entrants had a variety of business models. For example:

- Utility Warehouse (which had an electricity market share of 2.5% at the end of 2019) sold a bundle of services including broadband, mobile, and home insurance, as well as energy.

- Bristol Energy (which started in 2015 and was sold in 2020) was an example of a supplier set up by a local authority or Council in response to what it saw as profiteering by existing energy suppliers.
- Utilita (end-2019 market share of 2.9%) focussed on the prepayment segment.
- Bulb (4.8%) concentrated on expanding its customer base by selling a simple standard variable tariff product.
- Octopus (4.4%) developed an in-house platform (the software for running an energy supply business) which was subsequently licensed to other suppliers.
- Small "supplier in a box" models (so called because they could be started using a bespoke low cost software package) that were below the threshold size required to have to apply many of the social and environmental schemes (such as ECO and WHD).

A large number of smaller suppliers entered the market during this period, which built market share by offering keenly priced fixed-term tariffs. Such entry was encouraged by the way in which smaller suppliers were not subject to all of the same policy obligations faced by larger suppliers (in an effort to reduce barriers to entry in the sector).

The "Big 6" also retrenched during this period. In 2020, Ovo (the largest of the other firms at that time) acquired SSE's energy supply business. The nPower brand (which had been purchased by E.ON in 2019) was subsequently retired in 2020. By 2021 Q3, Octopus (by then the largest of the new entrant firms) had approximately the same number of domestic customers as Scottish Power.

Some of the suppliers which entered the market subsequently failed. While exits occurred for a variety of reasons, some were linked to increases in wholesale costs of energy. For example, GB Energy Supply, which had 160,000 customers, collapsed in 2016. It blamed increases in wholesale costs, combined with the way in which it had not hedged its purchases of energy (i.e. locking in a price in advance).[18] Further supplier failures occurred during 2018, including Spark Energy and Extra Energy which together had almost half a million customers on supply.[19] Again, rising wholesale costs were blamed. Nevertheless, by 2021 Q3, 49 companies were operating in the domestic retail market.

Following this, a surge in wholesale prices caused a large number of firms to fail. We describe this in more detail in section 3 below.

2.5 KEY THEMES

Based on this high-level summary of how the domestic energy retail market has evolved over time, a number of themes become apparent.

- **Decisions about the structure of the retail market are not made in isolation of the wider market structure.** This is the case when there is radical sector reform (as seen at the time of privatisation) where the government priorities were often on other parts of the sector (such as the generation market) and also as further changes are made to the market (for example, the introduction of the

[18] Exchange Utility, *GB Energy Supply ceases trading as energy rates continue to rise*, retrieved 15/02/2022

[19] The Guardian (2018), *Spark Energy goes bust and leaves 290,000 without a supplier*, retrieved on 15/02/2022

ROC arrangements to incentivise renewable generation). It is also the case that these major reforms take time.

- **Expansion of the supplier-hub model.** The role of the supplier has increased since the initial introduction of the supplier-hub model at market liberalisation. Due to their role as the single point of contact for consumers, suppliers have become the default home for the introduction of new consumer facing activities, even when they may conflict with suppliers' own interests e.g. reduction of energy consumption.

- **Increased politicisation of energy prices.** Throughout the period following liberalisation, it is clear that rising prices have been used as grounds for intervention in the energy market, even when these are largely outside of the suppliers' control. We have seen increasing politicisation of the energy market in recent years as demonstrated by the introduction of the default tariff cap and this is likely to continue as decarbonisation priorities increase alongside affordability concerns.

- **The regulatory framework largely dictates the type and level of competition.** It is the regulatory framework that largely dictates the way that competition operates in the market. For example, when the rules allowed suppliers to be exempt from certain costly responsibilities if they supplied below a threshold number of customers, there was a big growth in the number of small suppliers below those thresholds.

3 RECENT DEVELOPMENTS IN THE RETAIL MARKET

The period following September 2021 has seen particular disruption in the retail market, prompted by a dramatic increase in wholesale prices. This has had a number of consequences for the retail market.

- **Supplier failures:** It has led to an unprecedentedly large number of suppliers going out of business, including some larger ones such as Bulb, which served a total of 1.7 million customers. According to Citizen Advice report[20], nearly 4 million customers have seen their supplier fail since August 2021. The costs associated with this is estimated to cost consumers as much as £2.6bn, around £94 per customer from 2022.

- **Bill increases:** It has also led to a substantial increase in energy bills. For example, the energy price cap for the average dual-fuel customer is set to increase to £1,971 per annum from April 2022, which is an increase of more than 70% compared with the year before.

Whilst the increase in wholesale prices is a global phenomenon, questions have been raised about whether the current market structure in GB may have exacerbated the issues and is fit for purpose. We will consider whether the market can be designed to be more resilient to these types of shocks as part of work package 3.

This section looks in greater detail at the causes of this disruption and the implications this may have for its future reform.

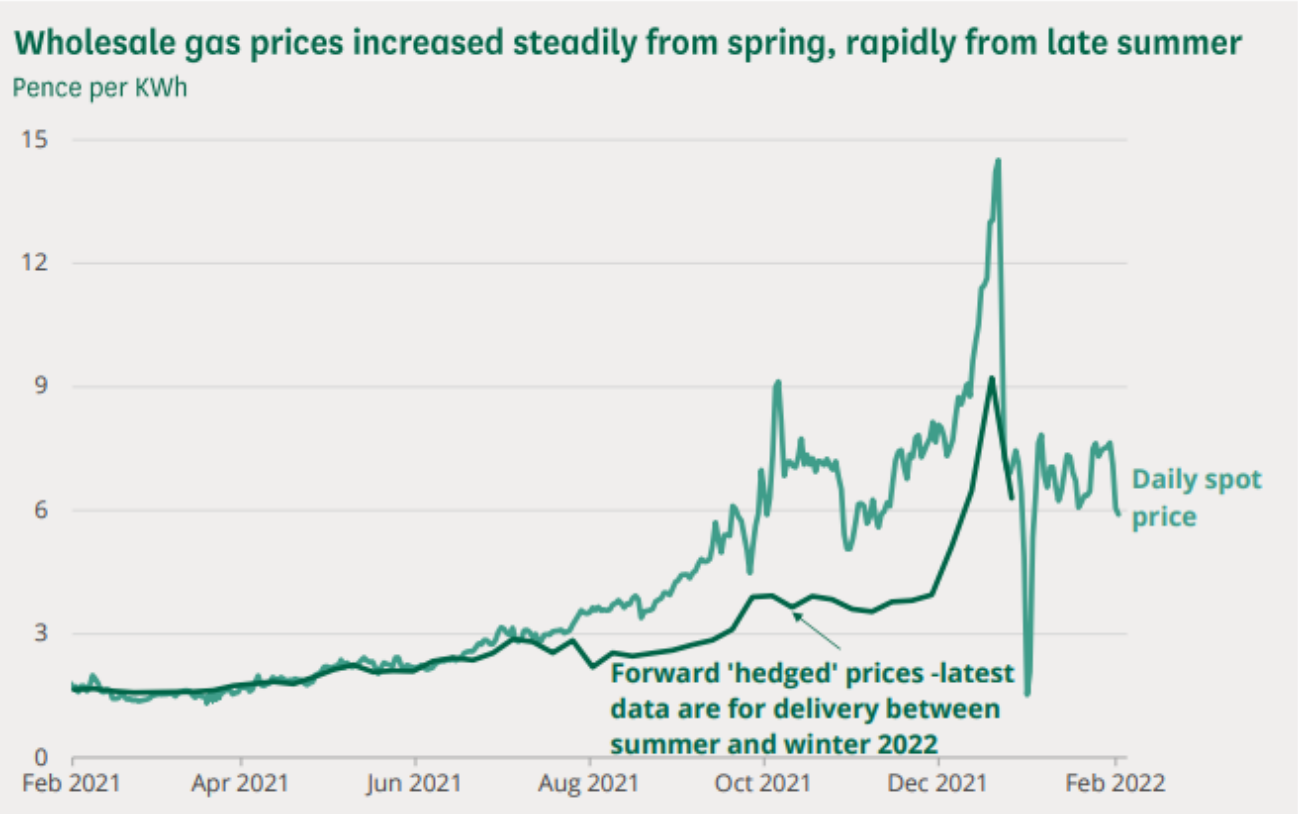
3.1 WHY DID WHOLESALE ENERGY PRICES RISE?

As shown in Figure 6 below, UK wholesale gas prices have increased dramatically from around 2p/kWh at the beginning of 2021 (which is roughly the level it had been at for the previous decade) to a peak of nearly 15p/kWh in December. Not only has there been a dramatic increase in the overall level of price but there has also been an increase in the volatility of prices. Further, both current and forward prices (for gas to be delivered towards the end of 2022) are still at historically high levels of around 6p/kWh, meaning that the current expectation is for prices to remain high. In GB, wholesale electricity prices often are determined by the price of gas generation,[21] and so were similarly affected.

[20] Citizens Advice, Market Meltdown: How regulatory failures landed us with multi-billion pound bill, retrieved on 24/08/2022

[21] The wholesale cost of electricity is determined by what economists call the "marginal cost" - the additional cost of producing one extra unit of electricity, given current demand. In GB, this additional unit is very often provided by a gas power station, and so if the price of gas rises, this directly impacts the price of electricity.

FIGURE 6 SPOT AND FORWARD WHOLESALE GAS PRICES



Source: House of Commons report: https://researchbriefings.files.parliament.uk/documents/CBP-9461/CBP-9461.pdf

These increases in gas and electricity wholesale prices were driven by global factors which are not unique to the UK. A few of the most significant causes are:

- **Declining European gas production**: Gas production in 2021 was nearly 20% lower than three years earlier, and is forecast to be roughly similar in 2022, before declining further throughout the rest of this decade.
- **Gas is seen as a "bridging fuel" during the climate transition:** Because electricity generation from gas is less carbon intensive than that from coal, lots of European countries continue to demand large amounts of gas, despite the fact that electricity generation from renewable sources is increasing. As a result, whilst production in Europe has declined, demand has remained stable in the last few years.
- **Covid recovery has increased demand:** The return to "business as usual" has led to economic growth and hence greater demand for gas and other natural resources. This has further exacerbated the demand and supply imbalance mentioned above. The combination of increased demand, and reducing supply means that European countries are more reliant on imports. However…
- **Geopolitical tensions:** These have become a specific issue between Western Europe and Russia. Russia is Europe's largest external supplier of gas. Whilst Gazprom (Russia's state owned gas company) has not cut its supply to Europe, it has chosen not to increase supply despite the high

profitability of doing so under current price levels. The ongoing crisis in Ukraine also remains a great source of uncertainty for gas supply in the future.

- **Low LNG supply:** another of Europe's key import sources is liquefied natural gas (LNG). However, a significant increase in gas consumption in China over the last few years has constrained LNG supplies and pushed up their price.

- **Low gas storage:** the imbalance between demand and supply caused by the above points is exacerbated by the fact that gas storage in Europe is lower than it normally would be. This is because last winter was unexpectedly cold which meant higher demand than anticipated, and therefore greater usage of stored gas. Although reserves increased during the summer, they were still lower going into winter than they would normally be.

3.2 INTERACTIONS WITH UK RETAIL MARKET REGULATION AND IMPACT ON SUPPLIERS

Although the causes of high gas prices mentioned in section 3.1 affect all European countries, the impact that they have on retailers and their customers depend on the specifics of GB retail market regulation.

Domestic customers are typically on one of two generic types of contract: they are either on the regulated default tariff cap described in section 2.3 or have taken an unregulated fixed term tariff, made as part of a competitive offer. In each case, either due to regulation or due to the terms of the contract, the price that retailers can charge is set in advance of delivery of the energy:

- Customers on the default tariff cap will see their prices change twice a year, in line with the process Ofgem undertakes to set the cap level. The cap is set on a "bottom-up" basis using regulated estimates of the different elements of cost that a supplier will face. The allowance that covers wholesale costs is based on an assumed hedging strategy that suppliers will have followed to buy energy for their customers in advance. For example, the price cap for winter 2021/22 is set based on the cost suppliers would have incurred if they purchased the energy from February 2021 through to the end of July 2021. There will therefore be a lag between when any spike in wholesale prices occurs and when it will feed through to higher prices in the cap. Furthermore, the half yearly updating of the price cap is based in legislation, and hence cannot be changed immediately when the market faces unprecedented shocks such as the current one.

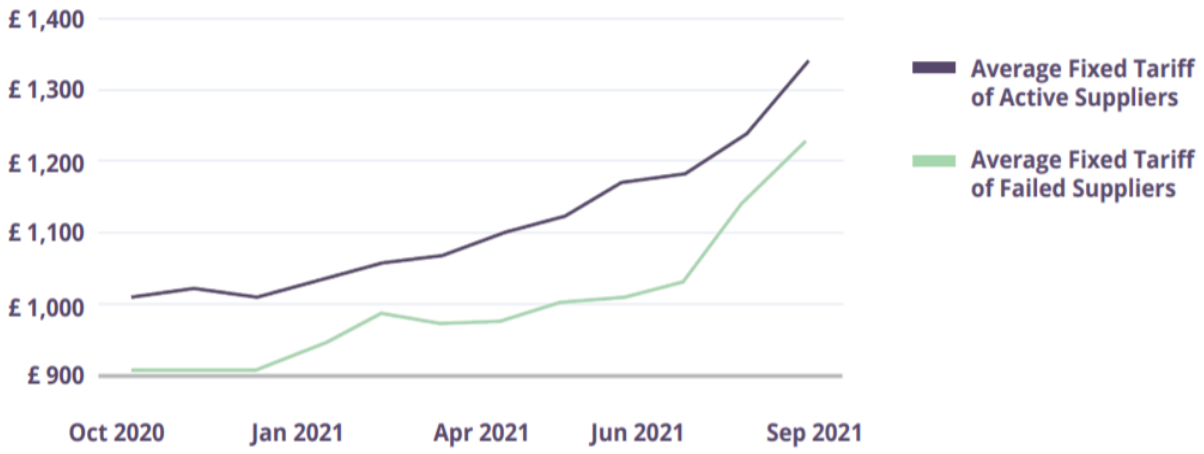
- Fixed term tariffs are not subject to a price cap, but are agreed in advance between the customer and supplier for a fixed period of time (often a year, but they can be for any period). Prior to the energy crisis, customers who shopped around could typically find a fixed-price deal which was cheaper than the default tariff cap. Because the price is fixed at the time the tariff is taken, suppliers are unable to increase prices until the end of the contract period, regardless of whether wholesale prices rise.

Given that the prices that they can charge customers are fixed for a period of time (whether under the default tariff cap or as part of a fixed term tariff), suppliers can reduce their risk by buying their energy ahead of time. This is known as "hedging" and it can reduce their exposure, by guaranteeing in advance the price that they will pay for the energy that they will be supplying to customers under the fixed price deals. However, there are two reasons why suppliers may not always hedge fully in practice:

- Not all suppliers choose to purchase all of their energy in advance, or have the finances to do so. In effect they are relying on the assumption that by purchasing the energy closer to the date of delivery, they will not get a significantly worse deal than buying it in advance. In times of low price

volatility, this may allow suppliers to save on capital costs – they do not need to borrow money in order to buy their energy in advance, and therefore do not need to spend money on interest. There was little regulation to oblige suppliers to mitigate their risks and, in a race to offer customers the lowest possible price, such risky behaviour was beneficial in the short run. It is notable that some of the cheapest fixed price deals prior to the crisis were offered by small suppliers which were not fully hedged, and that those suppliers who ultimately failed were offering cheaper deals than the rest of the market (see Figure 7 below). This was exacerbated by price comparison sites where customers would go to find the best energy deals, whose primary focus is on price as opposed to quality of service.

FIGURE 7 PRICE DIFFERENTIAL BETWEEN AVERAGE FIXED TARIFFS OF ACTIVE AND FAILED SUPPLIERS



Source: Citizens Advice, Market Meltdown: How regulatory failures landed us with multi-billion pound bill

- Even if they wish to fully hedge, suppliers do not know exactly how much energy they need to purchase for each given period. One source of uncertainty is the weather, which affects overall demand since customers demand more energy when the weather is cold. A second source of uncertainty for an individual supplier is that they cannot predict exactly how many customers they will have on each of their tariffs. This is due both to customers switching from supplier to supplier, and from customers switching between tariffs with the same supplier. The latter has been a particular problem during the current crisis because the price of new fixed deals in the market rose to reflect the higher wholesale costs whereas the default tariff cap was held below this level because of the lag between wholesale price rises and these rises being reflected in the cap (as described above). This meant that the fixed price competitive offers became more expensive than the default tariff cap and so the vast majority of customers chose to move on to the default tariff cap when their fixed price deals came to an end where in the past they may have taken another fixed deal. Suppliers were unable to reasonably predict and hedge for this increase in default tariff customers and were therefore required to purchase energy for these customers at higher prices. These prices were likely higher than the default tariff cap level.[22]

When suppliers have not purchased enough energy in advance to supply all of their customers, they must buy this energy at the time, at whatever the market price is. Due to the unexpected and large increases in

[22] Ofgem (2021). Reviewing the potential impact of increased wholesale volatility on the default tariff cap: November 2021 policy consultation.

energy prices heading into winter 2021, suppliers that had not fully hedged were faced with paying a much higher rate for their energy than was allowed for under the default tariff cap methodology, or which they assumed when setting fixed tariffs.

As a result of their energy costs being significantly higher than revenues, several suppliers made unsustainable losses and a large number went bankrupt. In total, these bankruptcies affected nearly 4 million customers, including Bulb, which served 1.7 million customers.

In the event of a supplier failure, there are two mechanisms used for assigning the customers of the failed supplier to a new supplier, and hence guaranteeing their continued energy supply:

- **The Supplier of Last Resort (SoLR) process**: under this process, other suppliers bid for the customers of the failed supplier in an auction. The new supplier can then apply to use an industry levy to recover the costs of taking on these customers – such as paying for the additional cost of buying energy for these customers and protecting their credit balances (which in many cases had built up amongst failed suppliers). Citizen's Advice has estimated that these costs will amount to £2.6 billion (or £94 per customer), which will be mutualised across the industry and ultimately passed on to customers.

- **The Special Administrative Regime**: under this regime, Ofgem can ask for an administrator to take over the company. In this instance, the government will give the administrator financial backing until a buyer of the company can be found or the customers can be taken on by other suppliers. Bulb, are to date the only energy company to be part of this regime and the government has set aside £1.7 billion to keep them running. Ultimately, the government is likely to seek to recover these costs with an energy levy, costing each customer around £61 per customer.

Taken together, these bankruptcies have been estimated to cost the industry up to £4.3 billion,[23] which would ultimately result in £155 being passed on to customers.

3.3 IMPACT ON CONSUMERS

Consumers face two price impacts as a result of the current increase in wholesale energy prices. The first of these is direct: the increase in wholesale prices are ultimately passed through into higher bills for end customers, either through the price cap or through fixed term tariffs. The price cap methodology means that there is some lag on this increase feeding through to end customers. Therefore, although energy bills under the price cap rose significantly to £1,277 per year this winter, they are set to increase further to £1,971 per year starting in April. The second cost incurred by consumers will be the indirect cost caused by supplier bankruptcies as described in the previous section. As mentioned, this may be as much as £155 per consumer.

The first of these impacts is somewhat inevitable, although a different market design might have changed when these costs are realised, and on whom they fall. The costs relating to supplier bankruptcies may have been more avoidable with a market structure which fosters greater resilience amongst suppliers. These costs also raise questions of fairness in two ways:

- Firstly, those customers who are more engaged in the energy market benefited from the lower tariffs offered by unsustainable and financially insecure businesses. However, the costs of these

[23] Ibid.

businesses' bankruptcies are socialised across the entire industry, meaning effectively that all customers are bailing out these failed suppliers. Therefore the disengaged customers who did not benefit from these lower prices must still pay the cost of clearing up the problems they created.

- More broadly, mutualising these costs on the basis of energy consumption is a regressive policy because less affluent customers spend a higher percentage of their income on energy.

In addition to these price impacts, the bankruptcies have had additional impacts on those customers of failed suppliers. These included customer confusion about what was happening and concerns over the security of their credit balances.

3.4 CONCLUSIONS

In summary, the current retail market design and regulation meant customers were protected from an initial rapid increase in prices thanks to the default tariff cap and fixed term contracts, but are likely to face increases further down the line. In addition, overall customer costs increased because of the supplier bankruptcies. This can be shown by comparing the impact of the shock in GB, with its impact in elsewhere:

- In Spain, the price cap methodology is such that increases in wholesale prices are passed on to end customers in real-time. As a result, customers felt a more immediate increase in bills in the short term. This caused Government to have to intervene through reductions to VAT and other taxes relating to electricity production and consumption, as well as increased discounts for vulnerable customers almost immediately, but there has been a far smaller impact on suppliers. Only a few small suppliers who offered fixed term tariffs went bankrupt, but their market share was much lower than that of the failed suppliers in GB.

- Similarly, in Germany the bankruptcies affected only small suppliers and were not on the level seen in the UK, but there was more of an immediate increase in tariffs.

- In France, the government has intervened to freeze regulated tariffs and prevent them from rising and also cover the supplier losses which will result from this decision. Therefore, the overall effect has been to protect the end consumer but for the increased energy costs to be borne by the taxpayer. Although this does not avoid the cost altogether this is arguably a more progressive way of funding the shortfall, and has avoided supplier bankruptcies and the associated costs.

The problems seen in GB raised questions about the need for reform of the market, including:

- **Reform of the default tariff cap.** Ofgem has already issued a number of consultations around making adjustments to the price cap including allowing for more frequent price changes and making adjustments to the way that the cap accounts for wholesale costs. It has also raised more fundamental questions about whether a price cap of this form is fit for purpose in this market.

- **Strengthening of prudential regulation.** The regulation of suppliers' financial practices to better ensure resilience in the face of unexpected shocks, and to avoid a situation in which excessive risk-taking is rewarded in the short term, are being discussed. This may increase the cost of entering the market as a supplier, but should also reduce the risk of future supplier failures.

- **More fundamental reform to the retail market.** More broadly, questions are being asked about whether more fundamental changes need to be made to the retail market, both to improve

resilience to the type of wholesale shocks that have recently been seen, and also to provide the right conditions to move to net zero.

We will be discussing these issues further in work packages 2 and 3.

4 THE CURRENT MARKET STRUCTURE

This section describes the roles and responsibilities of individual entities within the electricity and gas markets. It presents a breakdown of the customer bill, showing the main costs and which entities drive them. Finally, we present a series of flow diagrams designed to illustrate the service, data, and physical flows between organisations.

Particularly within the electricity sector, the need to continually balance supply and demand leads to a particularly complex set of relationships around the provision and use of flexibility services, which we highlight in the appropriate sections below.

This is not intended to be an exhaustive guide but instead provides a non-technical primer that can provide context to subsequent discussions on changes to the market.

4.1 THE ROLE OF DIFFERENT ENTITIES

The supply of both gas and electricity relies on several key entities, including energy producers, transmission and distribution networks and suppliers. The flows of energy, data, and services between these organisations are facilitated by a wider network of central system delivery bodies that co-ordinate essential services including balancing the electricity market, administration of network codes, and delivering essential data flows. In addition, there are a number of roles undertaken by third-party firms that provide services such as price comparison, energy efficiency advice, and installation of energy equipment. In this section we provide an overview of the key entities. We have split this into three sections to reflect similarities (and differences) between the gas and electricity sectors:

- **Common gas and electricity entities**. This section will cover entities that are common in both the gas and electricity market e.g. network companies, suppliers, and meter operators.
- **Electricity only entities**. This section will cover entities that are unique to the electricity sector e.g. prosumers.
- **Gas only entities.** This section will cover entities that are unique to the gas sector e.g. the gas system operator.

For each entity, we briefly describe their role in the system, the market structure (including the way in which they are regulated) and their relationship, if any, with end-consumers. The relationships between the different entities are illustrated in more detail in section 4.3.

4.1.1 COMMON GAS AND ELECTRICITY ENTITIES

This section describes the entities which have similar roles within both the gas and electricity sectors.

SUPPLIERS

Role: Under the supplier-hub model, suppliers act as the primary interface between customers and the wider energy system. As a result suppliers have several roles (discussed in section 2):

- **Energy supply**. The primary role of energy suppliers is to purchase energy from generators (electricity) and gas shippers (gas) and sell it to end consumers. Energy suppliers forecast expected demand for their customers and typically purchase this energy in advance via the forward market (up to a year in advance of delivery), the 'day ahead' market (one day in advance of delivery), and

the intraday market (up to an hour before delivery). As part of this role, they must manage the risk arising from the difference between prices paid by customers and costs incurred, particularly in relation to wholesale energy costs. Energy suppliers typically manage this through hedging (discussed in section 3). It should be noted that energy suppliers do not physically deliver electricity or gas themselves (see Figure 11).

- **Billing and cost recovery**. Suppliers provide a single bill to customers (electricity, gas, or dual fuel) which includes costs associated with the whole energy supply chain. This cost-recovery role is reflected in the customer's bill which is broken down into wholesale costs, network costs, social and environmental obligations, other direct costs, supplier operating costs and margin.

- **Metering**. Suppliers are responsible for procuring metering services for their customers and will typically outsource this to meter asset providers, meter asset managers, and debt collection services (see section 2.2.1). This includes the rollout of smart-meters where the UK has adopted a supplier-led model under which suppliers have a legal requirement to take all reasonable steps to install smart meters for their customers.

- **Social responsibilities**. Suppliers have a licence condition to protect vulnerable consumers including maintaining the priority services register which identifies customers that may need priority services, provision of the Warm Home discount for eligible customers, and are subject to specific rules around payments, disconnections, and final bills for customers.

- **Energy efficiency.** Suppliers that exceed the obligation threshold are legally required to participate in the ECO scheme which requires them to install energy efficiency measures such as insulation and inefficient heating thresholds in eligible households. Suppliers pass on this cost to customers via a levy on their energy bill. In practice, energy suppliers will outsource the installation of energy efficiency measures to third party installation companies and customers can contact any obligated supplier about ECO not just their own supplier.[24] The obligation threshold is based on both the number of domestic customers that a supplier has and the total amount of energy they supply to those customers.[25] Both thresholds must be met in order for a supplier to be consider an obligated supplier. Suppliers under the threshold can choose to opt in to the scheme and the Government is considering the removal of thresholds in the future.[26]

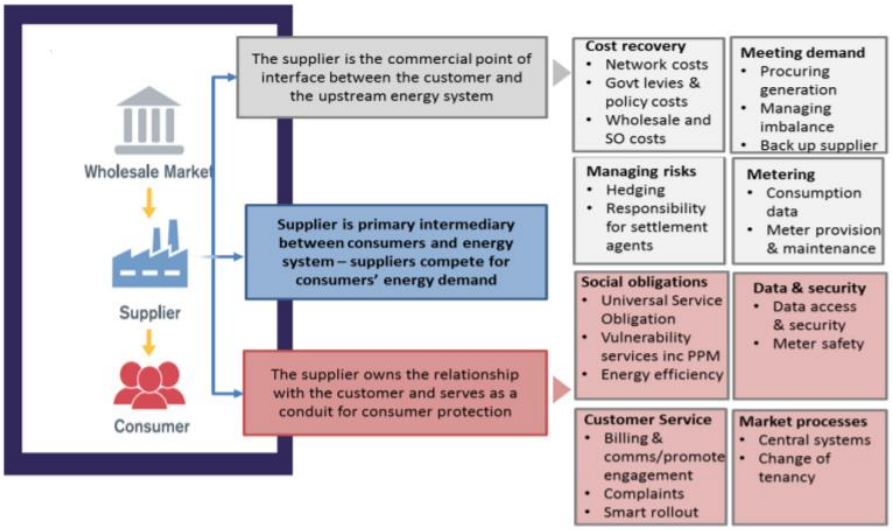
[24] House of Commons (2020). Energy Company Obligation (ECO)

[25] Further information on the specific thresholds for ECO3 can be found here: Ofgem (2020). Energy Company Obligation (ECO3) Guidance: Supplier Administration v1.3

[26] BEIS (2021). Energy Company Obligation. ECO4: 2022 - 2026

These roles and others are illustrated in the following diagram from Ofgem[27]:

FIGURE 8 ROLE OF SUPPLIERS



Source: Ofgem, Future supply market arrangements – call for evidence

Regulation and market structure: The retail energy market is subject to competition and there has been a recent increase in both market entry and subsequently market exit (see previous sections). However, suppliers remain subject to some regulation:

- **Licence conditions**. Suppliers must hold a licence in order to operate, with separate licences required for gas and electricity. The license conditions enforce the supplier hub model, since:
  - In order to carry out some activities (i.e. the supply of energy to consumers), a license is required; and
  - the license itself requires other activities (e.g. the smart meter rollout, or delivery of social and environmental programmes) to be carried out.
- **Price regulation**. Following the introduction of the Tariff Cap Act in 2018, suppliers are subject to a default tariff cap which limits the amount that they can charge standard variable tariff customers on a per unit basis.

Energy suppliers can be vertically integrated with energy generation, meaning they generate and sell their own energy. Historically, all of the "Big 6" energy suppliers were vertically integrated with respect to electricity.[28] Many of the bigger suppliers still own generation assets or are part of a parent company that does (for example, EDF operates the UK's nuclear power stations). However the trend in recent years has been away from vertical integration (for example, Ovo purchased only the retail arm of SSE and not its

[27] Ofgem (2017). Future supply market arrangements – call for evidence

[28] CMA (2016). Energy market investigation. Summary of final report.

generation business). By contrast, Centrica is the only one of the former "Big 6" with material gas production[29], although Shell, another supplier, also owns considerable upstream assets.

Energy suppliers can also be integrated with network provision, and in the past this was more common – for example, EDF managed the distribution networks around London, and SSE (which was at the time a supplier) managed electricity distribution networks in the South and in Scotland, as well as both the electricity transmission and distribution networks in Northern Scotland and owned a stake in SGN (a gas distribution network). However the recent trend has again been for separation, with Scottish Power now the only firm combining supply with network businesses (it runs the electricity transmission and distribution networks for Southern and Central Scotland, as well as the distribution network in Merseyside and North Wales).[30]

Relationship with end customers: Under the supplier-hub model, energy suppliers act as the primary interface between customers and the energy market for the supply of energy[31].

TRANSMISSION AND DISTRIBUTION (NETWORK COMPANIES)

Role: Network companies fall into two categories, transmission and distribution, and are responsible for physically transporting energy across the system. In addition, as part of the DSO transition, electricity distribution companies are increasingly managing flexibility services to help balance the system.

- **Electricity.** The electricity grid consists of two types of network that transport electricity: the high voltage transmission network and the lower voltage[32] distribution network. The high voltage transmission network is owned and operated by transmission companies whereas lower voltage systems that deliver energy from the transmission network to homes and other consumers are owned and operated by distribution network operators (DNOs). In addition, independent DNOs (IDNOs) operate a number of smaller local networks for new housing and commercial developments.

  The electrification of heat and transport will place significant new demands on the distribution networks. In order to minimise costly reinforcement (i.e. building new assets such as transformers and circuits), DNOs will need to make the most of the flexibility available on their networks – for example, procuring demand-side response, where consumers can reduce or shift their demand away from the peak. This requires actions similar to those carried out by the electricity system operator (described below) albeit at a local level, and a transformation from DNOs to "DSOs" (distribution system operators).

- **Gas**. The gas transmission network consists of high-pressure pipelines that supply gas from natural gas terminals situated on the coast to power stations, large industrial users, and the gas distribution networks. Gas transporters (GTs) own and operate lower pressure regional pipeline systems known as the gas distribution network (GDN) which convey gas from the transmission

[29] Centrica intends to sell its Norwegian oil and gas assets. See Centrica (2021). Proposed sale of Spirit Energy's Norwegian Assets.

[30] Companies that have both a supplier business and network provision business are subject to confidentiality and business separation provisions. See here for further details on how separation issues are currently dealt with by Scottish Power. SP Energy Networks (2021). Business separation compliance annual report.

[31] There are some exceptions where customers may directly contact DNOs which are covered below. This includes in the event of power cuts, connection of new properties, and registering for the priority services register.

[32] The distribution networks include different layers which operate at different voltage levels, down to the 250V provided to domestic consumers, which in this context is termed "low voltage".

system to individual premises. Similar to with electricity, independent Gas Transporters (IGTs) operate and maintain a number of smaller local networks.

Regulation and market structure: In both electricity and gas markets, distribution and transmission networks are made up of a series of local or national monopolies which are regulated by Ofgem. As is the case with suppliers, network companies must hold a licence to operate and collect the revenues they are allowed under their price controls based on charges on network users.

- **Electricity.** The transmission network in England and Wales is owned and maintained by National Grid plc, whereas in Scotland the transmission network is split between SP Energy Networks in the South and SSEN in the North. The transmission network for offshore wind is owned by offshore transmission owners (OFTO) which are appointed via competitive tender by Ofgem for new offshore wind developments. The electricity distribution network is split into 14 licence areas, each of which are operated by a separate DNO. These DNOs are currently owned by six different groups. In addition to the DNOs, Ofgem licences IDNOs to provide local electricity distribution networks. Unlike DNOs, IDNOs are not restricted to a single geographic region.[33] IDNOs are subject to a relative price control that links the price of the IDNO to the incumbent DNO.[34] As noted above, DNOs are currently undergoing a transition to become distribution system operators (DSOs), taking on greater responsibilities for co-ordinating and balancing regional grids to meet increasing demand for flexibility.

- **Gas.** The only gas transmission operator in the UK is National Grid Gas (NGG). There are eight gas distribution networks (GDNs) in GB, which are owned and managed by five regional monopolies known as Gas Transporters (GTs). Each gas transporter is responsible under its licence for ensuring that its pipeline system has adequate capacity to meet the firm demand that is connected to it. Gas transporter tariffs are regulated by Ofgem. IGTs must also obtain a licence from Ofgem and are subject to a relative price control that links IGT charges to those of the local GT.[35]

Relationship with end customers: Under the supplier hub model end customers do not typically interact with the network companies. Instead, suppliers pass on the costs of operating the network as part of customer bills and network costs currently make up c.25% of an average dual fuel bill. However there are exceptions where customers may contact electricity distribution companies or vice versa. In the event of a power cut customers are expected to contact their DNO rather than their supplier. Customers are also required to contact their DNO to get new properties connected onto the network or upgrade a connection e.g. for an EV charging point. Customers can also register for the priority services register with their DNO which provides extra support during a power cut.

DCC

Role: The Data Communications Company (DCC) was granted a licence to establish and manage a new data and communications network to connect smart meters in 2013. Following launch of this communication network in 2016, suppliers could install SMETS2 meters (the latest standard of smart meter) that would communicate with the DCC irrespective of the supplier which originally installed the meter.

[33] https://ina.org.uk/idnos-and-igts/

[34] Ofgem (2005). Regulation of Independent Electricity Distribution Network Operators.

[35] Ofgem (2013). Guidance for Relative Price Control.

Regulation and market structure: The DCC is a regulated monopoly company and operates under the Smart Meter Communications Licence. It is responsible for linking smart meters in homes and small businesses with energy suppliers, network operators and energy service companies. The DCC is subject to a price control to assess whether its costs are economic and efficient. All suppliers were required to become DCC users in 2017[36] and Ofgem have recently taken action against suppliers which have failed to use the DCC for smart metering including banning them from taking on new customers until they have become DCC users.[37]

Relationship with end customers: End users do not engage with the DCC, instead going through their supplier for the installation of a smart meter. Once installed, the meter will automatically take readings that are passed on to suppliers via the DCC.

SMART ENERGY GB

Role: The Government established Smart Energy GB to encourage the uptake of smart meters. It focuses on engaging with households and small businesses to build consumer confidence in smart metering as well as working with vulnerable consumers to realise the benefits of smart meters.

Regulation and market structure: Smart Energy GB is a not-for-profit organisation funded by energy suppliers.

Relationship with end customers: Smart Energy GB carries out engagement activity with end users to inform them on the benefits of smart meters and understand their benefits as well as offering a website where consumers can find information on smart meters.[38] It has recently launched the Smart Energy GB in Communities Fund which offers grants up to £25,000 to encourage smart meter uptake amongst vulnerable individuals.

ELECTRALINK

Role: ElectraLink is responsible for providing a Data Transfer Service (DTS) which enables suppliers, DNOs and central agents to communicate with one another. In particular, Electralink runs the Data Transfer Network (DTN) which underpins the electricity industry's regulated DTS, a managed file transfer service. The DTS ensures that data relating to energy consumption, change of supplier activity, meter installation and maintenance, and Green Deal projects are communicated between relevant parties on a single secure network.[39]

Historically, the DTS was only used by the electricity sector. However, Electralink has recently provided a commercial data flow to some gas suppliers to facilitate gas switching.[40] Electralink also collects and analyses data exchanged between energy market participants in order to promote a better understanding and transparency of market which aims to improve energy efficiency, innovation and reduction of costs to consumers.

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[36] Ofgem Press release (2020). https://www.ofgem.gov.uk/publications/ofgem-orders-nine-energy-suppliers-become-dcc-users#:~:text=The%20suppliers%20are%3A%20Ampoweruk%20Ltd,and%20UK%20National%20Gas%20Ltd.

[37] Ofgem press release (2020). https://www.ofgem.gov.uk/publications/ofgem-issues-five-suppliers-final-orders-become-dcc-users

[38] House of Commons Library (2019). Energy Smart Meters briefing paper.

[39] Electralink (2012). Written evidence submitted by Electralink Ltd (SMR83). Accessed at: https://publications.parliament.uk/pa/cm201314/cmselect/cmenergy/161/161vw76.htm

[40] Ofgem (2017). The Authoritiy's decision on changes to the Data Transfer Service Agreement.

Regulation and market structure: Electralink is a wholly owned subsidiary of the DNOs and the DTS is regulated by Ofgem. The DTS is provided on a cost-recovery basis regulated by the charging principles in the DTS Agreement, which includes a return on its investments.[41] Electralink is required to competitively procure its technology and services.

Relationship with end customers: ElectraLink does not interact directly with customers.

4.1.2 ELECTRICITY-ONLY ENTITIES

This section describes the entities which are unique to the electricity sector.

GENERATORS (EXCL. PROSUMERS)

Role: Electricity generators transform primary inputs such as gas, coal, and renewable resources into electricity. They must produce this electricity reliably (in the right quantities at the right time) and with the requested quality (voltage and frequency). This energy is sold to suppliers in the wholesale market (vertically integrated suppliers may also use the energy they generate themselves). As described below, the System Operator procures flexibility services from generators, ensuring that demand and supply on the system can be kept in balance at all times.

Regulation and market structure: Liberalisation of the electricity market established a competitive market for electricity generation, increasing the number of major power producers (MPPs – companies whos prime purpose is the generation of electricity) from six before privatisation 36 in 2001, before mergers caused numbers to fall back to 29 in 2006.[42] The recent growth in new generation, particularly renewables, has seen the market share of the top 9 major power products (MPPs) fall from 82.8% in 2015 to 77.8% in 2020, by which point there were 58 MPPs.[43] All generators (with some exemptions,[44] such as smaller generators) are required to hold a license from Ofgem.

Relationship with end customers: End retail customers do not interact directly with generators. Instead, all of these costs (including wholesale cost which make up around 30% of the total electricity bill[45]) are passed through to consumers by their suppliers.

ELECTRICITY SYSTEM OPERATOR

Role: The electricity system operator has several essential roles within the energy system:[46]

- **Balancing.** Whilst suppliers and generators trade based on predicted energy demand, the ESO ensures that the system meets actual demand in real time. This is referred to as balancing the system and requires the procurement of flexibility services from generators (as well as larger non-domestic consumers which can provide demand-side response). Taking a longer-term view, the ESO

[41] Electralink (2017). ElectraLink's response to the Ofgem consultation 'UK Link and the proposed Central Switching Service'

[42] DBEIS (2020). Competition in UK electricity markets. Accessed at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1021789/Competition_in_UK_Electricity_Markets_2020.pdf

[43] Ibid.

[44] See BEIS – Electricity license exemptions

[45] Ofgem. Accessed at: https://www.ofgem.gov.uk/energy-advice-households/costs-your-energy-bill

[46] Ofgem (2020). ESO roles and principles.

has a responsibility to find opportunities to drive overall efficiency in balancing services in the long term such as developing balancing services markets.

- **EMR.** The ESO is the Delivery Body for the Government's CfD scheme introduced as part of the Electricity Market Reform (EMR)[47] and runs the CfD process.

- **Information provision.** The ESO plays a key co-ordination role for the market, helping the market to co-ordinate network planning and operations. This is underpinned by a license condition which requires the ESO to publish information to support network planning and publish accurate and unbiased forecasts.

- **Market development and transactions.** The ESO is also expected to encourage and facilitate competition in all energy markets that it can affect, including balancing, ancillary services, and wholesale and capacity markets.

- **System insight, planning and network development.** The ESO co-ordinates with other market participants across network boundaries to support network planning and development, including facilitating competition to ensure value for customers and drive innovation. This includes engaging with a wide set of stakeholders to develop the Future Energy Scenarios (FES) and identifying the most efficient network planning and development solutions.

Regulation and market structure: National Grid ESO is the electricity system operator for Great Britain and is regulated by Ofgem. It is subject to requirements in the ESO licence, the ESO price control, and regular monitoring and reporting requirements.

Relationship with end customers: End customers do not interact with the ESO. Instead, balancing costs are collected via the balancing services use of system charge (BSUoS) which is passed on in customer bills as part of network charges and makes up approximately 4% of domestic bills[48].

AGGREGATORS

Role: Aggregators operate on behalf of a group of consumers, either to adjust their electricity consumption (in doing so providing flexibility services that can be sold to the ESO or DSOs) or, in the case of prosumers, to sell excess energy. Historically aggregators have focused on the non-residential sector but the increase in prosumers and growing prominence of the smart home has led to an increase in aggregators targeting households to provide demand-side response (DSR).[49]

Regulation and market structure: Aggregators are not required to obtain a supply licence to engage with customers, but neither are they able to engage with the wholesale electricity market on a standalone basis. Instead aggregators either work in partnership with a licensed supplier or obtain a supplier licence (supplier-aggregators).[50] The number of aggregators is still low, with 18 listed by National Grid ESO in

[47] The EMR was introduced by Government in 2013 as part of the Energy Act 2013 to incentivise investment in secure, low-carbon electricity. It introduced Contracts for Differences (CfDs) under which eligible renewable energy generators could bid for a CfD contract. CfDs guarantee a set price for electricity generated.

[48] WPD. A guide to Ofgem's proposals for changes to network charging. For community energy groups. Accessed at: https://www.regen.co.uk/wp-content/uploads/1376-WPD-CE-WP1-Guide-for-Network-Access-Consultation-vFINAL.pdf

[49] BEUC (2018). Electricity aggregators: Starting off on the right foot with consumers.

[50] Energy policy group (2019). Barriers to Independent Aggregators in Europe.

February 2022[51] and are focused primarily on the non-residential sector. However, there are several ongoing pilots to explore the feasibility and benefits of DSR in the residential sector.[52]

Relationship with end customers. Individual end-customers can sign up directly with aggregators who may target prosumers or bundle aggregation and DSR services alongside energy management devices or smart appliances. For example, participants in the flexibly-responsible Energy Delivery (FRED) pilot had their EV charging automatically shifted to the cheapest period of the evening.[53]

RESIDENTIAL PROSUMERS

Role: Residential prosumers refers to households who both consume and produce energy. Prosumers produce energy for their own consumption, primarily through solar photovoltaic panels on rooftops and may also store this energy or sell excess energy back to the grid or other consumers.

Regulation and market structure: The very small generators typically installed in a domestic property are exempt from the requirement to obtain a generation license. Special arrangements also exist for prosumers to receive income for their generation:

- **Self-consumption**. There is no specific legislation for self-consumption although the Government's Feed in Tariff programme included a payment for energy generated in addition to a payment for exported energy. This has since been replaced by the Smart Export Guarantee (SEG) which only pays consumers for exported energy.

- **Export**. Prosumers typically sell their excess energy back to the grid via the SEG which must be offered by all suppliers with over 150,000 customers. Alternatively, individuals may come together as part of a prosumer community to trade their surplus energy via an aggregator[54].

Relationship with end customers: Prosumers are a subset of end-customers that consume energy that they produce themselves. Where prosumers export surplus energy, this is delivered to other through the networks. Typically the renewable energy generation installation company will provide the necessary information to a customer's local DNO which will ensure that they are connected.[55]

ELEXON

Role: Elexon is responsible for managing and delivering the Balancing and Settlement Code (BSC) which includes:

- **Balancing**. At the end of a settlement period,[56] Elexon ensure that relevant parties are billed or paid correctly for balancing activity via BSUoS.

- **Electricity market reform** Elexon's subsidiary, EMR Settlement Ltd., is the EMR settlement services provider and acts as the settling agent to the Low Carbon Contracts Company for the Contract for

[51] https://www.nationalgrideso.com/industry-information/balancing-services/demand-side-response-dsr

[52] BEIS. Innovative Domestic Demand-Side Response Competition.

[53] Evergreen (2021). FRED Smart Charging Trial Findings.

[54] Ines et al (2019). Regulatory Challenges and opportunities for collective renewable energy prosumers in the EU. https://doi.org/10.1016/j.enpol.2019.111212

[55] How to Connect Solar Panels to the National Grid | UKPower

[56] Electricity is bought and sold on the wholsale market within half-hour "settlement periods".

Differences (CfD) and capacity market. Suppliers are required to fund CfD arrangements via the Supplier Obligation and they make these payments which are calculated and managed by EMR Settlement Ltd.

Regulation and market structure: Elexon is a not-for-profit organisation that is wholly owned by National Grid ESO. It is funded via parties signed up to the BSC. This extends to any entities which trade electricity in Great Britain in addition to generators, suppliers, and other energy industry participants such as data aggregators and meter operators. The amount that each party pays depends on their market share and role. Elexon's charges are fixed and agreed by BSC Panel on an annual basis.

Relationship with end customers: End customers do not interact directly with Elexon.

4.1.3 GAS-ONLY ENTITIES

This section describes the entities which are unique to the gas sector.

GAS PRODUCERS, LARGE SCALE STORAGE OPERATORS, AND IMPORTERS

Role: Gas producers, large scale storage operators, and importers (whether via interconnectors or shipments of liquid natural gas) provide gas to the wholesale markets at contracted quantities.

Regulation and market structure: UK gas production is currently composed primarily of multinational oil and gas majors. These companies are subject to regulatory regimes for oil and gas exploration and production the UK which is overseen by the Oil and Gas Act

Relationship with end customers: Gas producers and storage operators do not interact directly with end customers. Instead, they trade gas with gas shippers and retail suppliers who sell this on to end customers.

GAS SHIPPERS

Role: Gas shippers serve as an intermediary between gas producers and retailers, arranging and paying for transportation services from network businesses. They typically contract with upstream parties, such as offshore producers, LNG importers and interconnector shippers, to purchase gas at the point at which gas is delivered into the GB pipeline system. They also pay National Grid and gas transporters to transport their gas to homes and businesses.

Regulation: A gas shipper is required to obtain a license from Ofgem in order to arrange with a gas transporter for gas that enters or leaves of a pipeline system operated by that gas transporter.

Relationship with end customers: Normally, gas shippers do not interact with end customers. They are an intermediary contact between upstream parties, such as gas producers, and the gas suppliers. However, many gas suppliers also act as gas shipper (holding both types of licence).

GAS SYSTEM OPERATOR (GSO)

Role: The Gas System Operator (GSO) has responsibility for ensuring that gas demand and supply balance. It 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), resolving any residual imbalances and ensuring the system is robust to shocks. The GSO achieves this by buying and selling gas (and using its own stored gas) to ensure demand can be met with high reliability. The GSO also procures

demand-side response services from large non-domestic consumers[57] to help it ensure demand can be met during an emergency.

Regulation and market structure: The GSO is owned by National Grid Gas and is operated as a regulated monopoly. It is subject to a regulatory incentive scheme set by Ofgem with incentives for NGG to run the system efficiently and an upper cap on the maximum payment that the GSO can receive[58].

Relationship with end customers: There is no direct relationship between the GSO and end consumers.

XOSERVE

Role: Xoserve is the Central Data Service Provider (CDSP) for the gas market. Its functions include operating UK Link, the IT system that facilitates key processes for the gas network including customer switching, energy settlement, and managing and updating the supply point register. One of its key roles is to manage all the information relating to the 22m gas supply points in Great Britain.

Regulation and market structure: Previously, Xoserve was run as a private profit-making company, jointly owned by the five major gas transporters 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. With this decision, gas transporters and gas shippers were required to jointly participate in Xoserve's governance and fund its activities. Gas shippers are also responsible (along with gas transporters) for directly funding Xoserve's costs in delivering UNC-related services.

Xoserve restructured its operations in 2021 and separated into two companies: Xoserve and a new subsidiary called Correla. Xoserve retained its role as the CDSP with Correla delivering data services back to Xoserve via a commercial contract (DSC+).[59] Correla was subsequently acquired by NorthEdge in April 2021.

Relationship with end customers: Xoserve does not have a direct relationship to end customers, although its task is to ensure that retail gas market runs efficiently and reliably for all our customers. They exclusively work with gas suppliers, shippers and transporters.

4.2 BREAKDOWN OF THE CUSTOMER BILL

The previous section illustrates the breadth of entities that make up the energy system and the supply of energy to end consumers. It also showed how the vast majority of these entities do not contract directly with consumers: Under the supplier-hub model, the supplier is responsible for recovering all of these costs via a single bill.

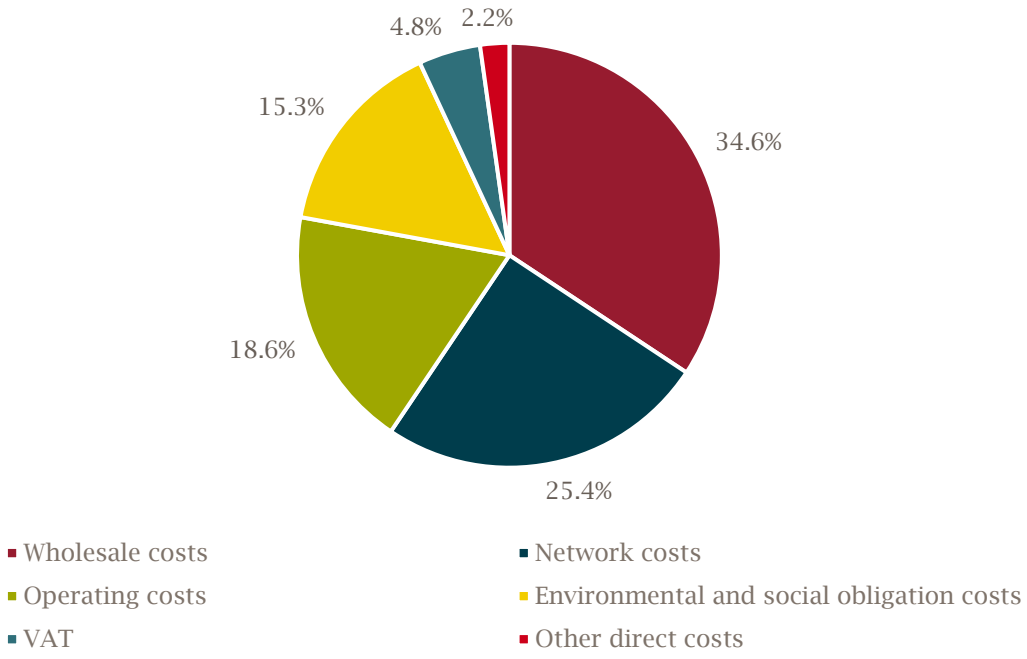
The breakdown of an average dual fuel bill as of August 2021 (shortly before the recent price rises) is set out below. However, given the recent increase in wholesale gas prices, the wholesale cost component of the bill will currently accounts for a much larger share of the total bill.

[57] National Grid (2016), *Gas Demand Side Response: An introduction*

[58] Gas System Operator (GSO) regulation | Ofgem

[59] Xoserve News (2021). Accessed at: https://www.xoserve.com/news/xoserve-board-announces-investor-and-new-operating-model-update/

FIGURE 9 BREAKDOWN OF A DUAL FUEL BILL



Source: Ofgem. Accessed February 2022: https://www.ofgem.gov.uk/energy-advice-households/costs-your-energy-bill
Note: This breakdown is from August 2021

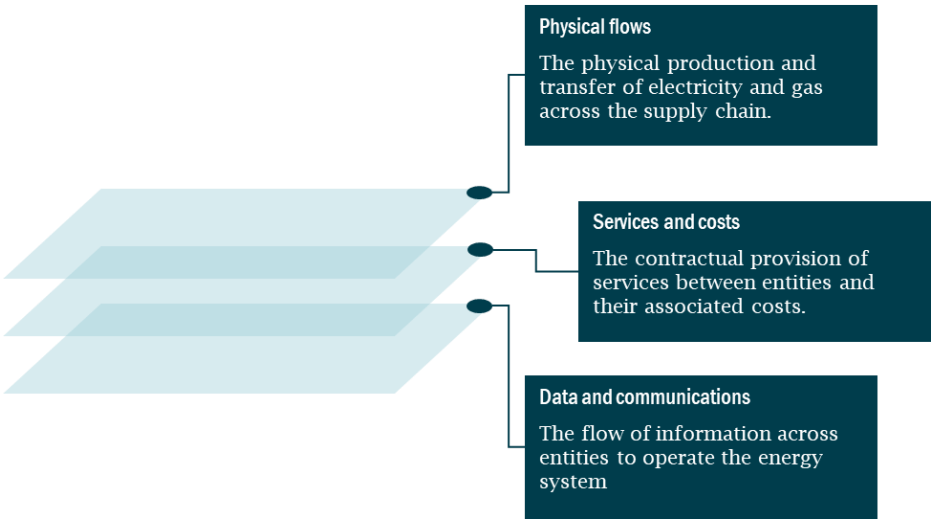
- **Wholesale costs**. Wholesale costs refer to the cost to suppliers of purchasing energy from electricity generators and gas producers on the wholesale market.
- **Network costs**. Network costs refer to costs associated with transmission and distribution of gas and electricity and include recovery of TNUoS and DUoS charges which fund the network companies.
- **Environmental and social obligation costs.** Large suppliers have obligations to fund government energy policies such as the ECO and WHD which are socialised across all customers.
- **Other direct costs.** This covers costs associated with third party services such as sales commission and brokerage, meter maintenance and installation, administration data and settlement service from Elexon and Xoserve, and wider smart meter programme costs (e.g. the costs associated with Smart Energy GB and the DCC).
- **Operating costs**. This covers the operating costs of suppliers themselves (customer service, billing, general operational costs) as well as a margin to allow suppliers to make a profit.

4.3 MAPPING THE SYSTEM

As we have set above, the energy system is highly complex with several entities interacting continuously with one another to deliver energy and energy efficiency measures. These interactions can be considered in three main "layers":

- **Physical flows**. This refers to the physical flow of gas and electricity across the system to end-customers.
- **Services and associated costs**. Entities will provide contracted services to one another with an associated cost for delivering this service e.g. DNOs provide distribution services to suppliers and generators who pay distribution use of system (DUoS) charges to the DNO in return.
- **Data and communications**. Data is continually shared between entities to deliver a well-functioning energy system. Much of this data is exchanged using the DTS but entities will also have other data and communication channels.

FIGURE 10 LAYERS OF FLOWS WITHIN THE ENERGY SYSTEM



Source: Frontier Economics

The remainder of this section presents a series of flow maps illustrating the relationships within each of these layers for gas and electricity:

- **Physical flows**. The charts illustrate:
  - how **electricity** moves through the system from generation to end customers; and
  - how **gas** moves through the system from producers/import to end customers.
- **Services**. The charts illustrate:
  - key services provided by one entity to another within the **electricity** system; and
  - key services provided by one entity to another within the **gas** system.
- **Data and comms flows**. The charts illustrate:
  - the key flows of data and communications in the **electricity** system, excluding those relating to smart metering data;
  - key data flows specifically relating to smart metering data for **electricity**;

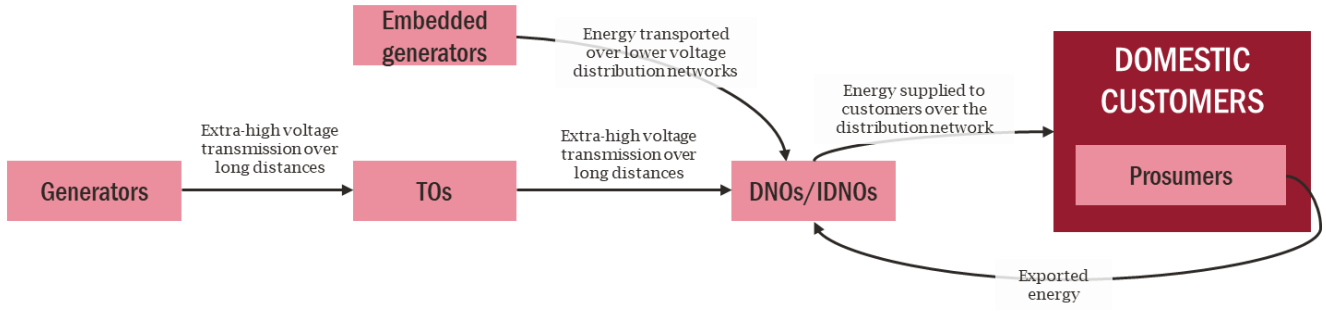
- the key flows of data and communications in the **gas** system, excluding those relating to smart metering data;
- key data flows specifically relating to smart metering data for **gas**;

In addition to these overarching diagrams, we provide a short overview of flexibility services for electricity and highlight the specific flows associated with this service.

4.3.1 ELECTRICITY: PHYSICAL FLOWS

As can be seen in the flow diagram below, relatively few entities within the electricity system handle physical electricity flows. Electricity produced by generators feeds through the transmission and distribution networks until it reaches end consumers (the exception is embedded generators which are connected directly to the distribution system and are not shown in the diagram below). In the case where end users generate electricity, for example via the installation of solar PVs on their rooftops, they can choose to export excess energy via the DNO. As can be seen in the flow diagram below, relatively few entities within the electricity system handle physical electricity flows.

FIGURE 11 ELECTRICITY: PHYSICAL FLOWS



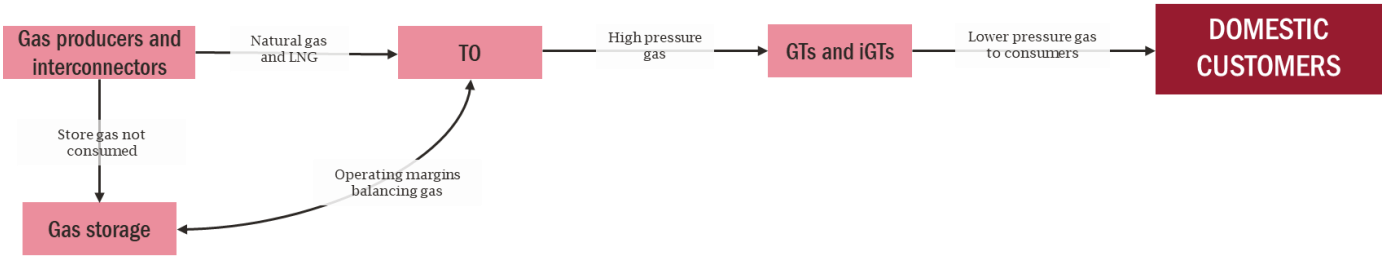
* Non-domestic consumers have been excluded.. Large industrial consumers may receive electricity direction from the TO.

Source: Frontier Economics

4.3.2 GAS: PHYSICAL FLOWS

Similar to electricity, there are relatively few organisations within the gas sector that physically produce or transport gas. As a general rule, gas is produced or imported and injected into the transmission (high pressure) and distribution (low pressure) networks which transport this to homes and businesses, first via the high pressure gas transmission network and then via the low pressure gas distribution network to end customers. There are exceptions not shown on the diagram such as biogas generation which can be connected directly to the distribution system.[60]

FIGURE 1 GAS: PHYSICAL FLOWS



* Non-domestic consumers including large industrial customers are not included here. Low-pressure generation such as biogas which can be connected directly to the distribution network are not shown here.

Source: Frontier Economics

[60] Cadent. Biomethane gas to grid. Customer connection guide.

4.3.3 ELECTRICITY: SERVICES

The electricity system relies on a complex network of services provided between multiple entities, many of which do not handle physical generation or transportation.

In the diagram below, each arrow relates to a service that one entity provides to another. For example, suppliers pay DNOs charges for network services, and so this is shown as an arrow from DNOs to suppliers. We have also highlighted all services which involve a supplier. This demonstrates the central role of the supplier "hub": Suppliers procure a wide range of services, which are passed on to their customers through a single bill. These services include:

- **Energy supply and balancing.** Trading of electricity between generators and suppliers can take place either via a power exchange or through over-the-counter (OTC) deals. Whilst the majority of wholesale trading is carried out via OTC deals, short term energy trading is carried out via two power exchanges, Nord Pool and EPEX SPOT.[61] Once energy contracts are agreed, a notification agent will submit these contract volumes to Elexon for the purposes of balancing. Typically both parties will agree on a single notification agent to notify on their behalf. At the time of delivery, the ESO will carry out balancing activities to ensure that demand is equal to supply. This balancing capacity is provided by generators, suppliers, and aggregators, and can be facilitated by third party flexibility platforms. Elexon will then carry a series of settlement calculations to work out how much each supplier or generator owes or is owed and sends settlement and reconciliation invoices (BSUoS charges). Transmission and distribution companies then transport this energy from generators to the end customer and charge generator and suppliers for this service (TNUoS and DUoS charges).

- **Billing and metering**. Suppliers are responsible for ensuring that procuring metering services for their customers and will typically outsource this to MAPs and MOPs which will install, maintain, and obtain meter readings (for non-smart meters) on the behalf of suppliers. Customers may also voluntarily provide meter readings to suppliers for more accurate bills. Suppliers will issue a single bill to customers which will include charges such as network charges as the supplier provides cost recovery services to distribution, transmission, and generation companies.

- **Smart metering**. As is the case with traditional meters, suppliers are the responsible organisation for promoting and procuring smart meters for their customers. To do this, they will work with Smart Energy GB to encourage uptake amongst their customer base, and partner with MAPs and MOPs for the actual installation and maintenance of smart meters. Unlike traditional meters, smart meter data is handled by the DCC which (through contracts with other organisations) builds and maintains the single smart meter network and provide this data to suppliers for the purposes of billing. The DCC also provides aggregated data to network companies to support long-term planning. DNOs are required to support this process by ensuring that either themselves, or their procured Registration Data Provider, provides information on individual meter point administration numbers (MPAN).[62]

[61] Elexon. https://www.elexon.co.uk/knowledgebase/where-can-i-find-details-of-wholesale-prices-of-electricity-in-great-britain/

[62] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641201/Annex_C_-_Draft_Legal_Text_to__SEC_Section_E_Removal_of_DCC_Opt_Out_Augu....pdf

- **ECO.** Whilst suppliers are responsible for meeting their ECO targets, they contract out delivery to third party installers who manage the installation process with customers on their behalf – see below.

- **Data transfer.** Electralink provides the Data Transfer Service, the regulated service for data sharing between organisations in the electricity sector.

There are a small number of entities which some (but not all) domestic customers may directly interact with:

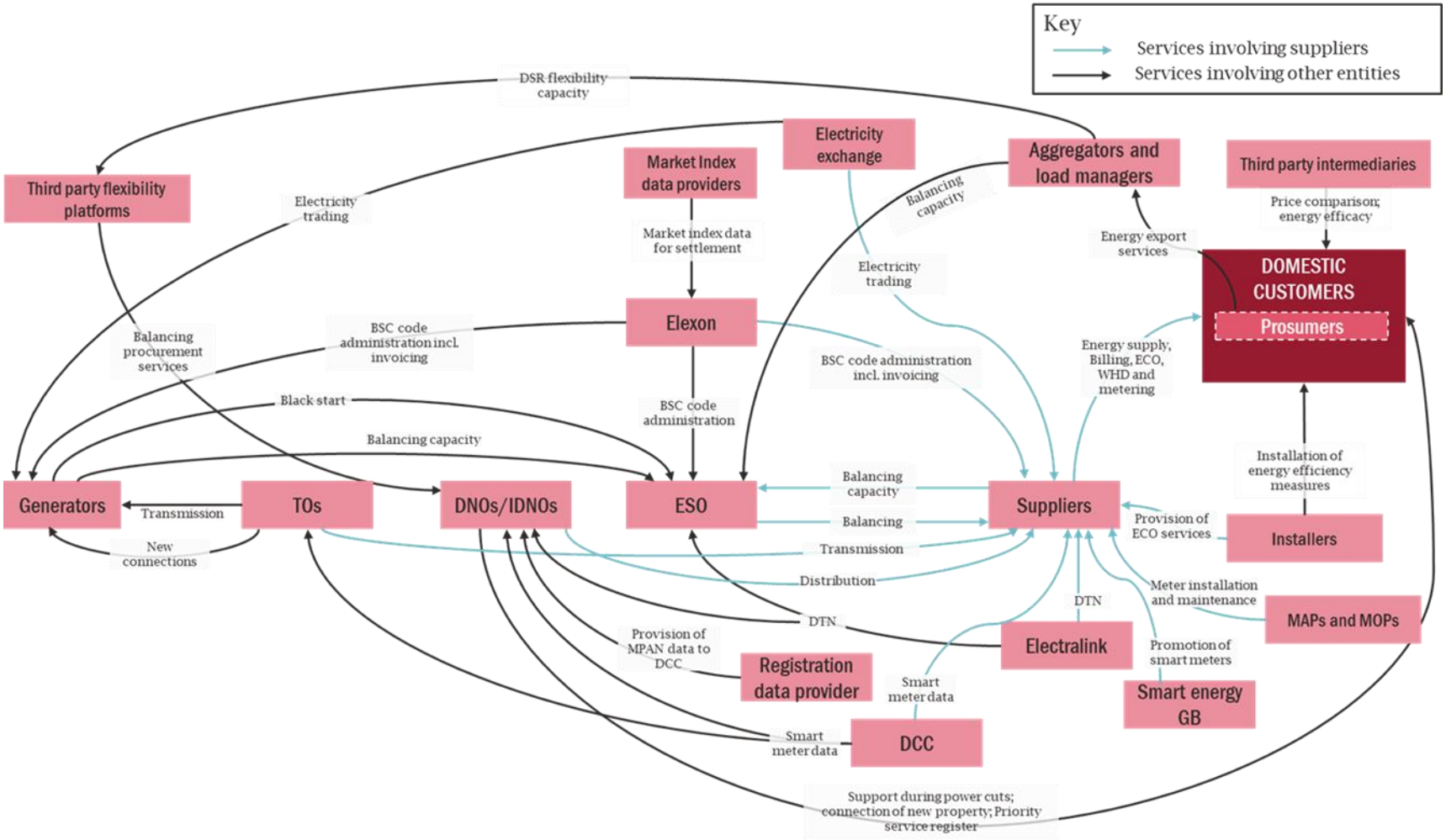
- **DNOs**. In the event of a power cut, it is DNOs rather than suppliers which will provide support to customers. This includes enhanced support for vulnerable customers on the priority services register. DNOs also provide specific services if customers require modifications to the network (for the example, installing or upgrading connections)

- **Installers of energy efficiency measures**. While suppliers facilitate and pay for the installation of energy efficiency measures under ECO, these are ultimately installed by third parties.

- **Third party intermediaries**. Consumers may interact with TPIs such as switching websites, energy brokers, and energy efficiency advice providers.

- **Aggregators**. Prosumers may optionally engage with aggregators to provide flexibility to other entities in the sector.

FIGURE 2 ELECTRICITY: SERVICES



Source: Frontier Economics

4.3.4 GAS: SERVICES

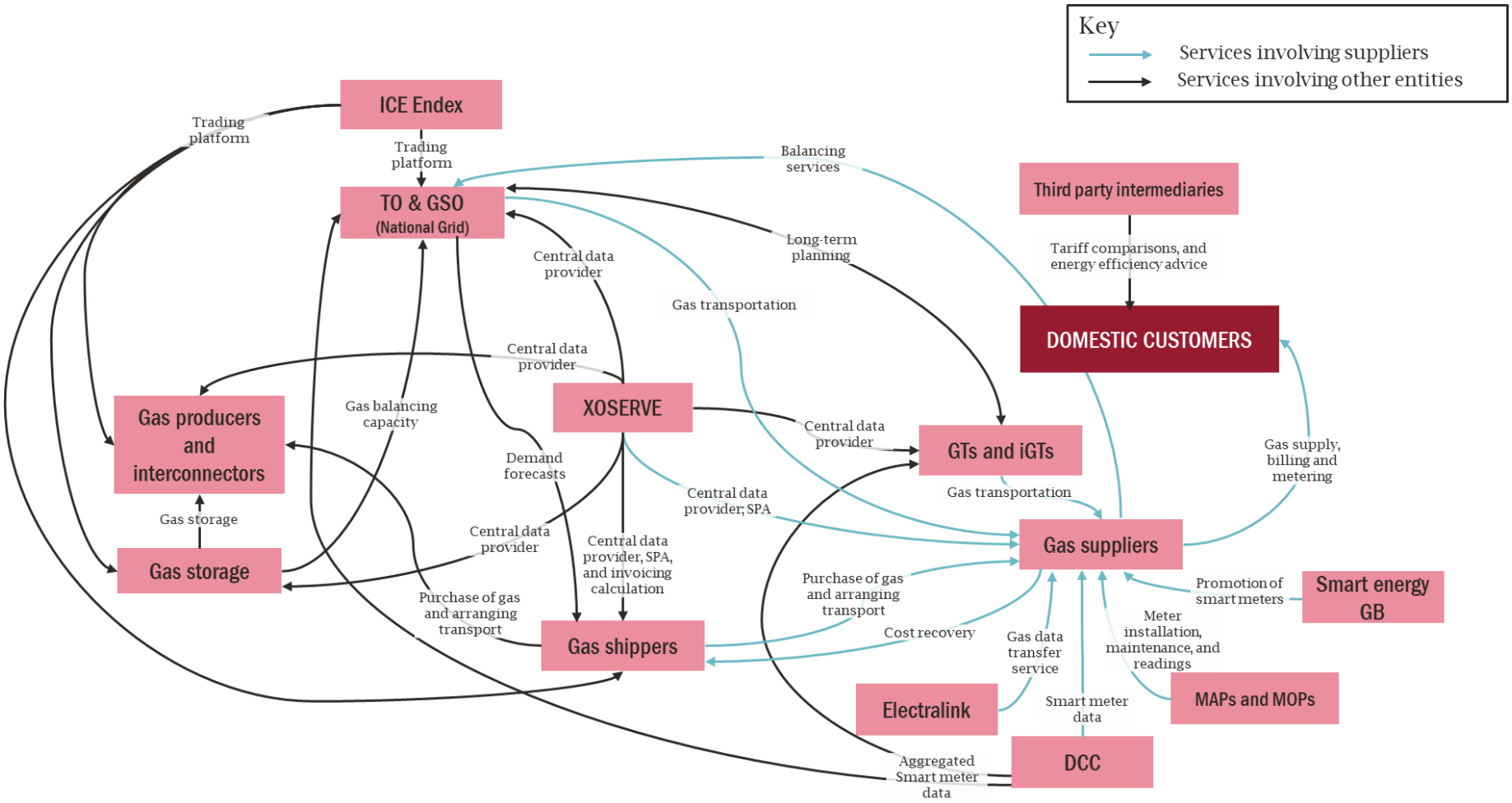
Entities in the gas sector deliver several similar services to those in the electricity sector – with the supplier playing an equally important role. However, there are a number of key differences relating primarily to the role of gas shippers which act as an intermediary between gas producers and suppliers.

- **Physical supply of gas and balancing**. Gas shippers play a central role in the physical supply of gas. They are responsible for purchasing gas required by suppliers from producers and arranging for it to be transported to end customers. They contract directly with suppliers, producers, and transporters, and notify National Grid of flows via gas flow nominations. National Grid, in its capacity as the system operator, will undertake balancing actions either by purchasing/selling energy on the on-the-day commodity market, facilitated by the ICE Endex exchange, or utilise operating margin capacity from storage operators or suppliers with flexibility. This gas is transported via the transmission network and gas transporters to end customers.

- **Billing and metering**. As in electricity, suppliers are responsible for providing metering services to their customers, and typically outsource this to MAPs and MOPs. Customers may also voluntarily provide meter readings to suppliers for more accurate bills. Suppliers will issue a single bill to customers which will include charges such as network charges as the supplier provides cost recovery services.

- **Data transfer**. Xoserve is the central data provider for the GB gas market. In addition, Electralink provides a limited set of switching-related data over its regulated DTS.

FIGURE 12 GAS: SERVICES



Source: Frontier Economics

4.3.5 ELECTRICITY: DATA AND COMMUNICATIONS FLOWS EXCLUDING SMART METER DATA

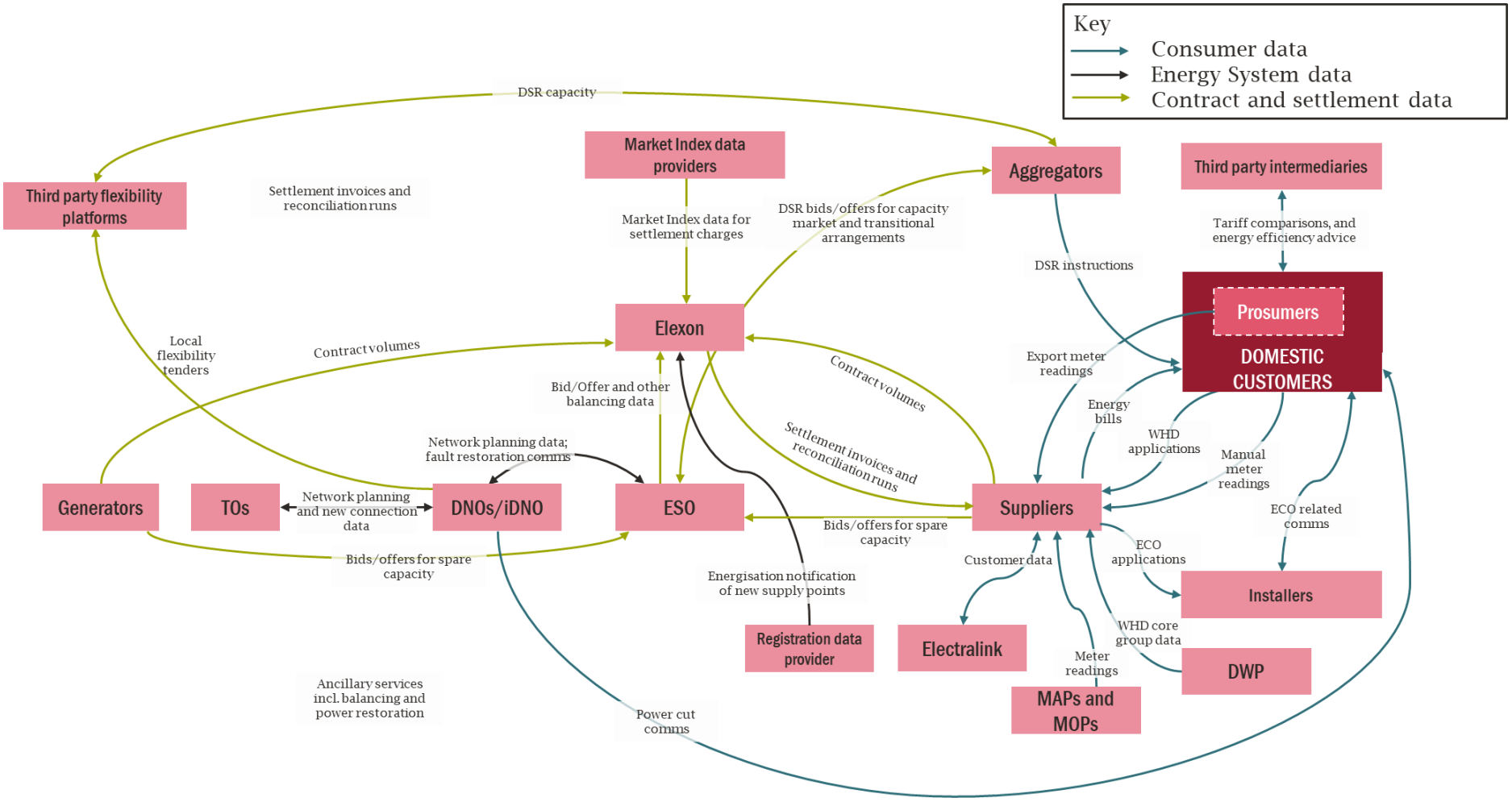
Each of the services set out in section 4.3.3 is underpinned by a network of data and communications. Many of these data flows rely on the Data Transfer Service provided by Electralink which allows electricity and other participants to exchange data securely. These flows can be broadly divided into three types:

- **Consumer data**. Data about consumers, or information sent to consumers. Much of this data will count as "personal" data under data protection legislation. This includes the following (as well as smart meter data, which is covered in the subsequent chart):
  - Notifications from suppliers to consumers (e.g. billing statements);
  - information sent from consumers to their suppliers (e.g. manual meter reads); and
  - data provided from the Department of Work and Pensions to suppliers to identify customers eligible for the core group of the Warm Home Discount. [63]
- **Contract and settlement data**. Data flows supporting the purchase of wholesale energy and flexibility services. This includes:
  - demand and supply notified to Elexon from suppliers and generators respectively; and
  - offers to sell energy and bids to buy energy made by generators through the balancing mechanism.
- **Energy system data**. Other data regarding the energy system and its operation – whether current, historic or forecast.[64] This includes:
  - Network planning data which the ESO and network companies are required to regularly exchange (formalised in the grid code); and
  - instructions sent by the ESO to generators to increase or decrease output as required to balance the system.

[63] BEIS (2021). Warm Home Discount. Better targeted support from 2022.

[64] The Energy Data Taskforce report includes a more detailed definition of energy system data.

FIGURE 13 ELECTRICITY: DATA AND COMMS FLOWS EXCLUDING SMART METERING DATA



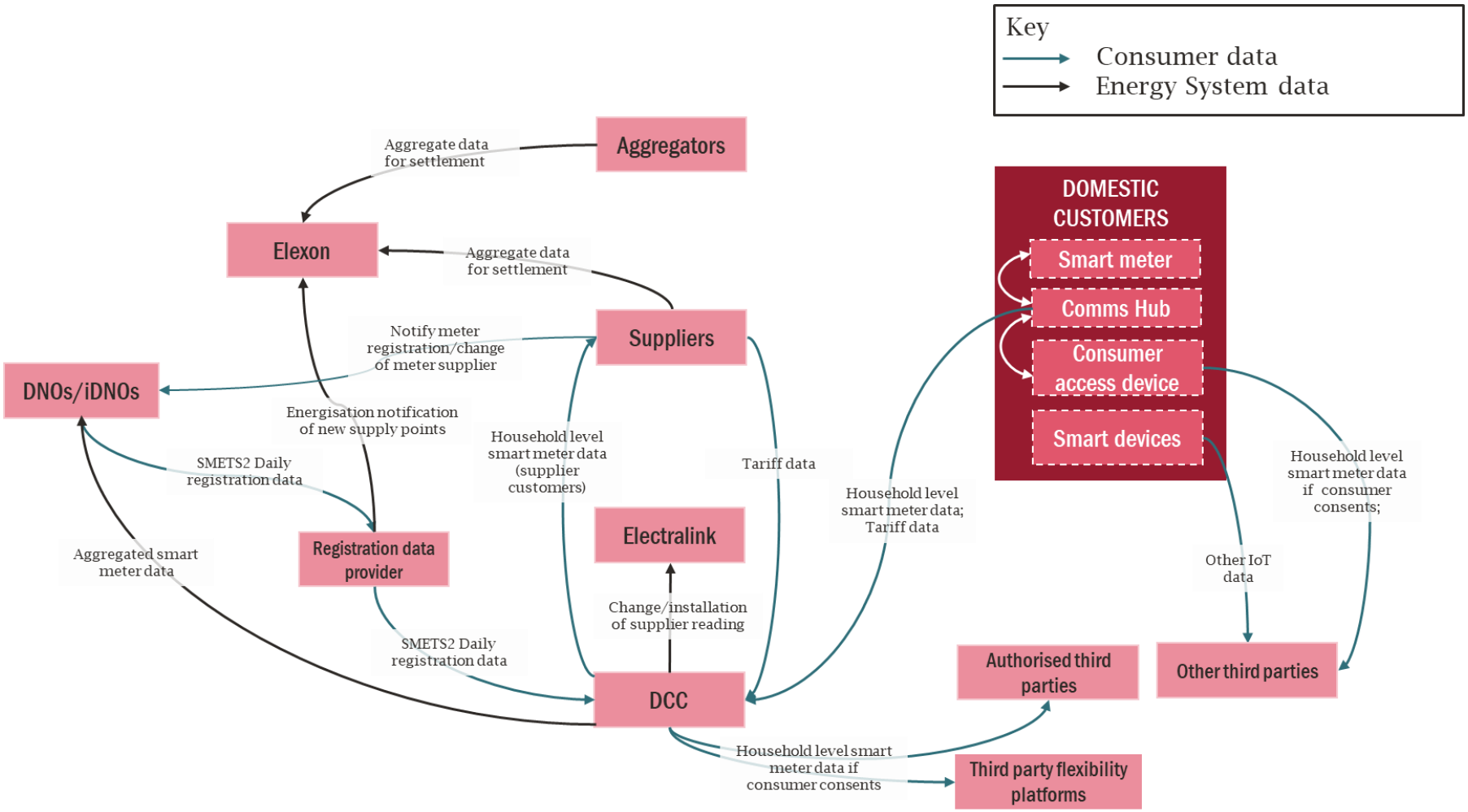
Source: Frontier Economics

4.3.6 ELECTRICITY: SMART METERING DATA

The rollout of smart meters has introduced several new dataflows into the electricity system to support more accurate billing as well as network planning. As with the other data flows described above, these can be divided into:

- **Consumer data**, particularly the flow of individual-level data from the smart meters themselves. There are three ways in which entities in the sector can access consumption data:
  - The smart meters send data, via the comms hub, to the DCC, from which authorised users can access it. By default, only suppliers have access to the fully granular smart meter data for each customer they serve. DNOs have access to smart meter data which is aggregated across customers in a local area and is used for network planning. Other DCC users can access individual data if they secure permission from the consumer.
  - Consumers can connect a "consumer access device" (CAD) to the comms hub, enabling data to be shared with third parties.
  - Finally, consumers may choose to install other smart devices, entirely independently of the smart meter system, which send data to third parties over the internet. For example, smart thermostats such as Nest and Hive are capable of sending information over the internet (so, for example, the user can see and adjust the temperature of their property when away).
- **Energy system data,** which consists primarily of aggregated smart meter data provided by the DCC to organisations that are not suppliers. This includes the aggregated data shared with network companies to support network planning as well as aggregated data provided to Elexon for settlement.

FIGURE 14 ELECTRICITY: SMART METER DATA FLOWS



Source: Frontier Economics

4.3.7 GAS: DATA AND COMMUNICATIONS FLOWS EXCLUDING SMART METER DATA

As is the case for electricity, services delivered within the gas system rely on several flows of information. Many of these dataflows rely on Xoserve which is the central data service provider for the GB gas market.

Key data flows include:

- **Consumer data**. For example manual meter readings provided by consumers to suppliers (as well as the smart meter consumption data described in the following chart). Xoserve is responsible for the central register which logs all premises with a gas supply along with supply addresses, expected and actual energy consumption, supplier identity and gas flow information. This information is used to provide information to suppliers when customers switch and to allocate network usage charges to shippers[65]. It plays a key role in the new Centralised Switching Service (CSS)[66] which intends to streamline switching for customers and includes moving to a supplier-led switching process via the CSS. This switching process is supplemented by the exchange of notification of old supplier information (NOSI), resolution of erroneous transfer (RET) and supplier agreed read (SAR) via Electralink's Data Transfer Network.

- **Contract and settlement data**. For example, Xoserve is responsible for delivering Transportation Billing on behalf of network operators, energy balancing invoicing, and credit & Risk on behalf of National Grid.

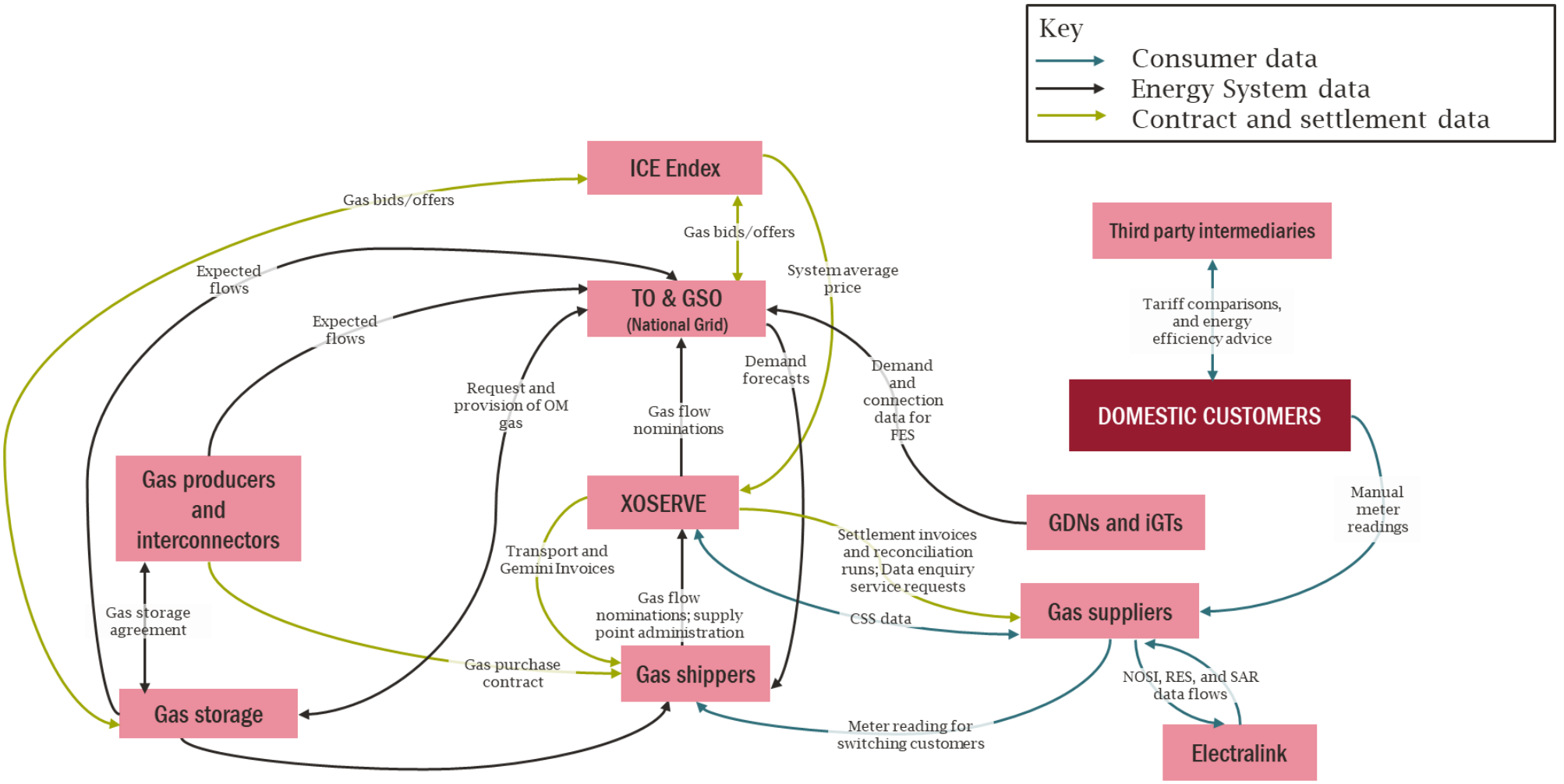
- **Energy system data**. Unlike the electricity market, the gas market relies on the use of gas shippers who act as market intermediaries to buy and sell gas and arrange for its transportation across the gas network. Gas shippers send National Grid supply and demand nomination for the gas they propose to input and offtake from the transmission system for any given day. This is used by National Grid Gas to calculate the "predicted closing linepack" i.e. whether the system is within an acceptable range of balance. If this is not the case, NGG will buy or sell gas on the On-the-day commodity market. Power station operators who can reduce their demand or organisations with gas storage facilities can provide flexibility contracts known as operating margins (OM). The GSO will call on OM gas on rare occasions to balance the system until other market-balancing measures come into effect.[67]

[65] Xoserve. The potential role of UK Link and Xoserve in Faster Switching.

[66] Xoserve. Ofgem switching programme Data Enquiry Service Consequential Change Requirements Overview.

[67] National Grid. End-to-end balancing guide. An overview of the commercial elements of the GB gas balancing activity.

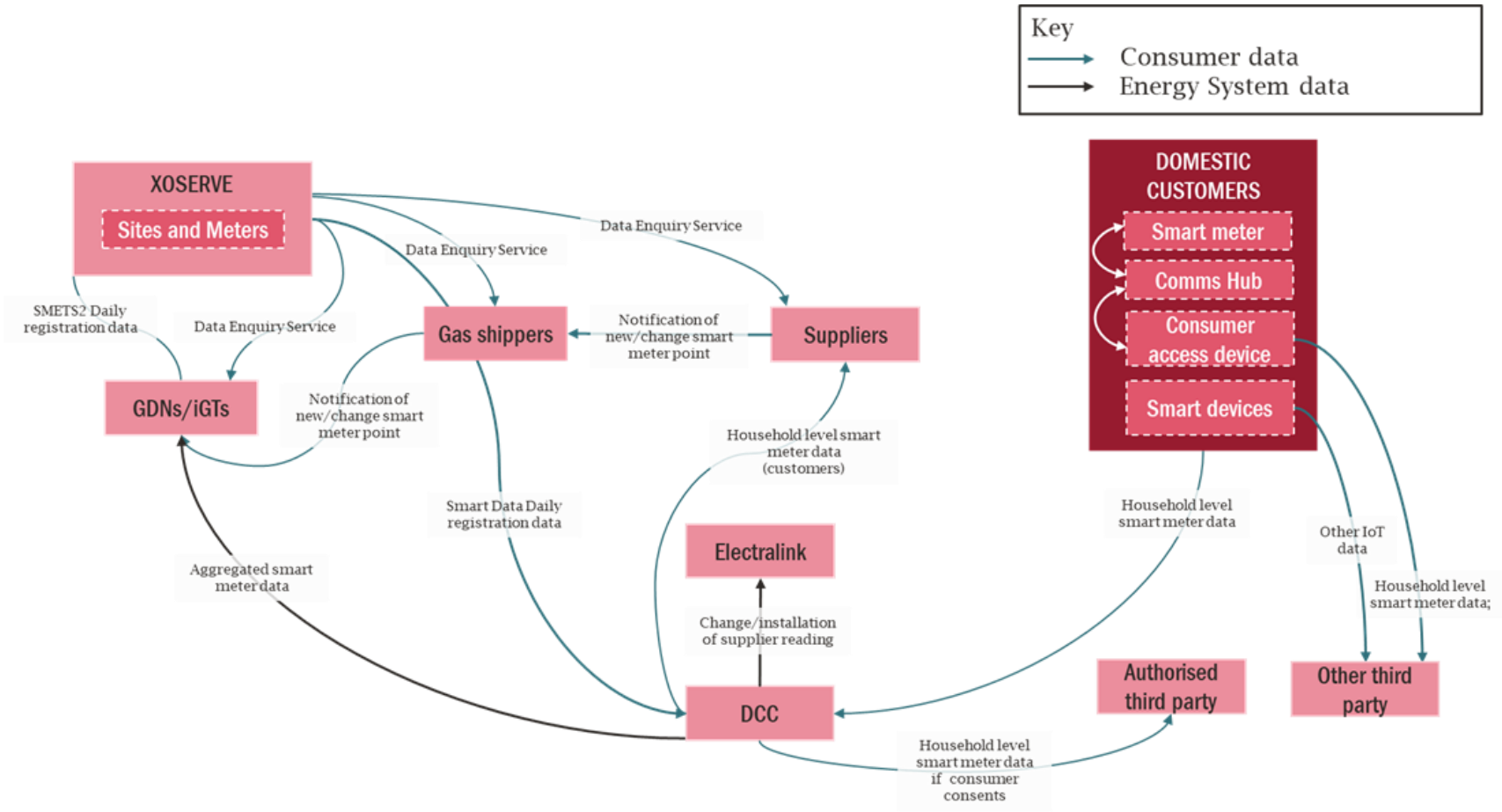
FIGURE 15 GAS: DATA AND COMMS FLOWS EXCLUDING SMART METERS



Source: Frontier Economics

4.3.8 GAS: SMART METER DATA

FIGURE 16 GAS: SMART METERING DATA



Source: Frontier Economics

4.3.9 ELECTRICITY FLEXIBILITY

According to Ofgem, flexibility is defined as "*modifying generation and/or consumption patterns in reaction to an external signal (such as a change in price) to provide a service within the energy system*".[68] Flexibility is required for both the electricity and gas systems, although the need for flexibility is generally considered more crucial in the former due to:

- the nature of the physical flows of electricity (which requires demand and supply and be matched at all times) compared to gas (which is subject to a considerable amount of inherent storage within the pipes – "linepack"); and
- the way in which increasing demands on the electricity networks (higher peaks in demand, and less predictable supply) are increasing the need for flexibility.

Flexibility can be provided by various entities in the system.

- Generators (including centralised pumped storage plants) can turn their output up or down. This was traditionally the main source of flexibility.
- Consumers can reduce or shift their demand. This is known as demand-side response. This might take place via their supplier, or a third-party aggregator.
- Networks can use "smart grid" functionality to reconfigure their systems (e.g. reducing voltage, or calling upon local batteries).

The flexibility provided by these entities is required for a variety of uses.

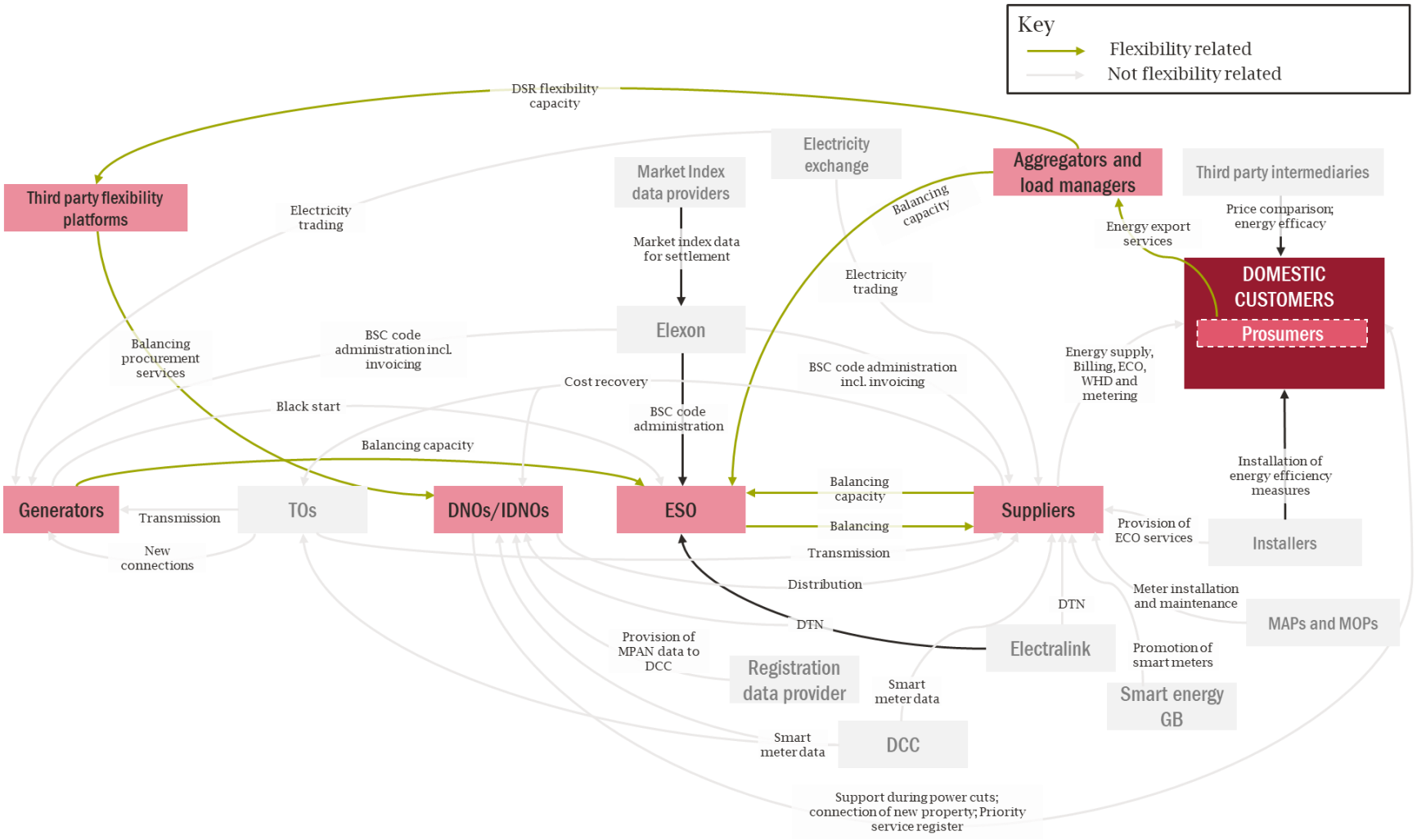
- National balancing of the system, carried out by the ESO, is required to ensure that electricity supply equals demand, and that constraints on the transmission network are not exceeded. This is carried out through a variety of contractual methods, including the balancing mechanism, as well as markets for specific ancillary services (e.g. STOR – Short Term Operating Reserve).
- At the local level, DNOs are currently undergoing a transition to DSOs. As part of this, they will take on flexibility management roles to deliver local flexibility in their area. For example, if the network is constrained in a particular area, rather than carrying out costly reinforcement a DSO might certain contract consumers to reduce their demand during the peak. DNOs are already taking advantage of such arrangements with larger consumers (such as industrial sites) In the future, increasing uptake of electric vehicles, heat pumps and other domestic smart technologies is likely to increase the availability of local flexibility from domestic consumers.
- Suppliers, wishing to purchase energy at the times it is cheapest, provide tariffs encouraging their customers to shift their consumption. At the moment the main example of this is the "Economy 7" tariff, typically used by customers with electric storage heating, and providing cheaper electricity overnight. However, the implementation of mandatory half-hourly settlement (where suppliers will have to pay for all their consumers' energy based on when in the day it was used) will likely lead to

[68] Energy UK (2018), *Defining Flexibility*

more widespread and sophisticated time-of-use tariffs. For example, Octopus Energy's "Agile Octopus" tariff exposes customers to wholesale market rates.

The chart below highlights the services in the electricity sector which specifically relate to the provision of flexibility.

FIGURE 17 ELECTRICITY: FLEXIBILITY RELATED SERVICES



Source: Frontier Economics

ANNEX A - GLOSSARY

Aggregators	Aggregators operate on behalf of groups of consumers in order to aggregate their actions and provide flexibility to the electricity system, such as adjusting demand or exporting generated electricity.
Ancillary services	Refers to services required to keep the electricity grid operating at the correct frequency and voltage, to respond to unexpected changes in supply or demand, and to allow the system to recover in exceptional circumstances. These include Frequency Response, Reserve markets, Reactive Power, Black Start, and Demand Turn-Up.
Balancing	The process of ensuring energy supply meets demand at all times for both electricity and gas.
Balancing Services Use of System (BSUoS)	BSUoS charges refer to the money charged by the ESO to suppliers for the costs of balancing the energy system.
Capacity Market	The capacity market is designed to ensure security of supply by incentivising generators by providing a payment for reliable sources of energy generation capacity, which is on top of their electricity revenues. Generators auction their capacity for future time periods.
Capital Costs	Refers to the cost a business faces in raising money, either through debt, or through issuing shares. This may vary depending on the risk associated with lending to the business in question.
Contracts for Difference (CfD)	CfDs are a financial contract that guarantees a set price for electricity, referred to as the strike price. Generators are either paid a subsidy or pay back the difference between the strike price and the wholesale price.
Data Communications Company	A regulated monopoly company which manages smart meter data and is responsible for linking smart meters in homes and small businesses with energy suppliers, network operators and energy service companies.
Day ahead market	Financial market for energy to be delivered the next day.

Default Tariff Cap	A maximum price level which suppliers are allowed to charge customers on certain tariffs, set by Ofgem. There are two separate price caps for customers who are on a) prepayment meters or b) credit meters. These price caps are intended to reflect the costs suppliers face in order to serve these customers their energy, including the cost suppliers face when purchasing the energy on the wholesale market, as well as payments to networks and other costs (such as ECO and Warm Home Discount). Customers who do not choose a new tariff after their previous fixed term tariff comes to an end are moved onto a tariff covered by the Default Tariff Cap.
Demand-side response	Refers to actions taken by energy consumers to shift their demand in order to keep the grid balanced (for example reducing consumption during high demand). Traditionally these responses were provided by non-domestic customers, but domestic customers are now starting to provide these services via aggregators.
Distribution Use of System (DUoS)	Refers to the regulated charges that the DNOs and GDNs make to energy companies which fund the maintenance and operation of the transmission system.
Electralink	A wholly-owned subsidiary of the DNOs which is responsible for a data transfer service which handles data relating to energy consumption, change of supplier activity, meter installation and maintenance, and Green Deal projects on a single secure network.
Electricity Market Reform (EMR)	Part of the Energy Act 2013, Electricity Market Reform was introduced to incentivise investment in secure, low carbon electricity. Its principal components were the Capacity Market (to ensure security of supply) and Contracts for Difference (to provide revenue stabilisation for low carbon electricity generation).
Electricity System Operator (ESO)	The body responsible for ensuring that the electricity system demand is met in real time. Also responsible for delivering the government's contracts for difference scheme, publishing information to support network planning, facilitating competition in all energy markets (such as balancing, ancillary services, and wholesale and capacity markets) and developing the Future Energy Scenarios (FES).
Elexon	A not-for-profit organisation that is wholly owned by National Grid ESO. It ensure that relevant parties are billed or paid correctly for balancing activity via BSUoS, as well as acting as a settling agent for contracts for difference and capacity market payments, via its subsidiary EMR Settlement Ltd.

Energy Company Obligation (ECO)	An Ofgem administered obligation in which large energy suppliers (those with more than 150,000 customer accounts) must provide energy efficiency measures, such as more efficient heating or insulation, to households. This may be outsourced to third-party installers but suppliers must hit a given target (determined by their market share in the energy retail market) of reducing the estimated lifetime bills of these households.
Fixed Tariff	Refers to a tariff agreed between energy retail suppliers and consumers, for a fixed period of time (typically one year), at a pre-agreed unit rate. This is an alternative to standard variable tariffs.
Forward market	An over-the-counter financial market for contracts for future energy delivery.
Forward prices	Refers to the prices of energy traded on the forward market.
Gas shippers	Gas shippers serve as an intermediary between gas producers and retailers, arranging and paying for transportation services from network businesses.
Gas System Operator (GSO)	The body responsible for ensuring that the gas system demand is met in real time.
Independent gas transporters	Smaller, independent gas distribution companies which operate and maintain local pipelines for new housing and commercial developments.
Interconnector	And electricity Interconnector is a high-voltage cable which runs under the sea and connects the GB energy system to neighbouring countries. This allows countries to trade their electricity.
Intraday market	Financial market for energy to be delivered within the same day.
Liquefied Natural Gas	Refers to Natural Gas which has been converted into a liquid form, for the purposes of transportation. This is an alternative to transporting gas by pipeline.
Mutualisation of costs	Instances where a cost associated with one particular supplier (e.g. a supplier which has gone bankrupt) is borne by all suppliers in the industry. This cost is ultimately passed on to customers.
Offshore transmission owner (OFT)	Owners of the transmission network for offshore wind developments.

Pre-Payment meter	Refers to a metering arrangement in which the customer pays for their energy prior to consuming it.
Residential prosumers	Refers to households who both consume and produce energy. Prosumers produce energy for their own consumption, primarily through solar photovoltaic panels on rooftops and may also store this energy or sell excess energy back to the grid or other consumers.
Smart Energy GB	A not-for-profit organisation funded by energy suppliers which was established by the government to encourage the uptake of smart meters.
Smart Export Guarantee (SEG)	Requires larger energy suppliers to pay a small scale generators of low carbon electricity for exporting it back to the grid.
Special Administrative Regime	An alternative to the Supplier of Last Resort process. Ofgem assigns an administrator to take over the failed supplier and ensure continued service of its customers' essential services until a buyer is found or the customers are assigned to a new supplier. The government will give the administrator financial backing, which it will ultimately claw back in energy tariffs. So far, this has only occurred once in response to the bankruptcy of Bulb Energy.
Standard variable tariff (SVT)	Refers to a tariff sold to energy customers which does not have a fixed end date, and whose price may vary based on market indicators. The price is not fixed for any given period, but is subject to the Default Tariff Cap.
Supplier hedging	Refers to actions taken by energy retail suppliers to reduce their risk exposure, typically by buying energy in advance. Suppliers contract with their customers either with fixed tariffs (whose unit rate is set in advance), or with standard variable tariffs, which are set in advance by the default tariff cap methodology. However, they do not know the future prices for electricity at the time of delivery and hence face price risks in the absence of hedging actions.
Supplier of Last Resort	The Supplier of Last Resort process assigns the customers of a failed supplier to a new (solvent) energy supplier. This is done on the basis of an auction in which suppliers bid for these customers and Ofgem assigns them to the best bidder. Customers are free to subsequently change energy supplier.
Transmission Network Use of System (TNUoS)	Refers to the regulated charges that the Transmission Operators make to generators and suppliers which fund the maintenance and operation of the transmission system.

Warm Home Discount	A discount (currently £140) applied to both fuel poor pensioners and other fuel poor customers. Energy suppliers with more than 150,000 customers are required to fulfil this obligation through rebates to these customer groups, although they can also fulfil some of it through other industry initiatives (such as advice on energy savings and help with reducing energy debts).
Xoserve	A non-profit business, regulated by Ofgem, whose responsibilities include managing customer switching, billing transportation charges, and managing and updating the supply point register. Manages all the information relating to the 22m gas supply points in Great Britain. It also manages the IT system which supports the Uniform Network Code (UNC) which lays out common gas transportation arrangements.