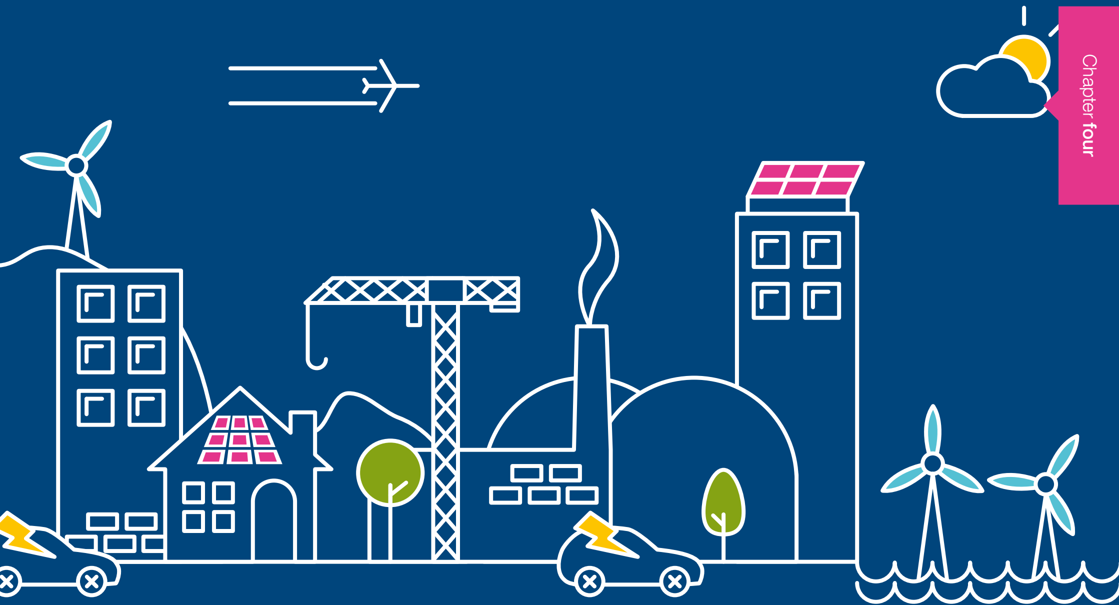
nationalgrid

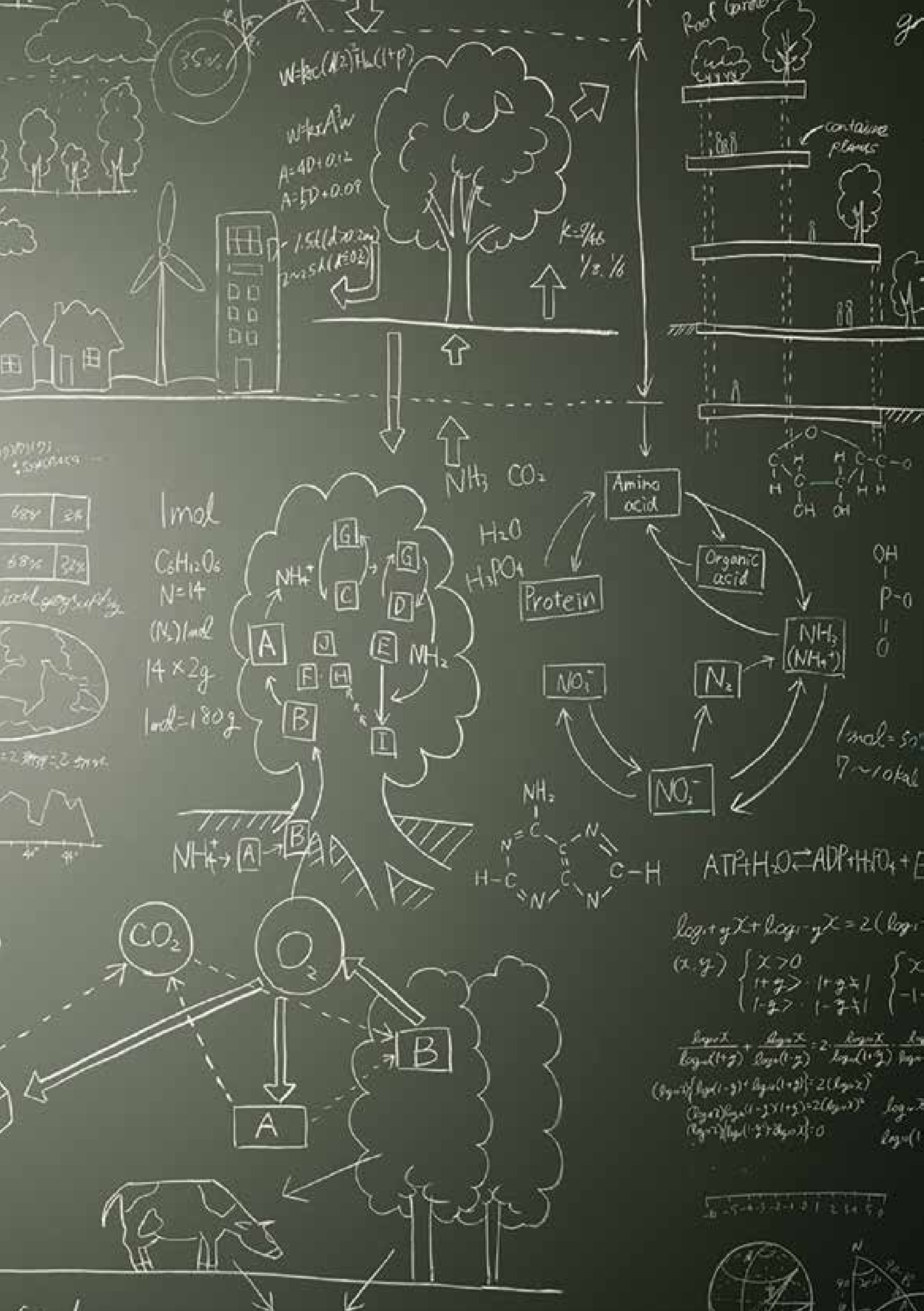
Future Energy Scenarios

UK gas and electricity transmission



Chapter **four**

JULY 2015



Amino acid
Organic acid
Protein
1mol
N=14
14×2g
1mol=180g

How to use this document

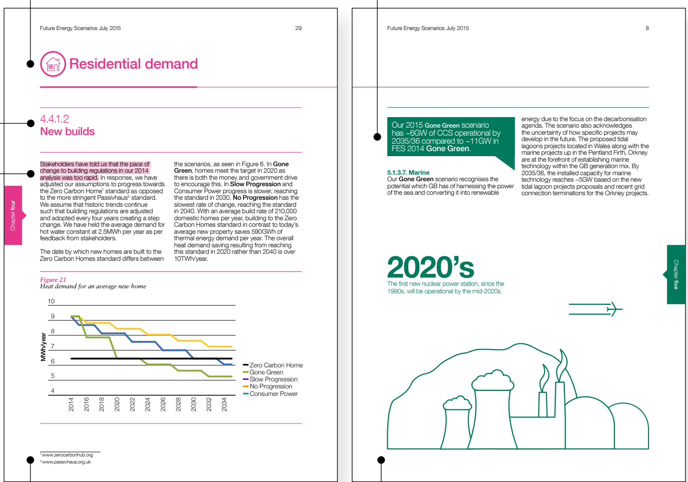
This document has been designed to present information in easily digestible sections, with the subject matter clearly defined in colour-coded chapters.

Heading and icon introduce the main topic on the page.

Key pieces of information are highlighted in boxes.

The main text is divided into sections by subheadings.

We have highlighted specific areas where we have responded to stakeholder feedback.



Footnotes are used for citations and further commentary.

Key data is emphasised with an image.

Chapters are tabbed and colour coded to help you find the section you are looking for.

Chapter four

Energy demand

Power demand

Gas demand

Residential demand

Industrial and commercial demand

Transport

Energy demand

4.1
Energy demand

In Gone Green and Slow Progression scenarios we see a reduction in overall energy demand despite the growth in population. This reduction is a result of society having 'greener' ambitions and changing its energy consumption behaviour. Gone Green, where the economy is more robust, sees a far greater likelihood of making the changes needed to achieve the government's carbon reduction targets. Consequently its overall energy demand is the lowest. It is the only scenario where these targets are met.

No Progression and Consumer Power, both lacking this green ambition, see an increase in overall energy demand, mainly as a result of there being more people and more homes requiring more energy.

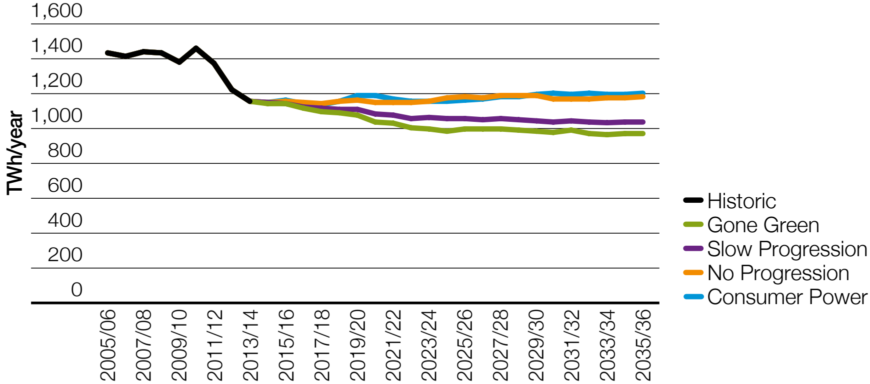
Key statistics

- Total annual energy demand across our scenarios is between 975 and 1,210 TWh/year by 2035, from a demand of 1,150 TWh/year today.
- Energy savings are achieved through the electrification of heat and continued improvements in energy efficiency in **Gone Green** – this leads to 40% of GB's energy use from power, up from 30% today.
- **Consumer Power** energy demand grows as a result of increased use of CHP shifting some of the power generation capabilities to the consumer site, increasing on-site gas demand by 30 TWh/year by 2035.

975 TWh

Total annual energy demand across our scenarios is between 975 and 1,210 TWh/year by 2035, from a demand of 1,150 TWh/year today

Figure 9
Energy: annual demand



We define energy demand, in this document, as the combination of gas and power demand across the residential, commercial, industrial, power generation and transport sectors. We do not consider energy from the conventional transport sectors, e.g. petrol or diesel vehicles, as petroleum products are not within the remit of National Grid.

A more detailed breakdown of the causes and effects for the residential, commercial, industrial and transport energy demands will be given later in this chapter, each in their subsections. The two key assumptions common to all our scenarios that influence overall energy demand are population and housing numbers. We use the economic and demographic forecasts by Experian Business Strategies to form the basis of our population growth and housing developments. We assume that the population of Great Britain reaches 71 million and that the number of homes grows to 32 million by 2035 in all of our scenarios. These compare with the population of 63 million and 27 million homes today.

With the same population and home projections, the different energy demands between our scenarios are mainly influenced by:

- economic growth and the implications on commercial and industrial demand
- demand from more appliances
- differing regulations that drive the rates of energy efficiency gains
- adoption of new technologies that displace existing appliances, such as the electrification of heat and transport
- adoption of on-site generation that influences demand for primary fuels such as gas micro-CHP.

Energy demand

4.1.1
Annual energy demand

The residential sector accounts for approximately 40% of today's energy demand. Future residential demand will fall in each scenario due to the electrification of heating with heat pumps and the continued efficiency gains in electrical appliances and lighting. Gas demand will be further reduced from improvements in insulation measures. The fall is most pronounced in **Gone Green** as this has the greatest take up of electric heating.

The industrial and commercial sectors account for approximately 50% of today's energy demand. Future demand will fall in three of the scenarios due to continued industrial decline and broadly flat commercial demand. The exception is **Consumer Power** where a switch in the commercial sector to on-site generation, predominantly micro-CHP, increases the demand for gas.

Across the transport sector demand increases in each of the scenarios, as the number of electric and gas vehicles increases. There is also a continuation of the electrification of rail transport.

The remaining 10% of energy is gas used for power generation – this is examined in more detail in Chapter 5, Power Supply.

This chapter differs in structure from the others within FES as the gas and power demands have been integrated. This approach has been adopted to enable you to better appreciate how the different sectors contribute to the whole energy requirement and how power and gas interact with each other at the sector level. As you progress through the chapter the detail will become granular. The first part takes a holistic view of energy demand, and is followed by separate overviews of the gas and power demands. Finally, the four sectors of residential, industrial, commercial and transport are addressed in detail as combined gas and power demands.

Power demand

4.2
Power demand

In each scenario total annual demand initially falls before rising to a higher level than today. When these variations occur, and to what extent, are dependent on the various factors affecting each scenario. The more prosperous economy in Gone Green and Consumer Power will lead to a noticeable increase in demand by 2035. Conversely, a weaker economy will produce only marginal increases in demand by 2035.

In general for all scenarios, residential demand rises, industrial demand reduces and commercial demand remains relatively flat.

Key statistics

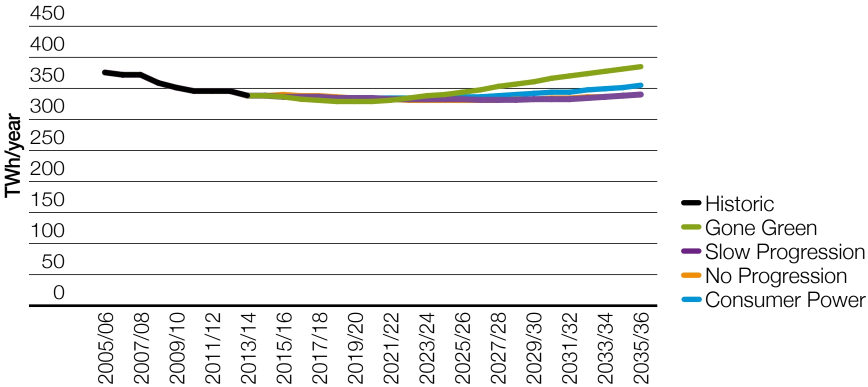
- The current annual power demand is 339 TWh/year
- By 2035/36 annual power demand ranges between 385 TWh/year in **Gone Green** and 340 TWh/year in **Slow Progression**
- The current peak demand is 60 GW
- By 2035/36 peak demand ranges between 70 GW in **Gone Green** and 61 GW in **Slow Progression**.

339 TWh

The current annual power demand is 339 TWh/year

Power demand

Figure 10
Power: annual demand (including losses)



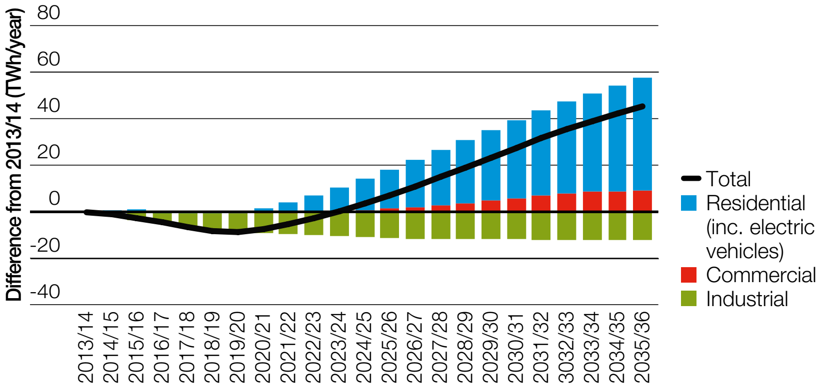
4.2.1 Results – Gone Green

Our **Gone Green** scenario (see Figure 11) experiences the greatest change in annual demand by comparison with today. Demand drops 9TWh/year by 2019/20 and then rises by 45TWh/year, to a total of 385TWh/year by 2035/36.

The initial dip is caused by a reducing industrial demand, which will continue to decline throughout the period, and is only partially offset by growth in the commercial sector. The residential sector remains flat due to a drop in demand for lighting, resulting from the adoption of LEDs, which is countered by a demand increase from the general growth in the number of households.

However, post 2020 we will see the start of the mass adoption of low carbon heating technologies and electric vehicles in the residential sector. The take up of these technologies causes demand to grow through 2035/36 and beyond. This is driven predominantly by incentives, offered as a result of a strong green ambition and an increase in prosperity.

Figure 11
Power: selected Gone Green power demand comparison to 2013/14 by type (excluding losses)



We believe that for environmental targets to be met beyond 2020, both transport and heating will have to be further incentivised away from conventional sources towards high efficiency electrified heat and transport which will run on electricity that has been largely decarbonised. This move to the electrification of heat will also depress the residential gas demand.

Power demand

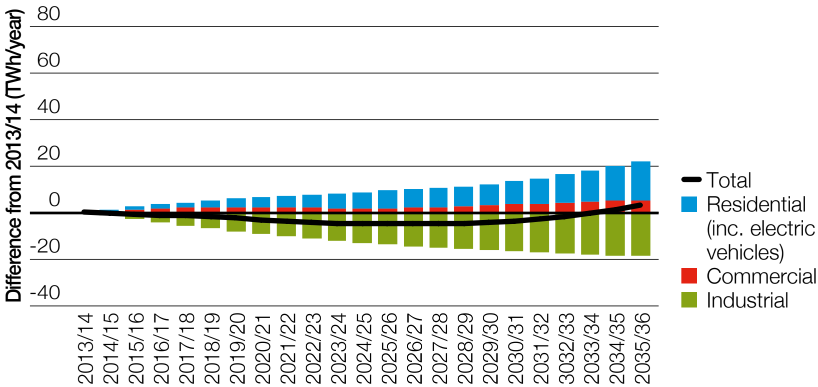
4.2.2
Results – Slow Progression

In **Slow Progression** (see Figure 12), without a prosperous backdrop there will be less demand growth. There will be limited money available to enable encouragement of green activities. Therefore, the uptake of electric vehicles and other low carbon technologies will be muted.

Residential demand will continue to grow as the number of households increases year on year.

Commercial demand will experience a slow growth over the period and only result in marginal additional requirements. This growth will be offset by a decline in industrial demand. The total annual demand will be below today's value until 2035/36.

Figure 12
Power: selected Slow Progression power demand comparison to 2013/14 by type (excluding losses)



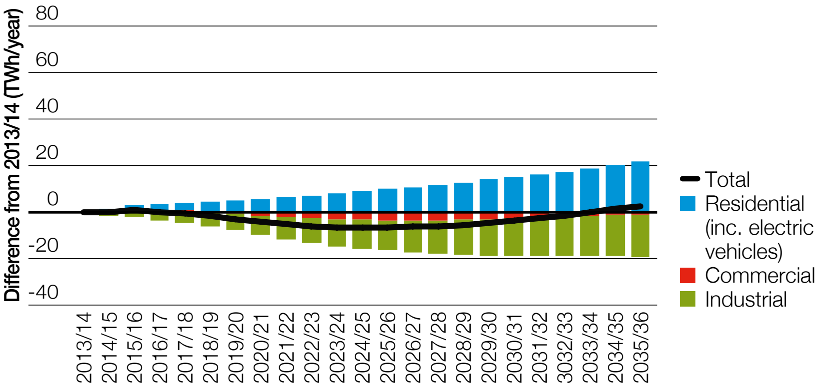
4.2.3
Results – No Progression

In **No Progression** (see Figure 13), with low prosperity and low green ambition, there is limited money or desire to spend money on energy efficient goods. As with all the other scenarios the increased demand from the residential sector is driven mainly by the increase in the housing stock, which rises continuously throughout the scenario.

With a lower green ambition and weaker economic growth there will be limited resources available to incentivise green activity via subsidies or other financial rewards. Therefore growth in electric vehicles and low carbon technologies will be less pronounced than in the more green scenarios. Electric vehicles will be relatively expensive and any take up of heat pumps will be minimal.

In a low prosperity world, commercial and industrial power demands will decline. The low level of green ambition will mean that commercial parties are likely to prefer gas, over power, for their heating requirements, as this will be relatively cheap. Industry's power demand will decline throughout the period.

Figure 13
Power: selected No Progression power demand comparison to 2013/14 by type (excluding losses)



Power demand

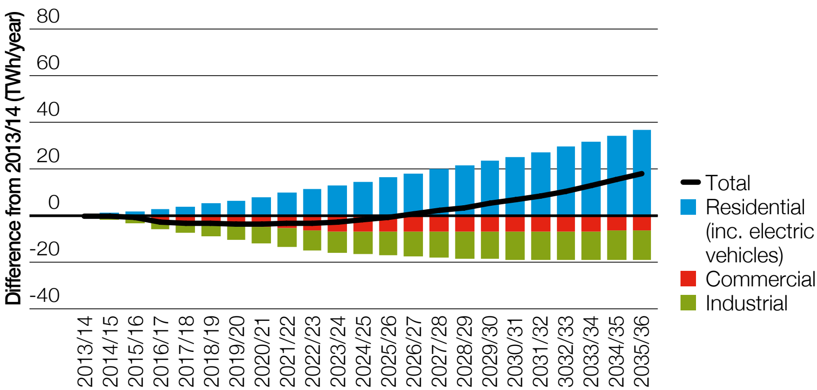
4.2.4
Results – Consumer Power

In **Consumer Power** (see Figure 14), there is a more prosperous society but less green ambition. This results in moderately strong growth in demand from the residential sector, caused by the increase in the housing stock and an increased uptake of desirable goods such as larger appliances and electric vehicles.

In the commercial sector, there will be more focus on gas heating rather than electricity, primarily due to the relative costs of gas and electricity.

The industrial sector's demand will decline throughout the period.

Figure 14
Power: selected Consumer Power power demand comparison to 2013/14 by type (excluding losses)

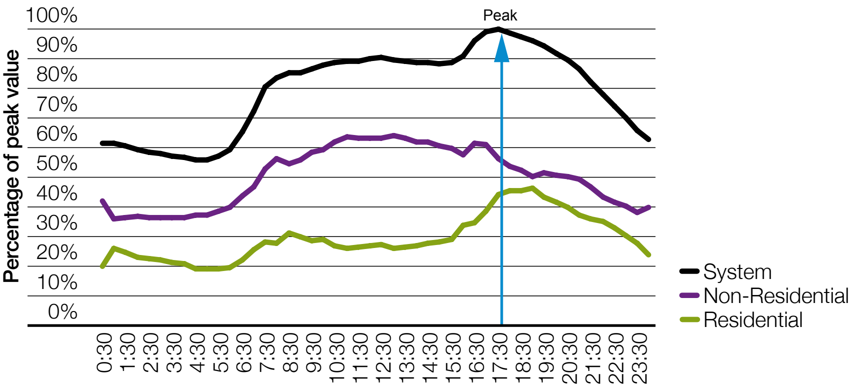


4.2.5
Peaks

Peak demand typically occurs at around 17:30hrs on a weekday between December and February. It comprises a declining industrial and commercial demand profile, when businesses are closing, and a rising residential demand profile, when people are returning home (see Figure 15). As this occurs in winter the dark conditions mean lighting demand is high and the less clement weather leads to a higher heating demand.

Both industrial and commercial demand side response (DSR), as well as residential time of use tariffs (TOUTs) will have a reducing effect on peak demand to a greater or lesser extent depending on the scenario. An explanation of DSR is given in the Industrial Demand section 4.5.4 and an explanation of TOUTs is given in the Residential Demand, Peaks section 4.4.5.

Figure 15
Power: typical peak hour demand



Power demand

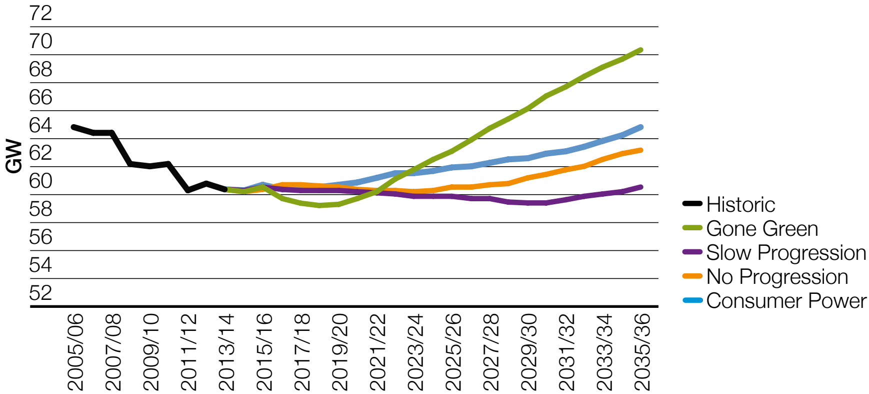
The peak demand profiles are closely related to the annual demand curves. The peak is a half hour snap shot of part of the annual demand, therefore they are quite similar in appearance.

The peak profiles (see Figure 16) that are least like their annual demand profiles are **Slow Progression** and **No Progression**. Their annual demands are very similar to each other but their peak profiles are not. The causes for this separation are the existence in **Slow Progression**, and less so in **No Progression**, of mechanisms which encourage responsiveness and limits demand during the peak period. These mechanisms are primarily residential TOUTs, and industrial and commercial DSR.

Gone Green also has these limiting mechanisms, but they are offset by the incentive-driven growth in heat pumps, which are likely to be used during peak time.

Consumer Power has these mechanisms to reduce its peak demand; however demand rises from more appliances which will exist in a more prosperous economy.

Figure 16
Power: average cold spell peak demand (including losses)



Chapter four

Method

We have chosen the following definition of demand as it provides a clear distinction between supply and demand. We do not consider any reduction of demand by any form of generation. Annual power demand used in this document is:

"The weather corrected demand[1] from residential, commercial and industrial consumers and transmission and distribution losses: power generation from distributed generation and micro-generation has not been deducted."

It does not include exports, or imports, to or from Ireland and the continent (please refer to section 5.2), station demand[2] or pump demand[3]. This definition has been chosen because FES is attempting to assess the underlying GB demand requirement.

Micro-generation and distributed generation are considered as supply, and do not reduce the demands thus differentiating between supply and demand. Station demand and pumped storage demand are not included but are taken away from the gross generation output; thus aligning with national demand.

We take National Grid's fiscal year weather corrected transmission demands and derive the underlying demand by adding our estimates of distributed and micro-generation output. We then calculate residential, industrial and commercial demand using other sources including Elexon and DECC's Energy Consumption in the UK and Digest of UK Energy Statistics.

In FES 2015 when we illustrate residential, industrial and commercial components we have not assigned the distribution or transmission losses. These are network losses and it is not appropriate to include them at the sector level. The network loses have been included in the total annual and peak demands. These losses, we estimate, to average around 6% for distribution and 2% for transmission, totalling 7% of annual demand.

Peak demand is the maximum demand on the system in any given financial year. Having created annual demands, we then calculate and calibrate the average cold spell (ACS[4]) peak demands. Peak demand is then aligned to National Grid's ACS history and operational ACS forecasts for winter 2014/15 and winter 2015/16.

In order to make longer term ACS peak projections from annual demand we apply a recent historical relationship of annual to peak demand. This creates an initial peak demand, to which we add components that we feel history cannot predict, such as electric vehicles, heat pumps, TOUTS and DSR.

[1] This is the actual demand figure that has been adjusted to take account of the difference between the actual weather and the seasonal normal weather.

[2] Station demand is the onsite power station requirement, for example for systems or start up.

[3] Pumping demand is the power required to fill hydro reservoirs.

[4] ACS is defined as a particular combination of weather elements which gives rise to a level of peak demand within a financial year which has a 50% chance of being exceeded as a result of weather variation alone.

Gas demand

4.3
Gas demand

Historical gas demand decline in GB is set to continue in Slow Progression and Gone Green, which see further efficiency improvements and an uptake of alternative heating appliances. Consumer Power and No Progression see increased demand from a lower energy efficiency drive, combined with growth in the power station and distributed gas CHP sectors.

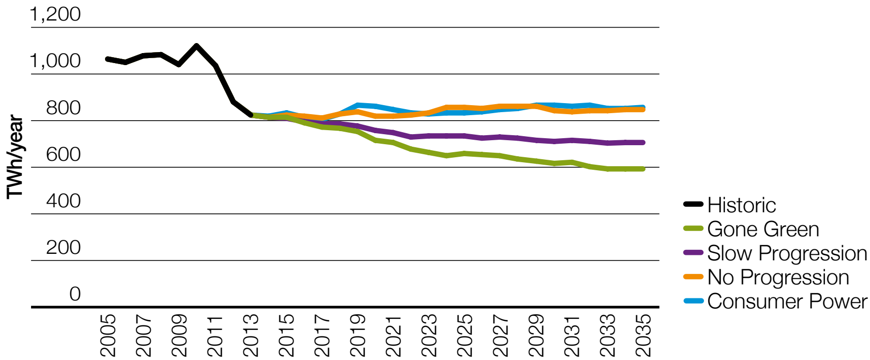
Key statistics

- Demand in **Gone Green** falls by 250TWh/year below today's demand by 2035
- In **Consumer Power**, gas demand increases by 40TWh/year in 2030 compared to 2013, largely from industrial and commercial growth

250 TWh

Demand in **Gone Green** falls by 250TWh/year below today's demand by 2035

Figure 17
Gas: total annual demand



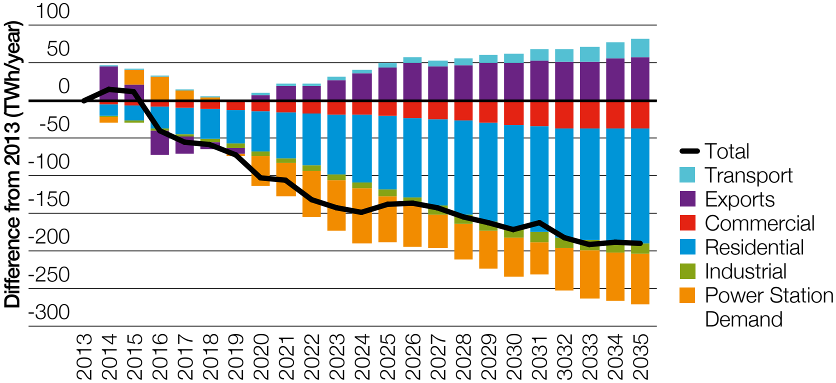
4.3.1
Results – Gone Green

Gas demand in **Gone Green** reduces sharply, led by residential demand. This is due to a high roll out of insulation, the replacement of old boilers with new, A-rated efficient ones, the introduction of smart controls, progressive building regulations for new homes and the displacement of gas through electrification of heating.

Similarly, commercial properties are encouraged to install heat pumps to benefit from low carbon heating sources. The switch to alternative heating significantly reduces the demand for gas across residential and commercial buildings. We have assumed that the Renewable Heat Incentive (RHI) or an alternative mechanism remains in place driving the uptake in low carbon heating, providing economic backing to an otherwise uneconomical choice. Renewable generation displaces gas power over time, which reduces demand from combined cycle gas turbines (CCGT).

Gas demand

Figure 18
Gas: Selected[1] Gone Green demand comparison to 2013 by type



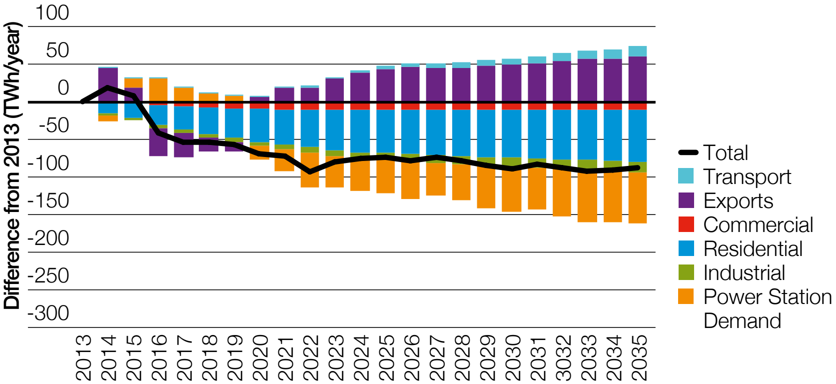
4.3.2 Results – Slow Progression

Slow Progression has similar trends to **Gone Green** with less favourable economic conditions. The support for heat pumps isn't on the same scale as **Gone Green** and capital cost reductions do not materialise. Gas demand remains high in the residential sector with a lower uptake of alternative heating appliances, but demand still declines as a result of improved thermal efficiencies and new boilers.

Developments in renewable power generation lead to lower CCGT generation demands over time. However the timescales are later than in **Gone Green**.

[1] Selected key demand sectors e.g. not including shrinkage

Figure 19
Gas: Selected Slow Progression demand comparison to 2013 by type



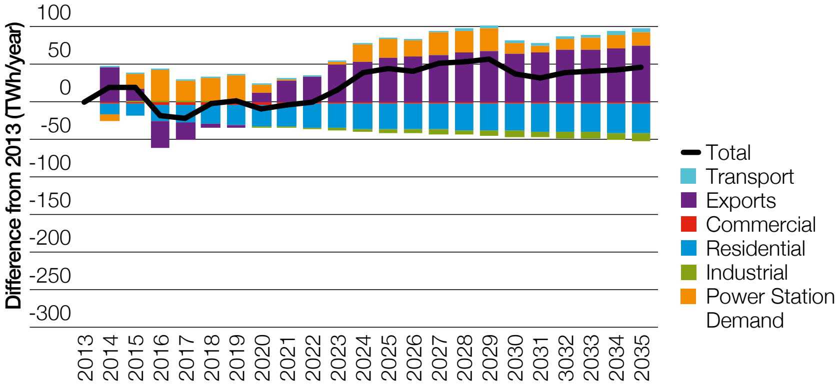
4.3.3
Results – No Progression

The **No Progression** world favours gas as an energy solution requiring additional gas for power generation. Residential demand falls mainly from the uptake of A-rated gas boilers, but the fall is less pronounced than in **Gone Green** or **Slow Progression**. This is because less insulation is installed and the ambition for a green economy is scaled back.

Industrial demand for gas continues to decline, as the economy grows at a slower rate, while commercial demands remain flat. Additional demand from power stations and the increase in gas demand for exports to Ireland offset efficiency savings in the residential market.

Gas demand

Figure 20
Gas: Selected No Progression demand comparison to 2013 by type



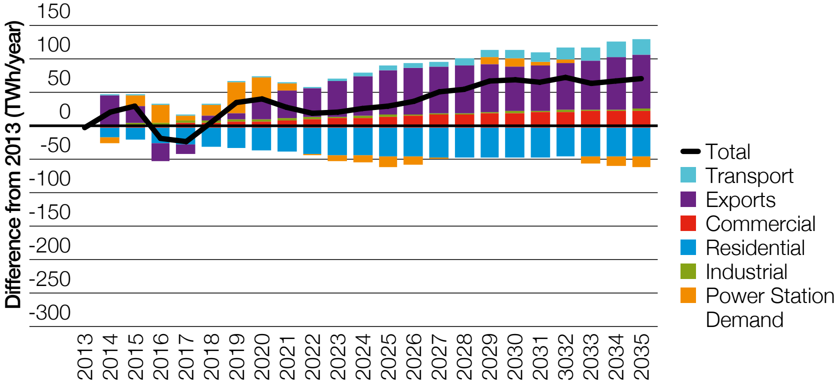
4.3.4
Results – Consumer Power

Gas demand for power generation remains fairly flat in **Consumer Power**. Retail gas prices are lowest in this scenario leading to significant investment into distributed renewable and combined heat and power (CHP) generation. The investment in distributed generation reduces the need for CCGTs pushing some power generation downstream from the network and into customer properties.

Residential customers continue heating their homes with gas and start to access new technologies to take advantage of the price spread between power and gas. Micro-CHP and fuel cells become commercially viable, boosting gas demands and offsetting some of the efficiency improvements associated with buildings and appliances.

Commercial demand grows in **Consumer Power** due to fuel switching from power to gas and installation of gas CHP. Heating for commercial buildings moves away from electricity to benefit from relatively lower retail gas prices and CHP provides economical on-site power production. Gas vehicles start to replace diesel HGVs.

Figure 21
Gas: Selected Consumer Power demand comparison to 2013 by type



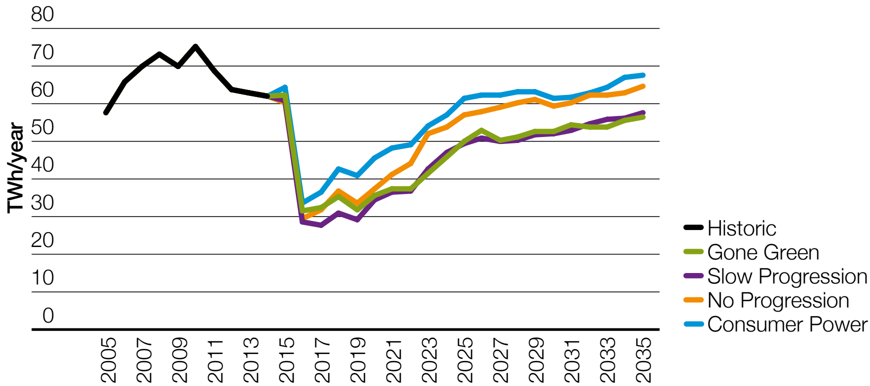
4.3.5
Ireland and Europe

The level of gas exports to Ireland is highly influenced by the timing and scale of supply from indigenous Irish supplies. We have assumed that the Corrib gas field starts operation in October 2015 with a step change in production rates from March 2016. We have assumed that Corrib will reduce the exports from Great Britain. However, we also assume the field is relatively short lived with production rates reducing over time and the reliance on exports gradually returning.

Our scenarios for Ireland and Europe include underlying energy demand growth related with higher economic growth in **Gone Green** and **Consumer Power** and lower growth in **No Progression** and **Slow Progression**. We have aligned higher development in renewable generation to **Gone Green** or **Slow Progression** and slower developments with higher gas demand for power generation in **Consumer Power** and **No Progression**. Our scenarios are developed by taking the underlying demands for residential and industrial demands from the Network Development Plan prepared by Gaslink, the Irish gas system operator. Gas demand for power generation was flexed in line with the submissions of the Northern Ireland and Irish electricity transmission system operators SONI and EirGrid to the ENTSO-E ten year network development plan.

Gas demand

Figure 22
Gas: demand from the National Transmission System to Ireland



Flows to and from Europe via interconnector UK (IUK) is sensitive to both UK and continental gas supply/demand balances. As described in the Gas Supply section in chapter 5, the level of imports from the continent and liquefied natural gas (LNG) are interrelated and subject to uncertainty. We provide more detail on the impact of exports and imports in the Gas Supply section.

4.3.6
Peaks

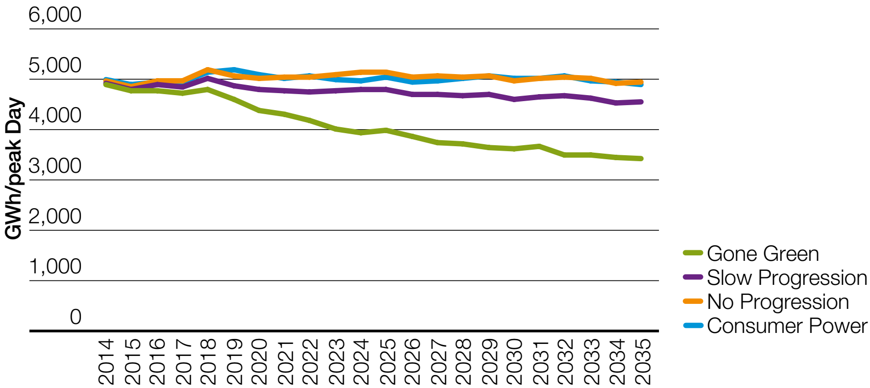
The 1-in-20 peak gas demand is based on a historical relationship between daily gas demand and weather combined with the amount of gas power station demand expected on a peak day.

The relationship between the peak day demand and weather is periodically reviewed and during 2014/15 we adopted the industry standard demand to weather relationships that take effect from October 2015 (see Method). Peak gas-fired electricity generation is less related to weather and more dependent on assumptions about generation availability and the position of gas-fired power generation within the generation order.

Unlike annual gas demand for power generation, the peaks in **Slow Progression**, **No Progression** and **Consumer Power** remain broadly in line with recent history, due to the increasing requirement for gas-fired power generation to act as a back-up for renewable generation. In **Gone Green** the peak gas demand decreases primarily as a consequence of reduced residential demand.

Figure 23 shows the peak demands for all four scenarios. The difference in peaks reflects the differing assumptions in residential and commercial annual demands and level of dependence on gas-fired generation.

Figure 23
Gas: peak demand



Gas demand

Method

Peak gas demands are based on the relationship between gas demand and weather, in the form of a composite weather variable (CWV), which includes temperature and wind-chill. Approximately every 5 years the CWV is re-optimised to ensure that the relationship remains valid. During the latest re-optimisation[2], a new weather dataset was introduced to coincide with the introduction of a formal weather station substitution methodology which is outlined in the Uniform Network Code. The new weather dataset has also been adjusted for the effect of climate change. Our peak demands in Figure 23 make use of this new climate adjusted weather, and as such are lower than in previous years' analysis. Peak day demand at local distribution zone level has subsequently fallen by 7% on average as a result of the updated method.

This year we have separated the Industrial and Commercial demands by sub-sector from their economic definitions. These do not map directly onto the gas load bands 72–732 MWh/year and >732 MWh/year. As such we have used an indexed growth method to map across while keeping the net demands constant between the two load bands.

[2] CWV Approach Document: gasgovernance.co.uk/desc/250314

Residential demand

4.4
Residential demand

GB residential energy demand is intrinsically linked to the number of homes in Great Britain. Heating, which dominates residential energy demand, is falling as a result of increased insulation and more efficient boilers. In Gone Green we expect a shift to more electrical heating in the form of heat pumps.

Residential power demand grows consistently due to a continued growth in the number of homes and population, which will require basic appliances such as refrigerators, cookers, audio visual appliances, etc. There is a more rapid growth in the number of electrical goods such as telecoms, tumble dryers and dishwashers.

Key statistics

- Homes with electric heating grow in **Gone Green** from 2 million today to 8.7 million in 2035
- Homes with micro-generation heating appliances grow from 1,200 appliances today to 2.7 million in 2035 in **Consumer Power**
- Annual power demand (including electric vehicles) increases from today's 110 TWh/year to 157 TWh/year in **Gone Green** and 127 TWh/year in **Slow Progression** by 2035
- Annual gas demand falls from today's 321 TWh/year to 296 TWh/year in **No Progression** and to 183 TWh/year in **Gone Green** by 2035

110 TWh

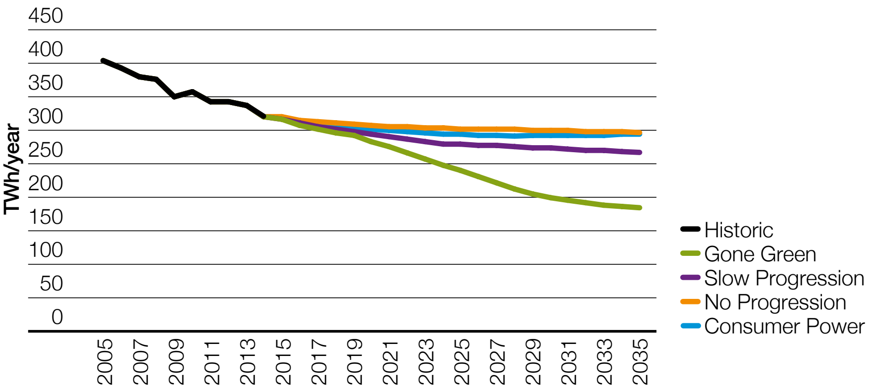
Annual power demand (including electric vehicles) increases from today's 110 TWh/year to 157 TWh/year in **Gone Green** and 127 TWh/year in **Slow Progression** by 2035

Residential demand

In **Gone Green** and **Slow Progression** the energy-hungry halogen light bulb will fall out of use by 2035. In **Gone Green** they are replaced by LEDs. In **Slow Progression** they are replaced by a mixture of LEDs and compact fluorescent light bulbs. Halogens will survive in **Consumer Power** and **No Progression**.

Time of use tariffs will become available within all the scenarios. The take up and the associated peak time savings will vary across the scenarios. **Gone Green**, which produces the most saving in 2035, will have a peak reduction of 3.7 GW, whereas **No Progression**, which will produce the least savings, will achieve only 0.3 GW.

Figure 24
Gas: annual residential demand



Residential gas demand is driven by the heating demand in homes. This in turn is affected by the thermal efficiency of the building (insulation), efficiency of the boiler or other heating appliance, and the temperature of the property.

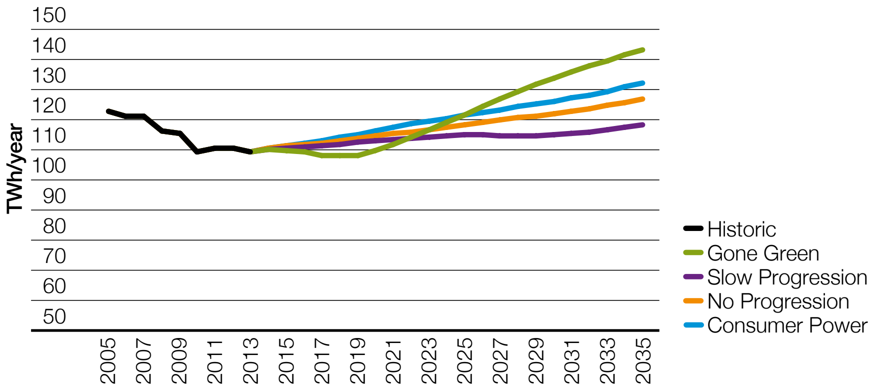
In **Gone Green** around 10 million homes install low carbon heating technologies (LCHT) by 2035, including, air source heat pumps (ASHP), ground source heat pumps (GSHP), hybrid heat pumps, micro combined heat and power (mCHP), and biomass. This causes a decline in gas demand of around 140 TWh/year from today's levels (321 TWh/year).

Slow Progression has a slow decline with LCHT still replacing gas boilers, but at a much slower rate than in **Gone Green**. Gas demand is reduced by the higher levels of insulation installation.

No Progression has the least efficiency gains from boiler replacements and insulation.

Consumer Power has higher efficiency gains from insulation and boiler replacements. However, the LCHT installed are gas focused (mCHP and fuel cells) which sustains a level of gas demand for this scenario.

Figure 25
Power: annual residential demand (excluding electric vehicles and losses)



The power demand in **Slow Progression**, **No Progression** and **Consumer Power** all experience steady rises from today's level. These increases are driven by an underlying increase in the number of households with their associated requirements for power consuming products. In addition, there are increased power demand requirements from appliances, heating and hot water in established homes. These increases are tempered by an overall drop in demand from lighting as a result of a growth in installations of more efficient LEDs.

In order for government carbon reduction ambitions to be met, low carbon heat sources, such as heat pumps, will have to significantly increase their numbers. This is only likely to occur if effective incentives or regulations are introduced.

Gone Green has a different trend in comparison with the other three scenarios. After an initial sharper reduction, it adopts a steeper increase in its power demand requirement. The decline is a result of the widespread adoption of LEDs. They rapidly replace halogen bulbs as a result of policy implementation and the higher price of electricity. However, post 2020, there will be a steep rise in the power demand requirements for space heating as a result of a significant rise in the deployment of heat pumps. This is as a result of government incentives promoting heat pumps in order to decarbonise the economy. There will be a proportional drop in gas demand for heating purposes.

Residential demand

4.4.1
Results – heating and air conditioning

Heat is currently responsible for 8% of total electricity demand and 28% of gas demand. Changes in heat demand, such as the introduction of new technologies and improved efficiencies, have a substantial impact on overall gas and electricity consumption.

The introduction of new heating technologies could displace the traditional gas boiler; this effect is mainly reflected in **Gone Green**. Figure 26 illustrates how the gas boiler's market dominance falls from 85% to 55% by 2035 as technologies such as heat pumps and biomass boilers grow. This has a large impact on both gas demand – the offset gas boilers – and power demand, as most of the LCHT are ASHP.

Figure 26
Residential heating technologies in Gone Green

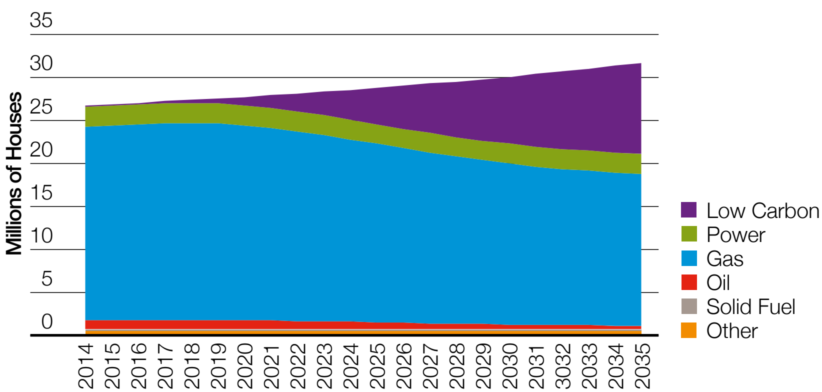
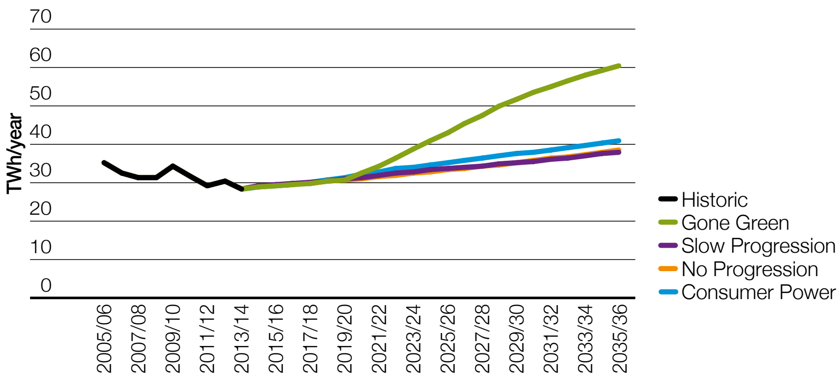


Figure 27
Power: annual residential heating demand (including air conditioning) (excluding losses)



With the exception of **Gone Green**, power demand for the residential sector experiences a steady and slow rise over the period. This is driven mainly by the increases in the housing stock and population. The major component of the electrical heating profiles is space heating, which represented 73% of the total in 2014. Consequently, the variations in our power demand trajectories can be explained by a combination of a slowly rising resistive heating and LCHT demands. However, the LCHT with the largest market share, in all of our scenarios, is ASHP; their take up significantly influences the **Gone Green** projection.

In **Gone Green**, there will be significant government drive to promote heat pump deployment. This situation is mirrored in the commercial sector (see section 4.6).

In this year's analysis we have assumed a less aggressive demand from heat pumps, in all scenarios, as a result of feedback from stakeholders. We have also adopted a new modelling approach that fully considers the costs and technology selection by household segments. This enables us to make adjustments for consumer and market behaviours.

Residential demand

Insulation

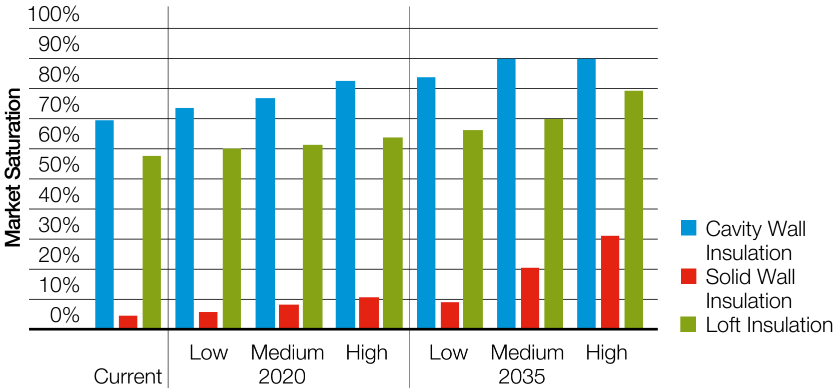
Government insulation figures show that the markets for cavity wall and loft insulation are starting to saturate. Most of the easy to install installations were completed under the Carbon Emissions Reduction Target (CERT), Community Energy Saving Programme (CESP) and Warm Front schemes which closed in 2012. By the end of 2013, approximately 60% and 70% of the potential installations of loft and cavity wall insulation respectively had been installed. There is, therefore, less room for further growth in these markets, in stark contrast to that of solid wall insulation.

There remains a significant potential for solid wall insulation but to date the high cost has resulted in a low uptake, as seen in Figure 28. Only 4% of potential installations were completed by the end of 2013. However, during 2014 installations of solid wall insulation increased significantly following the release of the Green Deal Home Improvement Fund (GDHIF). The fund paid over £35m for solid wall insulation in 2014, and more funding has been allocated for future installations.

Government figures show there are over seven million solid walled homes without solid wall insulation. To insulate all of these homes through the current funding scheme would cost between £20bn and £30bn.

Figure 28 shows the current level of market penetration of the three insulation types, along with the range of possible outcomes in 2020 and 2035. **Gone Green** contains the high case for solid wall, cavity wall and loft insulation, while **No Progression** has the low case for all three. In **Slow Progression** we assume high cases for cavity wall and loft insulation while solid wall insulation is at the medium rate due to the higher costs and less capital being available. **Consumer Power** has the medium cases of cavity wall and loft insulation and the low case of solid wall insulation. This is due to solid wall insulation being relatively expensive and considered lower in priority with a weaker green ambition.

Figure 28
Insulation uptake ranges



The rapid uptake of the GDHIF has shown that there is consumer appetite for insulation. In order for there to be a continued high uptake, funding schemes need to continue beyond 2017. Additionally, high levels of support such as the GDHIF need to be offered to incentivise home owners to install solid wall insulation.

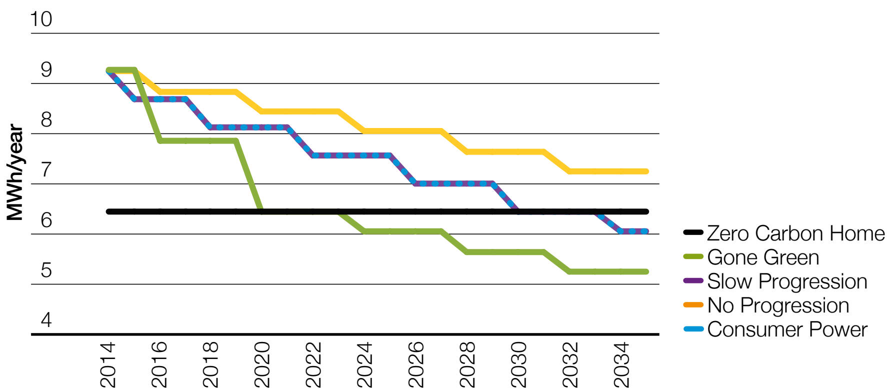
Residential demand

New builds

Stakeholders have told us that the pace of change to building regulations in our 2014 analysis was too rapid. In response, we have adjusted our assumptions to progress towards the Zero Carbon Home[1] standard as opposed to the more stringent Passivhaus[2] standard. We assume that historic trends continue such that building regulations are adjusted and adopted every four years creating a step change. We have held the average demand for hot water constant at 2.5MWh per year as per feedback from stakeholders.

The date by which new homes are built to the Zero Carbon Homes standard differs between the scenarios, as seen in Figure 29. In **Gone Green**, homes meet the target in 2020 as there is both the money and government drive to encourage this. In **Slow Progression** and **Consumer Power** progress is slower, reaching the standard in 2030. **No Progression** has the slowest rate of change, reaching the standard in 2040. With an average build rate of 210,000 domestic homes per year, building to the Zero Carbon Homes standard in contrast to today's average new property saves 590GWh of thermal energy demand per year. The overall heat demand saving resulting from reaching this standard in 2020 rather than 2040 is over 10TWh/year.

Figure 29
Heat demand for an average new home



[1] www.zerocarbonhub.org
[2] www.passivhaus.org.uk

Internal temperature

Increases in average internal temperatures causes increases in heat demand. As such we have assumed that in **Gone Green** and **Slow Progression** average internal temperatures do not increase beyond today's level due to the social engagement and ambition to reduce emissions.

In **Consumer Power**, temperatures are assumed to rise at the highest rate consistent with higher levels of disposable income, to a maximum cap of two degrees.

No Progression is also assumed to see temperatures increase, but is capped at a one degree increase. Both of these caps are in line with stakeholder feedback.

A one degree change in internal temperatures results in a 1% to 3% change in heat demand. Therefore, by 2035 internal temperatures could account for a difference of up to 12 TWh/year of thermal demand between **Gone Green** and **Consumer Power**.

Internal temperatures are affected by consumers' real and perceived disposable incomes, and energy prices. As higher temperatures become more affordable the average temperature is likely to increase (up to a limit) unless social attitudes to energy consumption changes to produce different behaviour.

Residential demand

Smart thermostats

A smart thermostat is a device which allows consumers to remotely control their boiler thermostats via the 'cloud'.

The UK market for smart thermostats has taken off rapidly in the past few years. Estimates suggest that there are between 200,000 and 400,000 devices currently in the UK market. Thermostat companies, technology firms and energy companies are offering the devices at a relatively low cost to consumers as an energy saving device.

Customers who buy smart thermostats in **Gone Green** and **Slow Progression** experience a higher impact on their energy demands than in **Consumer Power** and **No Progression**. They experience a 20% reduction compared to 10% in the other two scenarios. This is a result of the types of technologies adopted and how they are used.

In the greener scenarios, residents are engaged with reducing their energy demands, aiming to maintain the heat comfort in their home but in a more efficient way, reducing wasted heat. However, in **Consumer Power** and **No Progression**, the technology is also used to make life more comfortable in the home, such as warming the house in advance of it being occupied, so savings are reduced.

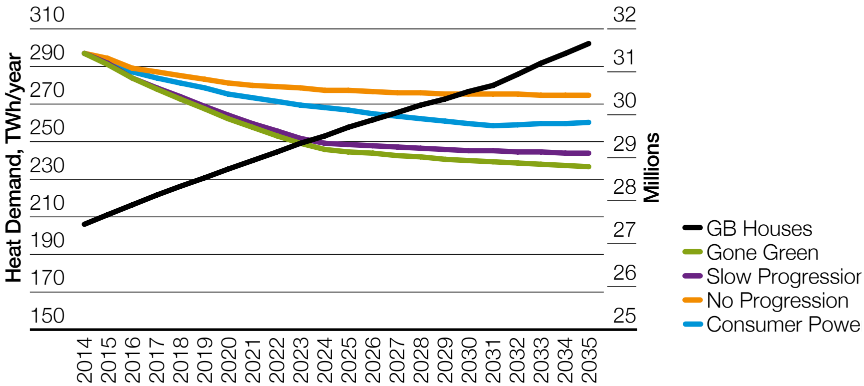
Our analysis has suggested that there is a potential to reduce current heat demand by 20TWh/year to 40TWh/year through installing smart thermostats. This would lower demand by 6% to 12%.

In order for smart thermostats to have a large market impact, consumers need to be engaged with home energy management. Additionally, actual energy and bill savings need to reflect the manufacturers' claims of 10% to 40%.

Traditional heating systems

Gas boilers dominate the current residential heating market, with approximately 85% of GB homes 'on gas' today. There are continued efficiencies to be made from replacing older boilers with new, more efficient models. We assume that 1 to 1.5 million 'A-rated' appliances are purchased each year in response to legislation in 2005, which ruled that the majority of new boilers must be of the most efficient level. The remaining populations of band B-G appliances decline throughout the period to 2035 to near-zero values. This creates the following overall gas demand savings in Figure 30; aggregating the impact of insulation, boiler replacements and new property demand reductions.

Figure 30
Gas: demand savings from insulation and boiler replacement



Chapter four

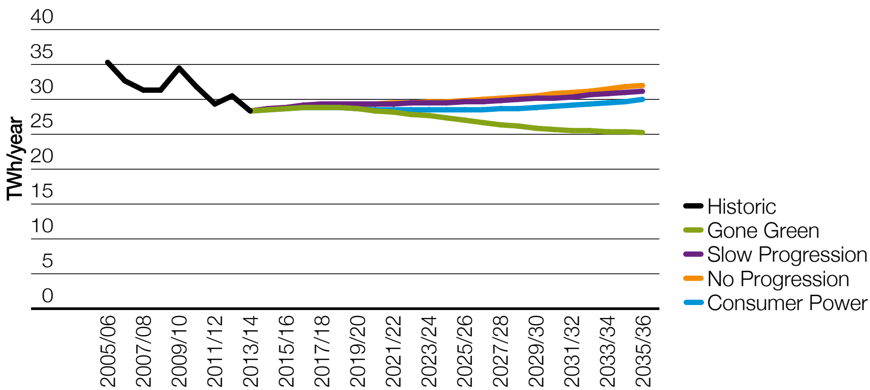
Residential demand

The electrical heating of rooms can be performed by either resistive means (bar heaters, storage heaters, etc.) or via LCHT (heat pumps, etc.).

There will be a general increase in demand associated with new build housing requirements. This increase will be tempered by the introduction of the newer technologies post-2017 and improved housing insulation. As shown in Figure 31, this dampening effect is more pronounced in both **Gone Green**, and, less so, in **Consumer Power** where incentives will not be available.

This dampening effect will be reduced further in **Slow Progression** and **No Progression** as we assume that there are lower energy efficiency gains in these scenarios, due to less money in the economy and thus driving down the demand for these technologies and inhibiting innovation.

Figure 31
Power: annual demand for residential resistive space heaters and hot water (excluding losses)



Low carbon heating technologies

We have defined a low carbon heating technology as one that has a lower carbon intensity for heating homes than an A-rated efficient gas boiler. Ground source and air source electric heat pumps, gas heat pump, hybrid heat pump, biomass, micro combined heat and power (mCHP) and fuel cells are examples of the technologies considered low carbon.

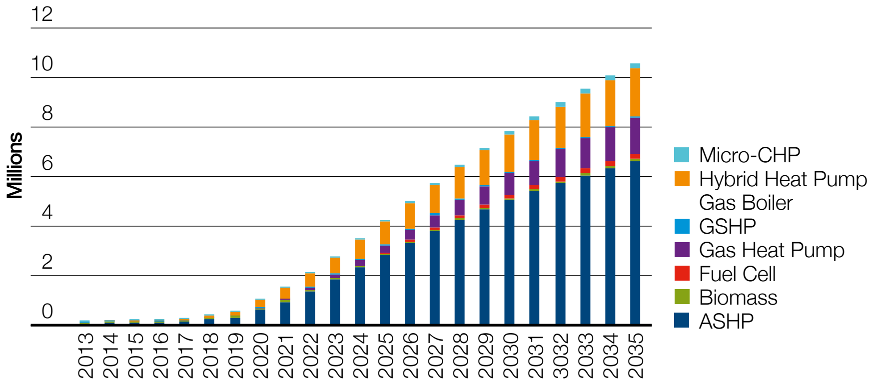
There are numerous factors affecting the decision to choose an alternative heating technology. The main drivers cost savings, reducing energy use or emissions.

Stakeholders told us that 79% of new builds have a gas connection, and we have adjusted our assumptions accordingly. However, the range and uptake of alternative technologies across both existing and new homes differs between the scenarios.

In our 2014 scenarios we assumed that alternative technologies would initially displace mainly non-gas appliances. Conversely, recent data and stakeholder feedback has shown that installations are displacing both gas and non-gas heating appliances, and we have adjusted our assumptions as a result.

The shift to low carbon heating in the residential sector requires continued government support. An incentive such as the Renewable Heat Incentive needs to continue into the long term to provide competitive prices compared to gas heating.

Figure 32
Installed low carbon heating technologies in Gone Green



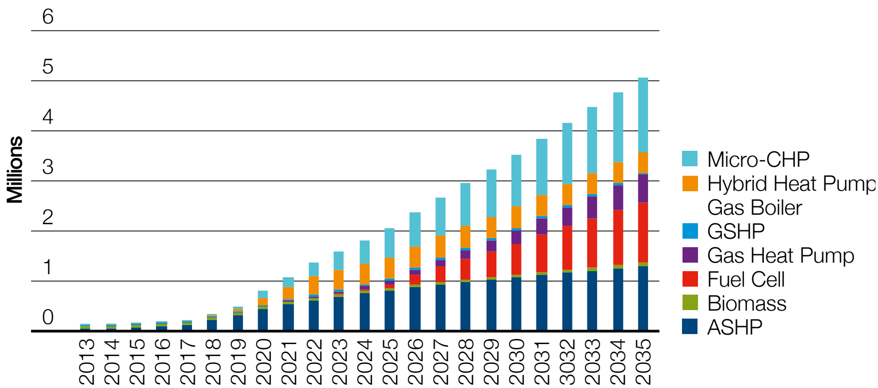
Residential demand

In **Gone Green** there are 10 million installed low carbon heating technologies in 2035, mostly air source, hybrid and gas heat pumps.

Consumer Power has the second highest shift, reaching five million alternative appliances by 2035. Due to the large difference between gas and electricity prices, there is a large uptake of mCHP units. The high level of research and development also supports fuel cells entering the market.

For our 2015 scenarios we commissioned a new modelling tool, which was built with the support of Delta-Energy and Environment. This is a step change on our previous modelling. It allows us to consider the GB housing stock as 22 different housing segments and to fit heating technologies into those homes based on economics, physical fit and soft factors like government push.

Figure 33
Installed low carbon heating technologies in Consumer Power



In both **Slow Progression** and **No Progression** there is much lower take up, reaching around two million alternative technologies by 2035.

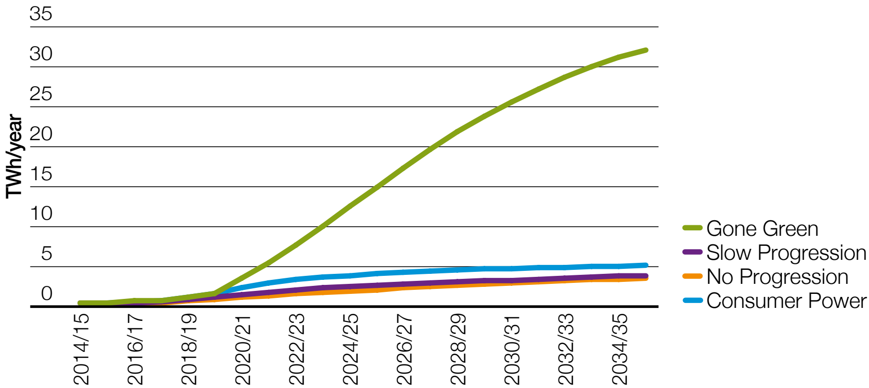
In this year's modelling, our demand levels for all scenarios have increased. This is due to a combination of three factors. Firstly, we now believe that heat pumps will not be as efficient as we had previously thought as a result of an update to our market and technology research, thus heat pumps will draw more demand. Secondly, we have reassessed which types of homes are likely to install the projected number of heat pumps; we now believe that they will be larger homes which will require more heat than the average sized home, thus drawing more demand. Thirdly, homes that are currently heated electrically are a poor fit, economically, for retrofitting heat pumps: they would need to install a central heating system. Thus these homes sustain their resistive heat demand.

Slow Progression and **No Progression** will see a steady power demand rise due to new housing stock increases. As discussed at the start of this section, **Gone Green** will experience a dramatic rise in the deployment of newer technologies which we believe needs to be driven by incentives. **Consumer Power** has an initial increased use of newer technologies as they will be seen as desirable products and there will be the money available to spend.

The contribution of LCHT to peak power demand, by 2035, could be as much as 9.6GW in **Gone Green** and around 2GW in the other scenarios.

Chapter four

Figure 34
Power: annual demand for residential low carbon heating technologies (excluding losses)



Residential demand

Heat networks

Heat networks, also known as district heating systems, supply heat to a number of buildings from a central production facility through an insulated pipe system. They are typically built in high heat density areas such as city centres. Such systems currently supply approximately 200,000 residential homes in the UK, less than one percent of homes. As such, they have a very small impact on heat demand.
The government's long-term vision includes a larger role for heat networks. Expanding the role of heat networks has the potential to lower emissions at the point of use and could run from an efficient local source.

The development of heat networks remains unclear and is dependent on geographical factors. In 2015/16 we have commissioned Buro Happold to help us with our modelling. This will lead to dedicated research into the economic, regional resources and longer term potential heat sources that could unlock low carbon opportunities for district heating.

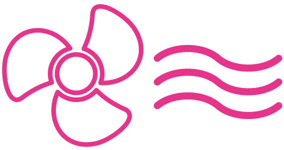
Gone Green has the highest uptake of heat networks due to having sufficient heating systems installed to drive the central heat production, and regulation guiding the building of systems. The systems are new CHP, particularly biomass CHP which is not driven by an on-site industrial or commercial building demand. There are around 1.4m residential connections by 2035, with a thermal demand of 12TWh/year in **Gone Green**.

No Progression has the lowest development with around 600,000 total homes connected by 2035, representing a thermal demand of 4TWh/year.

Our capacity and power outputs associated with CHP can be found in the Power Supply section in chapter 5. You can read more in the Future of Heat case study in chapter 7.

Air conditioning

This year, as a result of stakeholder feedback, we have modelled air conditioning. The power demand from air conditioning units sees a steady rise based on a slow increase in their adoption and the rise in the housing stock. In **Consumer Power**, we assume that the rate of increase is twice that of the other scenarios, rising from today's low base of 0.1 TWh/year to almost 6 TWh/year by 2035.



6 TWh

In **Consumer Power**, we assume that the rate of increase is twice that of the other scenarios, rising from today's low base of 0.1 TWh/year to almost 6 TWh/year by 2035.

Residential demand

4.4.2
Appliances

As a result of stakeholder feedback we have tempered our assumptions on the energy efficiency gains in **Gone Green**, **Slow Progression** and **Consumer Power** scenarios. We have retained the assumptions for **No Progression** as this scenario maintains its low efficiency gains.

Most of the appliance types modelled follow a similar trend within each of our scenarios, see Figure 35. In all scenarios we envisage a continued and steady growth in power demand from certain appliances i.e. cooking, wet and audio visual appliances. A more accelerated demand growth is seen from telecoms and other appliances, and also dishwashers and tumble dryers.

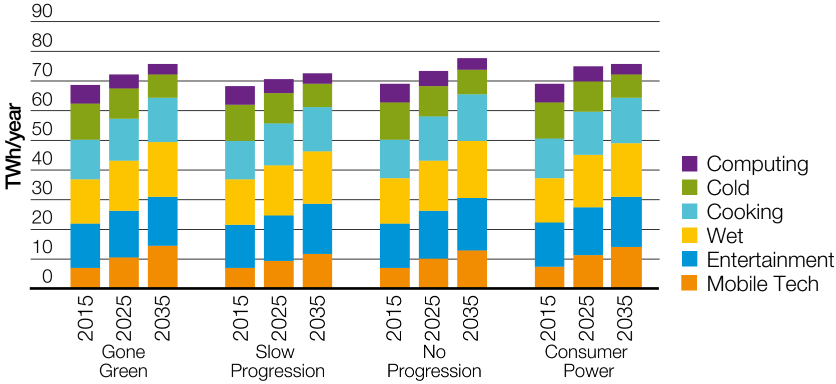
We also assume steady declines in the demand from refrigeration. In all the scenarios they have reached their saturation point in the current housing stock. Any increase in numbers, as a result of new housing, will be offset by continued efficiency gains of new appliances.

In all the scenarios computing demand falls. DECC data[1] for 2013 shows demand from computers declining after a period of slow down due to the falling numbers of desktops and the increasing efficiency of monitors and laptops. We continue this trend in our projections.

There are more appliances in **Gone Green** and **Consumer Power**, due to prosperity, than in **Slow Progression** and **No Progression**. We use lower energy efficiency assumptions in **No Progression** and **Consumer Power**, due to low green ambitions. This combination results in **No Progression** having the greatest demand followed by **Gone Green** and **Consumer Power**. **Slow Progression** has the least demand.

[1] Energy Consumption in the UK (ECUK) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/375388/domestic.xls

Figure 35
Power: annual demands for residential appliances by categories



Residential demand

4.4.3 Lighting

In all our scenarios there is a terminal decline in electricity demand from filament light bulbs and a decline in halogen bulbs depending on the scenario. In terms of bulb numbers LEDs become the dominant light source in all scenarios and they represent over half of all the bulbs in use by 2035. The overall effect is a decline in the demand from lighting.

In **Gone Green**, LEDs are adopted almost universally by 2030, driven by higher electricity prices, higher technological innovation, which will also drive down the units' price, and the legislative banning of selected halogen bulbs[3]. Compact fluorescent lights (CFL) will be eliminated in the more prosperous **Gone Green** and **Consumer Power** scenarios. The opposite environment will exist in **No Progression**, with its lower electricity prices, lower technological innovation and low policy drivers. This slows the LED development and adoption rate and, by default, prolongs halogen usage.

Slow Progression follows **Gone Green**'s adoption of the LED but at a slower rate because there is less money available to drive innovation, and the lower cost of electricity will not force as rapid a consumer change.

Halogens maintain their market position in **Consumer Power** due to consumers being less concerned about the cost and their limited awareness, and motivation to adopt low carbon appliances. As in **Gone Green** CFL deployment will not continue. This view of the persistence of halogens was supported by stakeholder feedback received in 2013 and reinforced in 2014 where, of those polled, the majority view was that 20% of light bulbs would be halogen in 2030. Today they represent 39% of light bulbs.

20%

20% of light bulbs would be halogen in 2030

[3] Halogen Banning: EU laws currently ban Class D halogen lamps by 2018.

Figure 36
Power: annual demand for residential light bulbs in Gone Green

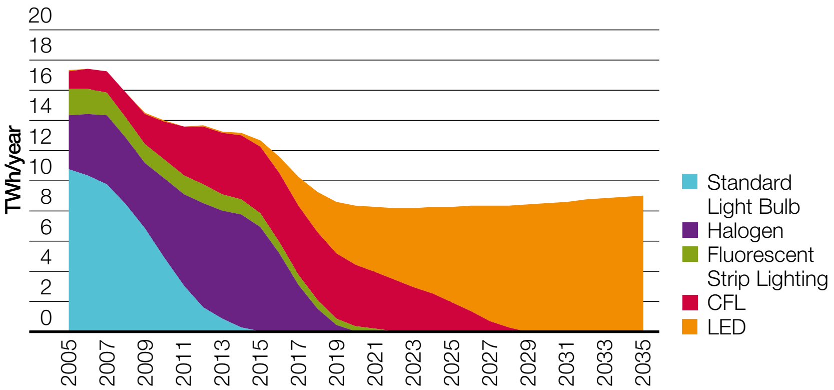
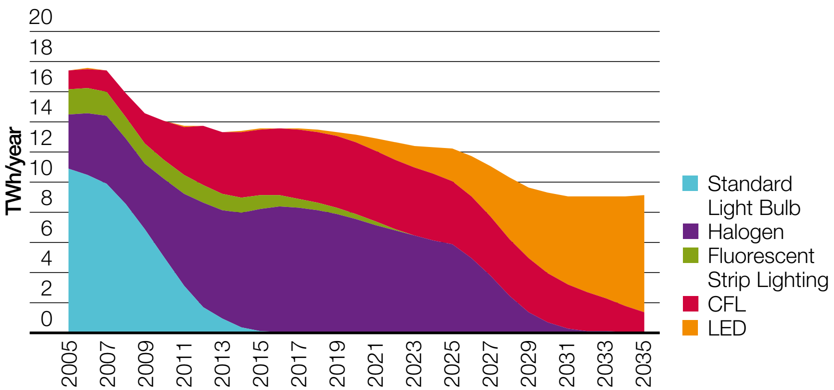


Figure 37
Power: annual demand for residential light bulbs in Slow Progression



Residential demand

Figure 38
Power: annual demand for residential light bulbs in No Progression

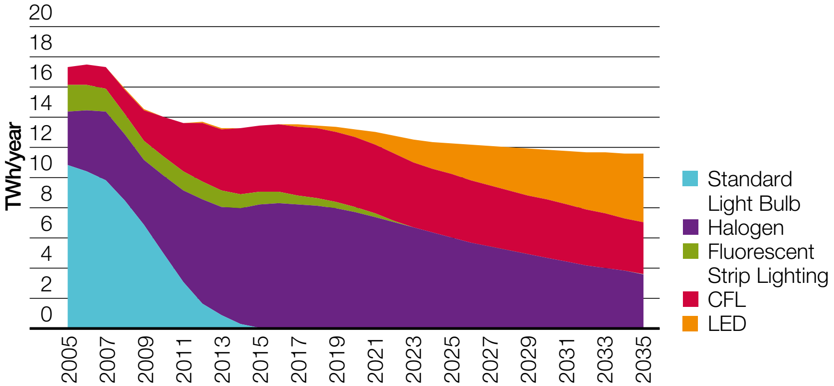
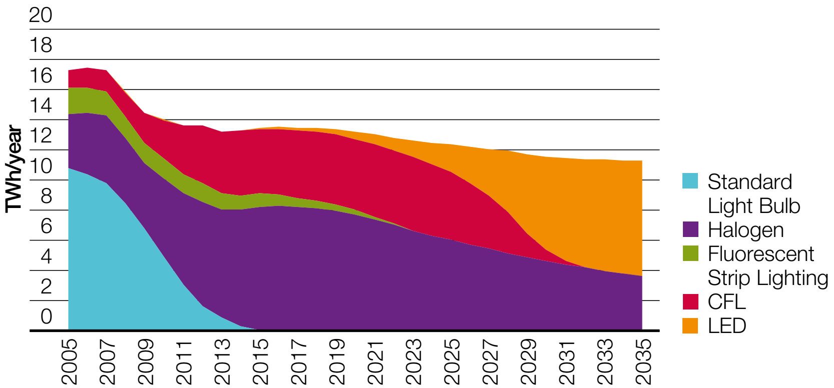


Figure 39
Power: annual demand for residential light bulbs in Consumer Power



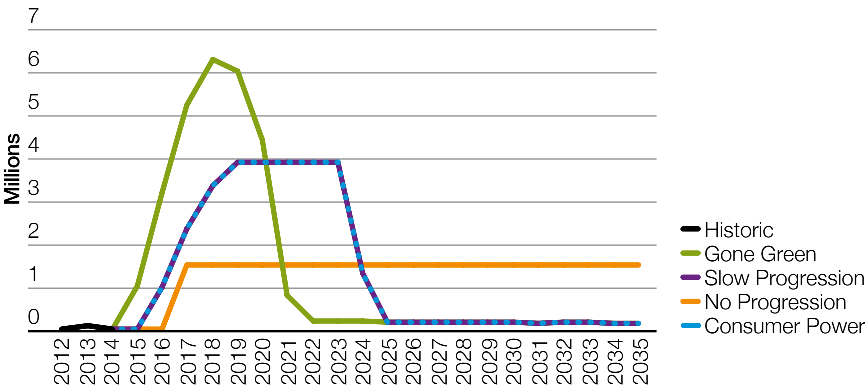
4.4.4
Residential electricity smart meters

We have used three potential rollout programmes for residential electricity smart meters. In **Gone Green** we have adopted DECC's profile which peaks at around 6 million electrical smart meters installations per year. For **No Progression** we have delayed the implementation by two years and used historic replacement rates of 1.5 million units per year. For **Slow Progression** and **Consumer Power** we assume that a mid-course is adopted and so the roll out will be delayed by one year and the installation rate will follow a midway position which is capped at almost 4 million units per year.

For the government's electricity smart meter roll-out programme to progress according to plan, we estimate that at its peak in 2018, there will be approximately 6 million installations per year.

Chapter four

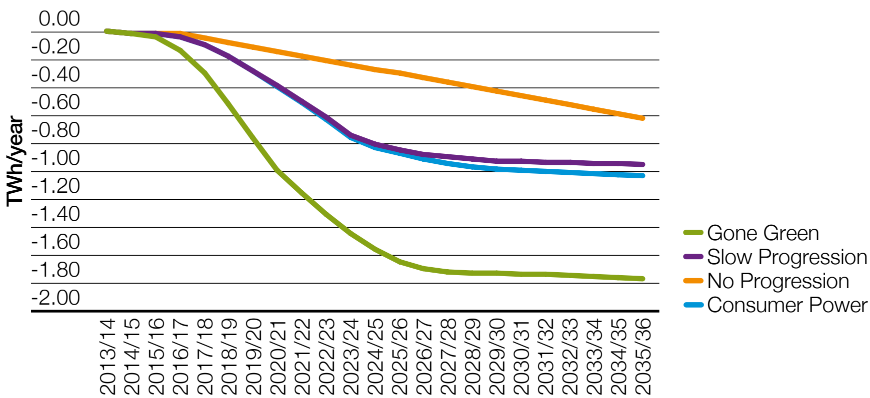
Figure 40
Power: smart meter roll-out profiles



Residential demand

The effect of smart meters on overall demand is better understood following the outcomes of trials. For **Gone Green** there will be the most rapid adoption of smart meters and their functionality as the roll-out programme is delivered fully and consumers are engaged. In **Slow Progression** and **Consumer Power** the installation rate is more muted resulting in slower take up. In **No Progression** there is neither the will to deliver the roll-out or to interact with the meters, nor the prosperity to drive through a rapid deployment of smart meters. Consequently the demand reduction is the lowest.

Figure 41
Power: residential demand reduction through smart meters



4.4.5
Peaks

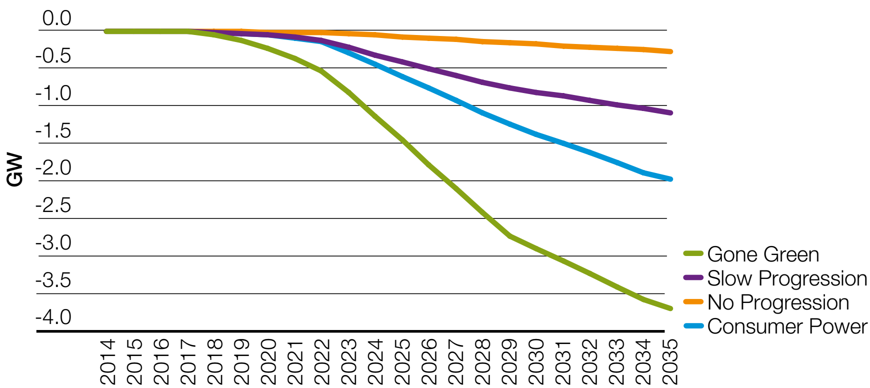
Smart meters allow for within-day banding of retail electricity charges. Such ability will permit associated TOUTs to significantly reduce peak demand by encouraging consumers to use power at other times of the day when the energy prices are lower.

Gone Green shows the biggest reduction in peak demand due to the effects of smart meters. This is driven by an on time smart meter roll-out programme and a rapid and enthusiastic take up of TOUTs.

Slow Progression and **Consumer Power** have a medium take up rate but a slightly delayed implementation rates. **Slow Progression** does not have the affluence to deliver the required changes but does have the ambition, whereas in **Consumer Power** there is the affluence for deployment but not the ambition.

No Progression does not have the affluence or the ambition to deploy and utilise the technology. Consequently it returns the flattest of all the profiles.

Figure 42
Power: peak reduction due to TOUT and smart appliances



Residential demand

Method

Annual demand

We create residential power demand using a bottom-up method. For each component part we use historical data, where available, as our starting point. The main source being DECC's Energy Consumption in the UK[4]. Then we create projections using a selection of historic assessments, household projection data provided by external consultants, outcomes from reported external projects', regression analysis, deterministic and econometric methods. These we benchmark against stakeholder feedback and other external projections and trial results. We adjust each projection with our scenarios' assumptions to create the final results for each component. We combine these to form the residential demand. The components parts we use are:

Appliances
- cold appliances
- wet appliances
- consumer electronics
- home computing
- cooking
- telecommunication and others.

Heating
- resistive heating
- resistive hot water
- air conditioning
- low carbon heating technologies.

Lighting

Time of use tariffs

To model the reduction created by the installation of TOUTs, we took from Customer Led Network Revolution's[5] a figure of 2.8% as the maximum residential annual demand reduction. This figure has then been adjusted downwards in response to other factors such as the roll-out rate of smart meters and engagement level of consumers within the scenarios.

To model the effects of residential TOUTs we have made a number of assumptions such as the time extent of the tariffs and the percentage of people whom are engaged in changing their power consumption pattern. These assumptions are supported by the outcomes of projects, in particular those from Ofgem's Low Carbon Network Fund, Customer-Led Network Revolution and Low Carbon London[6].

However, there still remain a number of uncertainties, which could significantly change how the consumer could or would react to TOUTs, for example:
- profile of the smart meter roll-out
- timing of the introduction of TOUTs
- structure and mechanics of the TOUTs
- differentials in the prices attached to TOUTs periods.

Where we have used trial data we have assumed that the results reflect a **Gone Green** society because the participants were volunteers who were engaged in the projects' aims. We have varied the proportion willing to change dependent on the scenario. As a basis we use data including Ofgem's categorisation of consumer groups by switching behaviour[7] to attempt to identify behavioural types. Feedback from the 2014/15 consultation cycle, showing that the majority of stakeholders thought that 20-40% of consumers would change their behaviour as a result of TOUTs, accorded with our projection range.

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[4] https://www.gov.uk/government/statistics/energy-consumption-in-the-uk
[5] http://www.networkrevolution.co.uk/
[6] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-%28LCL%29/
[7] https://www.ofgem.gov.uk/ofgem-publications/39708/rmrfinal.pdf

For the smart appliance effect on peak demand we assume that those appliances whose demand could be moved from peak time would do so under the TOUT modelling. We have not included the effect of TOUTs on heat pump usage during the peak periods as we assume it is unlikely that they will be turned off when they are most needed to heat homes on winter evenings.

Heating
Our analysis of residential heat demand includes routes to improving energy efficiency by improving the efficiencies of existing products, through boiler replacements and insulation, and introducing new technologies including heat pumps and fuel cells.

For our 2015 scenarios we commissioned a new modelling tool, which was built with the support of Delta Energy and Environment, to add further depth to our analysis. We have included a larger variety of new technologies (last year only considering ASHP), including hybrid, gas and ground-source heat pumps, micro-CHP units, and fuel cells. The new model considers 22 housing segments, four of which are new build homes. These are broken down by magnitude of thermal demand and property type. The model considers whether the 13 technology types physically fit within each of the 22 residential property segments from the thermal requirement of the property and the size or requirements of the technology. An assessment of the economic drivers and constraints based on residential retail prices (which vary between scenarios, see the Primary Assumptions in Section 3.2 for more detail) is then completed against these thermal demands. These comprise the rational economic decisions which should be made regarding heating technologies. Additionally, the model then incorporates softer factors which affect the take-up of new technologies, including consumer appetite for new technologies, government support, and installer and manufacturer push.

New builds
We have continued to use evidence-based analysis where possible, however, for topics with less data available we have used a stakeholder-focused approach. In response to stakeholder feedback we have adapted the analysis on building regulations to primarily refer to the Zero Carbon Homes target as opposed to the Passivhaus standard.

Insulation
To calculate the impact of insulation, boiler replacement and smart thermostats we use the average saving per house, as published by Ofgem[8]. In reality the savings would differ between homes dependent on their age, size and behavioural patterns.

We created high, medium and low cases for insulation uptake to explore how effective incentive schemes could be in the future. We assumed that rates reflect the trends seen in the approved and notified Energy Companies Obligation (ECO) rates across 2014 as reported by Ofgem[9]. In addition we adjusted the high case to reflect potential increases following supplementary funding incentives. These insulation ranges are used when calculating thermal demand for choosing heating technologies.

District heat
We have recently commissioned a study to inform our scenarios for 2016. We have aligned our district heating scenarios with the combined heat and power (CHP) scenarios and are maintaining our assumption from FES 2014 that CHP is the main source of heat supply. We also assume that the majority of growth is in new builds as opposed to retrofits.

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65694/7387-calculation-eco-targets-final-ia.pdf
[9] https://www.ofgem.gov.uk/environmental-programmes/energy-company-obligation-eco

Industrial and commercial demand

4.5 Industrial demand

Energy demand in the industrial sector is influenced by the rate of economic growth (an indicator of manufacturing output) and energy prices. Declining energy demand in manufacturing is the underlying trend across all scenarios due to the changing mix of sub-sectors and their different energy intensities and this is set to continue.

Key statistics

- **Consumer Power** is the only scenario with gas demand growth over the next 20 years, limited to 3%
- **Gone Green**'s demand for gas declines by 15 TWh/year by 2035
- All industrial scenarios have decreasing power demands.

3%

Consumer Power is the only scenario with gas demand growth over the next 20 years, limited to 3%

Figure 43
Gas: annual industrial demand

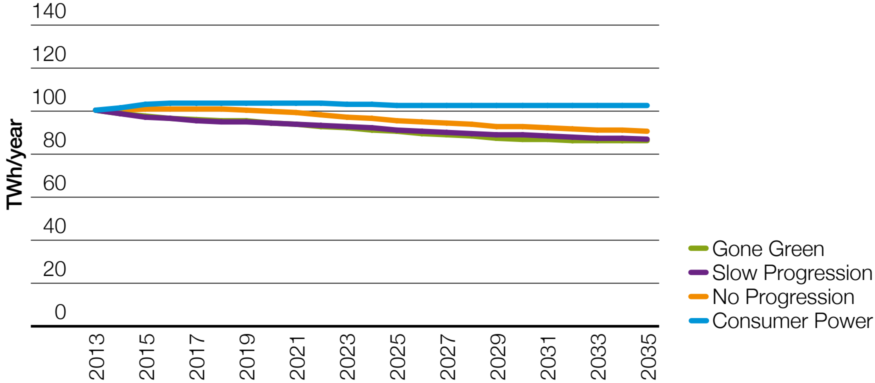
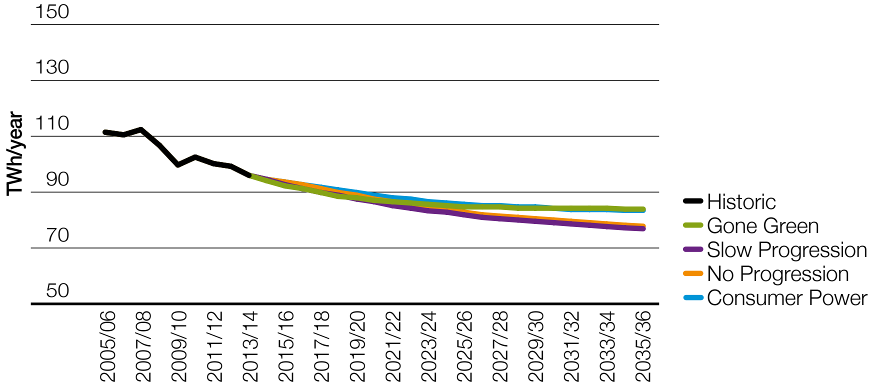


Figure 44
Power: underlying annual industrial demand (excluding losses)



Industrial and commercial demand

4.5.1 Results

Industrial power demand declines in all four scenarios from approximately 90TWh/year today to between 72-79TWh/year in 2035. This is mainly due to the changing mix of industrial sub-sectors and their relative energy intensity, see 4.5.3 for more detail. The stronger economic growth in **Gone Green** and **Consumer Power** helps to delay the underlying trend of declining demand, and is the key reason for the gap between these two scenarios and **No Progression** and **Slow Progression**.

Gone Green has some element of electrification of heat from the adoption of heat pumps. However, with high power prices and expensive up-front costs a strong business case for heat pumps requires the renewable heat incentive (RHI) – which has continued support in **Gone Green**. This support combined with a strong economy leads to 550MW of air source heat pumps (ASHP) being installed by 2035.

Gas demand in the industrial sector has a similar declining outlook in all scenarios apart from **Consumer Power**. The lower gas prices in **Consumer Power** leads to uptake of gas CHP to take advantage of the price spread between power and gas, an additional 1.1GW of installed electrical capacity is installed leading to an increase of 18TWh/year of gas demand.

The CHP effect offsets a more general declining gas demand trend in **No Progression** albeit to a smaller extent than in the more affluent **Consumer Power**, approximately 500MWe of capacity is installed by 2035. The higher gas prices in **Gone Green** and **Slow Progression** lead the declining gas demands; **Gone Green**'s heat pumps further replace gas demand with the additional effect of reducing the total energy requirement.

We have worked with Arup and Oxford Economics to create a new industrial and commercial energy demand model for our 2015 scenarios.

The model looks in detail at the impact on energy demand from changing economic situations, retail prices and new technologies. It does this by breaking down energy demand into 24 economic sub-sectors for more granular interrogation. Gross value added (GVA) per subsector can then be applied in the model and individual trends realised.

Power and gas demand modelling is combined into a single application allowing the relationship between gas and power demands to be further observed due to price differentials; this includes the impact of gas CHP installations to use gas to generate power on-site.

4.5.2
Industrial heat pumps

Heat pumps, in this report, refer to pumps capable of producing low grade heat useful for space heating or hot water demand. These pumps cannot replace gas demand which is used to satisfy high grade process heating demand. **Gone Green** has the drive from government to reduce carbon emissions, partly through electrification of heat. However, this space heating demand is a small part of the total thermal demand across the high intensity sub-sectors of mineral products, refining, chemicals, metals, printing and textiles where heat pumps are currently unsuitable.

4.5.3
Industrial combined heat and power

CHP capacity is already installed in high intensity industry, constraining the possibility for further growth in the sector. Installed capacity ranges from very large pseudo-Power Stations (200MWe installations) in the refining sectors to much smaller factory size CHP (3-4MWe) in manufacturing processes like food and beverages or machinery and equipment. These CHP units are classed as distributed generation, unlike commercial CHP which is classed as micro-generation (<1MWe). [Read more about CHP in the Power Supply section, in chapter 5]

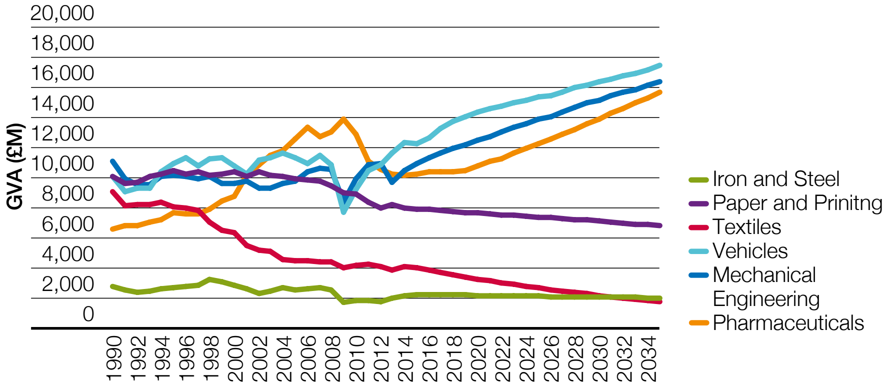
Industrial and commercial demand

4.5.4
Industrial economic outlook

The underlying price and economic outlook in each scenario is the same across the industrial and commercial sectors. See the commercial section for more detail.

The industrial landscape is changing in the UK and this is one reason why GVA growth in the sector does not lead to proportionally changed energy demands, see Figure 45 which uses Oxford Economics' data. There is strong growth forecast in mechanical engineering GVA but this does not translate into energy consumption. Pharmaceuticals are also set to have strong growth and are the fourth largest contributor to industrial GVA today but have the lowest energy demands. GVA from textiles has halved between 1990 and 2014 and looks set to halve again by 2035, with the subsequent reduction in demand. Paper and printing, the third largest GVA out of 13 industrial sub-sectors in 1990, retreats to seventh largest in 2035.

Figure 45
Selected industrial sub-sector GVA



These shifts to the dominant contributors to UK industrial output change the fundamental industrial energy demand dynamic. Higher intensity sectors are shrinking, reducing energy demands proportionally. This explains the underlying decline to industrial energy demands, despite buoyant GVA, and why economic growth is decoupling from energy demand at a national level.

4.5.5
Industrial and commercial power DSR

Demand side response (DSR) we define as a deliberate change to an end user's natural pattern of metered electricity consumption brought about by a signal from another party.

The Triad charging regime provides one way that large industrial users of electricity can reduce their energy charges by reducing consumption over peak periods. The Triad refers to the three half-hour settlement periods with highest system demand between November and February, separated by at least ten clear days. National Grid uses the Triad to determine charges for demand customers with half-hour metering. Their charge for the year is based on a tariff which is multiplied by their average demand during the three Triad half-hours.

There are also emerging industry-led engagement activities such as 'Power Responsive' which seeks a collaborative approach towards realising the DSR potential in both the business and residential sectors. Power Responsive is a framework to facilitate the rapid acceptance of demand side solutions. It will turn debate into action. Its goal is for all businesses to realise cost savings and to secure energy amenity now and in the future[1].

We recognise that the demand side response community is a key stakeholder group for us to fully engage with in our role as System Operator and residual balancer. Currently we are actively seeking the views of existing DSR contracted parties on a range of topics to facilitate the delivery of DSR within our balancing services in order to address current issues, develop and implement opportunities and share knowledge and collaborate.

We conducted a literature review on DSR to search for information on its potential effects. This search involved reviewing both theoretical and trial outcomes which were available in the public domain. It highlighted to us both a scarcity of solid data and, from what was available, a wide range of conclusions. We adopted the less extreme conclusions in order to develop a credible model.

Similar to the residential TOUT section 4.4.5, the strength of the DSR response will be dependent on what the market place offers and where the most value for such offerings can be realised. As yet there is uncertainty as to what form these value streams will take but work to map out the value streams has been instigated.

For all of our scenarios, we assume a 1 GW Triad reduction as the present state (see Methodology section for an explanation of Triad). The projections then reduce in 2016, when a modification to the Balancing and Settlement Code starts to take effect[2]. This requires certain businesses to be settled half-hourly and as such they have the potential to be exposed to the within-day price variations of electricity. This will introduce a driver for businesses to use less power at peak, as power prices should be at their highest.

[1] For more information on Power Responsive please see: http://www.powerresponsive.com/

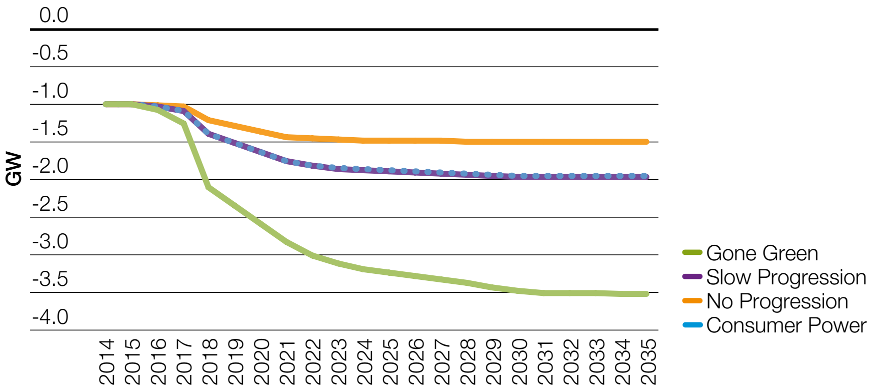
[2] Balancing and Settlement Code (BSC) P272: Mandatory Half Hourly Settlement for Profile Classes 5-8.

Industrial and commercial demand

From winter 2018/19 the DSRs which are contracted under the capacity mechanism will be available and, it is assumed, they will remain in place thereafter. In the same year, we assume that DSR under short term operating reserves (STOR) will be available to the capacity mechanism, where they will be able to access additional revenues. We see this dual availability repositioning taking place over four years and then remaining stable. Thereafter, new markets and revenue streams will open up as a result of this changing environment. This market place will reach maturity by 2030.

For **Gone Green**, we adopted a higher technical uptake rate and a higher utilisation rate of DSR. This is because the price of electricity will be high, there will be greater peak demand and hence there will be relatively larger savings to be made. There will also be an ambition to encourage such behaviour changes. In **No Progression** the cost of power will be lower and so the savings will be much less; consequently, we used more pessimistic figures. For **Slow Progression** and **Consumer Power** we used mid-ranges, see Figure 46.

Figure 46
Power: industrial and commercial demand side response peak power reduction



Chapter four

Method for industrial and commercial demands

Economic data was purchased from Experian and Oxford Economics and used to create a high and low case for UK economic growth. Retail energy prices are benchmarked against DECC's scenarios.

The model examines 24 sub-sectors and their individual energy demands, giving a detailed view of GB demand, and uses an error correcting model to produce projections for each sub-sector individually. The model then has two further modules to investigate the economics of increasing energy efficiency (e.g. heat recovery) and new technologies such as on generation (e.g. CHP) or different heating solutions (e.g. biomass boilers).

These modules consider the economics of installing particular technologies from the capital costs, on-going maintenance costs, fuel costs and incentives. These are used along with macro financial indicators such as gearing ratios and internal rate of return (IRR) for each subsector to consider if the investment is economical and the likely uptake rates of any particular technology or initiative. This allows us to adjust the relative cost-benefits to see what is required to encourage take up of alternate heating solutions and understand the impact of prices on on-site generation which give our scenarios a wider range.

We make use of Experian's economic foresight to set our baseline of UK economic growth. Our stakeholders told us that they did not expect to see higher growth than this and so we flexed the growth of GDP down to set our low growth scenario using Oxford Economics' model.

Gone Green has high power and gas prices; the cost of new renewable generation is high and this is passed on to the customer. The high retail gas prices relate to the ambition of decarbonisation: we have assumed there will be some intervention on the gas prices to discourage the use of gas. Economic growth is higher at an average of 2.4% pa.

Slow Progression uses our baseline power prices and high gas prices. The scenario is following **Gone Green**'s footsteps but at a slower rate – there are less renewables on the system so the price is kept lower. However the ambition for decarbonisation remains the same resulting in the higher gas prices. Economic growth is lower at an average of 1.9% pa.

No Progression has low power prices – it has the least investment into renewable generation – and baseline gas prices. Gas demand continues to be prevalent for heating and generation. Economic growth is lower at an average of 1.9% pa.

Consumer Power has low gas prices and baseline power prices due to the levels of renewables. Its lower gas prices stems from UK domestic supply making up a larger proportion of gas supplies and the inertia to going green, allowing gas to be utilised despite the carbon implications. Economic growth is higher at an average of 2.4% pa.

Industrial and commercial demand

DSR

We see there being a number of enablers to DSR including:

- Balancing services
  - – Demand Side Balancing Reserve
  - – Short Term Operating Reserve
  - – Firm Frequency Response
  - – Frequency Control Demand Management
- Electricity Market Reform mechanism
- Triad avoidance actions
- Turn Down contracts with suppliers
- TOUTs
- Interruption Contracts with distribution network operators.

As Triad avoidance operates on a business by business basis, there is no definitive network system data on the magnitude of the effect. Consequently an estimate is produced by National Grid and this has been used as a starting point in our modelling.

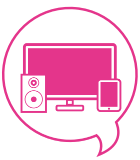
Data from the Capacity Mechanism auction and from National Grid's balancing services are used to further inform our modelling of DSR.

4.6
Commercial demand

Commercial gas and power demand has a weak relationship with economic growth. Productivity doesn't necessarily require the production of more objects but instead can come from scaling efficiency gains such as the use of information technology. Demand is influenced more heavily by energy prices. This sector is providing most of the nation's growth, allowing more investment into technologies like CHP to produce lower cost electricity, and heat pumps to produce renewable heating.

Key statistics

- Underlying annual power demand is relatively flat across all of our scenarios. Variations in demand range from a reduction of 10 TWh/year in **Gone Green** in 2035 to an increase of 5 TWh/year by the same time in **Consumer Power**
- This range is reversed for gas demand: **Gone Green** loses nearly 40 TWh/year and **Consumer Power** increases by about 20 TWh/year by 2035
- Heat pumps add 1.5 TWh/year to power demand in **Gone Green** by 2020
- New CHP accounts for 7.9 TWh/year of additional gas demand between now and 2020 in **Consumer Power**.



20 TWh

Gone Green loses nearly 40 TWh/year and **Consumer Power** increases by about 20 TWh/year by 2035

Industrial and commercial demand

Figure 47
Gas: annual commercial demand

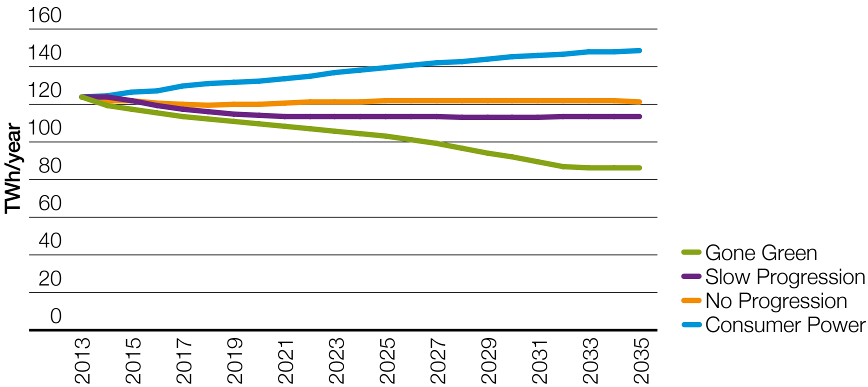
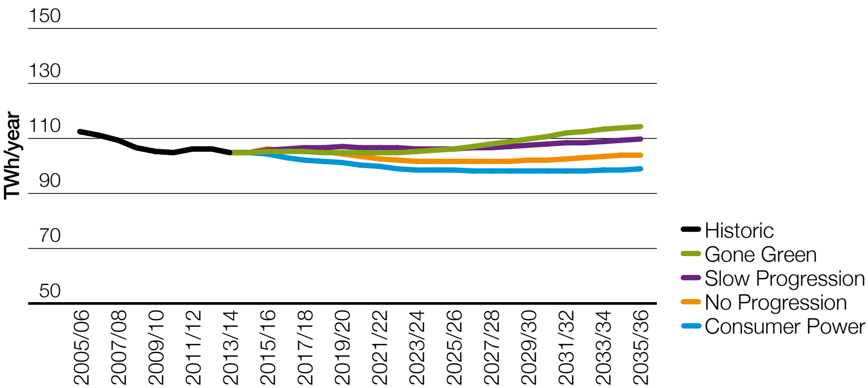


Figure 48
Power: annual commercial demand (excluding losses)



4.6.1 Results

Consumer Power has a relatively stable gas price with escalating electricity prices. Under such conditions the buildings that use electricity for heating start to switch to gas boilers. As such approximately 7 TWh/year of power demand switches by 2035, close to 40% of space heating, hot water and catering related demands. Furthermore, commercial buildings also install gas CHP to avoid buying power from the grid and benefit from lower cost electricity supplies which causes strong growth in gas demands. However, the underlying power demand is not reducing in this scenario.

Gone Green shows the opposite situation occurring, heat is further electrified to reduce its carbon intensity and the switch is instead from gas boilers to electrical heat pumps.

Heat pumps are the low carbon heating solution of choice, with biomass also used in CHP systems. Both are economically attractive due to subsidies, higher gas prices, continued R&D, and increased production bringing economies of scale and capital cost savings. Buildings with waste heat (e.g. refrigeration) can utilise the waste as a resource to make heat pumps more efficient, bringing larger cost savings and a better business case.

Both **Slow Progression** and **No Progression** have fairly stable energy demands; gas is favoured in **No Progression** and power in **Slow Progression** reflecting the higher green ambition in the **Slow Progression** world. This also reflects the relative increase of power and gas prices compared to each other.

Industrial and commercial demand

Chapter four

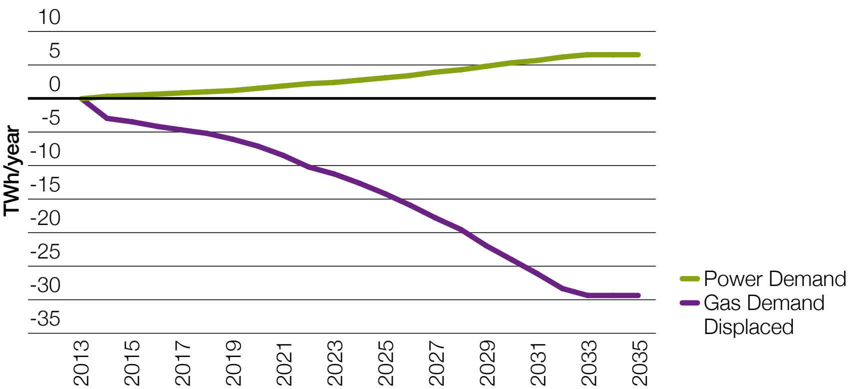
4.6.2
Heat pumps

For electrification and renewable heating to manifest within **Gone Green**, progress has to be made in reducing the capital costs of installing heat pumps along with maintaining incentives to ensure the appliances are economical compared with alternatives. The RHI is funded through the Treasury and is committed until March 2016. In order for **Gone Green** to achieve the 2020 targets the RHI or an alternative mechanism needs to continue to support renewable or low carbon heating from April 2016 onwards.

Additional improvements to the coefficient of performance (COP) from either improved technology or more sophisticated installation setups, such as utilising waste heat from refrigeration, will help too. The combined effect of these leads to a viable business case in **Gone Green** to install heat pumps in commercial buildings.

A high COP, the ratio between electrical input and thermal output, means that the amount of gas offset by installation of heat pumps is several times the increase in new power demand. This ensures that running costs can be similar or lower to alternative gas appliances. In **Gone Green** the average COP is 3.5–4.0 for commercially installed ASHP over the next 20 years. By 2035 2.1 GW of heat pumps are installed, requiring 6.5 TWh/year of power demand but offsetting nearly 30 TWh/year of gas demand.

Figure 49
Change in power and gas demands due to installed commercial heat pumps in Gone Green



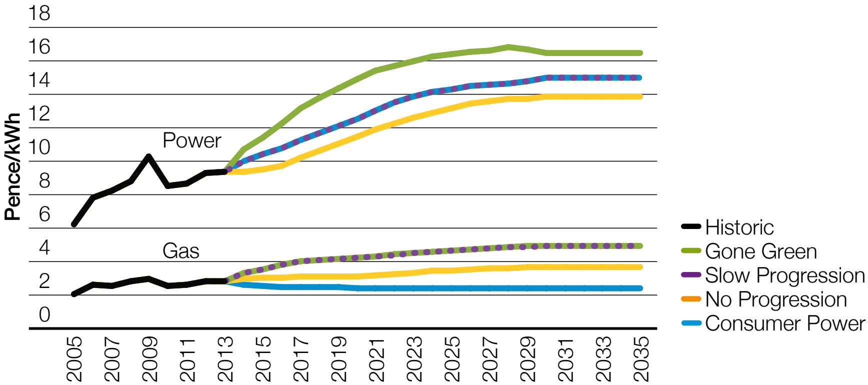
4.6.3
Combined heat and power

CHP uses input energy to produce both electrical energy and thermal energy and is therefore more efficient than producing those two outputs separately. Commercial CHP are generally installed as small scale units with a capacity of <1MW of electrical output and therefore are classed as micro-generation in this report. CHP can have higher overall energy efficiencies compared to conventional gas heating with separate power generation, assuming the heat is used locally and not wasted. Economically, gas CHP could provide lower cost power supplies should retail power and gas prices diverge with electricity becoming relatively more expensive.
The type of input fuel e.g. gas or biomass, has a significant impact on the carbon benefits of on-site CHP.

Should the generation mix progress towards lower carbon sources i.e. carbon intensity progressing to 50gCO_2/kWh by 2030, then the carbon intensity of fossil fuel CHP would result in higher levels than retaining power supplies from the grid and conventional gas heating.

Consumer Power has the highest installation of gas CHP due to the favourable conditions in the scenario. Lower gas prices with base electricity prices and a growing economy, therefore more money to invest, causes the economics for installing gas CHP to be attractive. The other three scenarios share a similar low level of gas CHP installations.

Figure 50
Power and gas retail prices

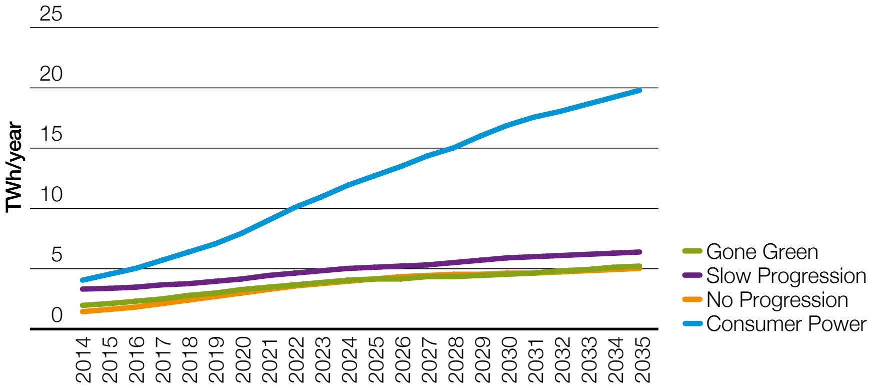


Chapter four

Industrial and commercial demand

Gone Green has the highest uptake of biomass CHP of any of our scenarios. This renewable energy source aligns with the objective of removing carbon emissions from commercial sites. Within this scenario's power generation mix, there is plenty of renewable generation. This results in power from the grid being cleaner and therefore it is greener than the alternative gas CHP.

Figure 51
Gas: demand from additional CHP installation in the commercial sector



Transport

4.7
Transport

From domestic cars to commercial vehicles, including vans and heavy goods vehicles (HGVs), transport is an important area of focus if the UK is going to hit its carbon targets. Electricity and natural gas can both be solutions, giving lower emissions from vehicles in GB. In Gone Green and Consumer Power, electric vehicles (EVs) continue their strong market growth. Natural gas vehicles (NGVs) also make a breakthrough due to good fuel economics and lower emissions.

Key statistics

- Currently NGVs are estimated to be less than 0.1% of the fleet, this is set to grow to 1–3% by 2020 in our scenarios
- Plug-in EVs account for 20,000 cars on Britain's roads but could surpass the one million mark as early as 2022, adding about 2 TWh/year to electricity demand
- In 2035, electric vehicles account for an additional 14 TWh/year in **Gone Green** and **Consumer Power**, however the additional peak demand in **Gone Green** is 1 GW vs 3 GW in **Consumer Power**
- In our scenarios, gas demand for vehicles increases to between 5 and 25 TWh/year in 2035.

20,000

Plug-in EVs account for 20,000 cars on Britain's roads but could surpass the one million mark as early as 2022, adding about 2 TWh/year to electricity demand

Transport

Figure 52
Power: annual demand from electric vehicles (excluding losses)

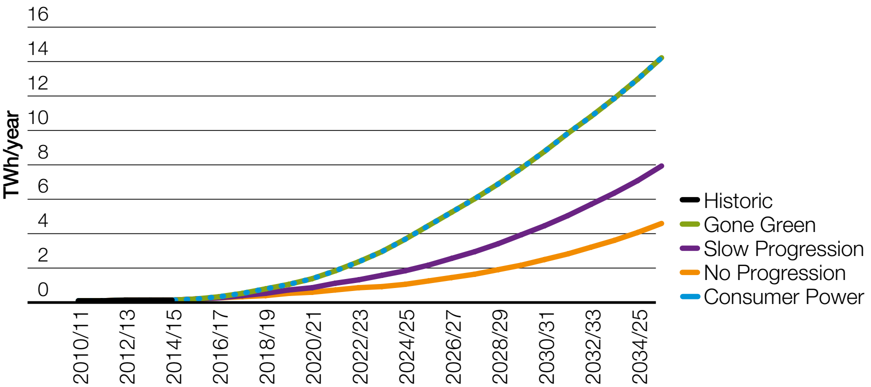
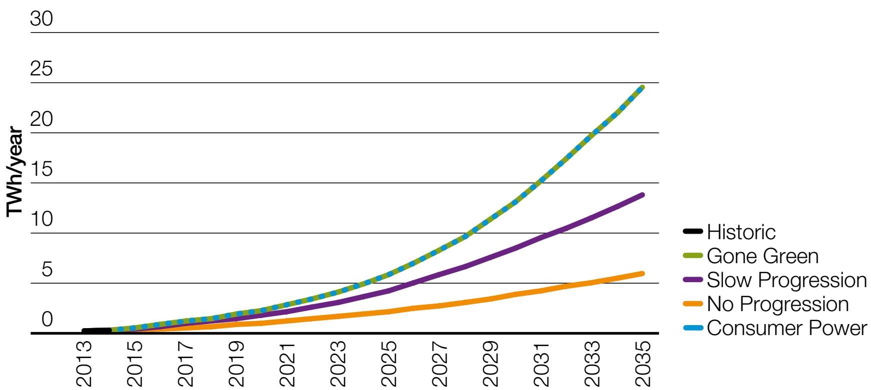


Figure 53
Gas: annual demand from natural gas vehicles



4.7.1
Results – electric vehicles

In this report we have only considered plug-in electric vehicles, which covers pure electric (PEV) and plug-in hybrids (PHEV). EVs which are hybrids with no plug-in recharging mechanism do not have an impact on power demand.

Consumer Power has continued strong growth in the EV market and, with **Gone Green**, the highest uptake of the vehicles. Consumers find the innovative technology and low running costs of electricity compared to petrol appealing and investment in the industry brings down the capital outlay. **Gone Green** has similar results but with environmental concerns given heavier weighting. This is supported by government ambition to decarbonise transport and customers wanting to switch away from internal combustion engines. Recharging stations are easily available allowing for EVs to be used for longer distance travel.

For sales of EVs to continue to grow, battery costs (the most expensive component of an EV) need to come down alongside continued proliferation of fast charging points to combat "range anxiety".

For **No Progression**, the upfront cost implications prevent customers from buying into EVs, cost reductions (mainly batteries) aren't realised and conventional vehicles continue to dominate sales.

This is also true to some extent in **Slow Progression**. However, consumers have the desire to decarbonise their transport with the wish to balance it against the cost and convenience. This leads to demand for PHEV which maximise fuel efficiencies from internal combustion engines without compromising on range and without the cost of large expensive batteries. The same number of PEV is added to GB's roads as in **No Progression**.

The government has committed to support purchases of new EVs with a 35% discount (up to £5,000) for a car and 20% discount for a light goods vehicle (up to £8,000). Funding is available for on-street charging points and support for EVs has led to the Highways Agency installing quick charge points at most motorway service stations to combat the drawback of limited range. These factors have helped to make EVs competitive against conventional vehicles thus contributing to the high growth in sales over the last two years.

Transport

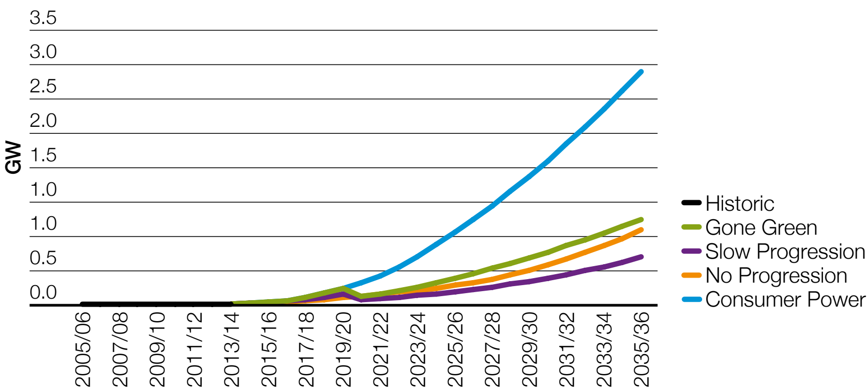
4.7.2
EV peak demand

We apply one of two profile options to our four different scenarios. The first profile is based upon an uninhibited charging regime that operates in all our scenarios up to 2020 and thereafter only in **No Progression** and **Consumer Power**. Secondly, for **Gone Green** and **Slow Progression**, we assume that TOUTs will come into effect in 2020, in line with the domestic roll-out programme and for the same reasons (see the Methodology for section 4.4). This explains why there is a dip in these two profiles and then a rise in their trajectories.

The implementation of TOUTs separates the **Gone Green** and **Consumer Power** profiles shown in Figure 54. It also raises peak demand for **No Progression** above that for **Slow Progression**, a reversal of their relative positions in the annual demands.

Peak power demand, in 2035, for **Gone Green** is 71 GW and **Consumer Power** 65 GW and so electric vehicles will only contribute 1.4% and 4.6% respectively to the peak load.

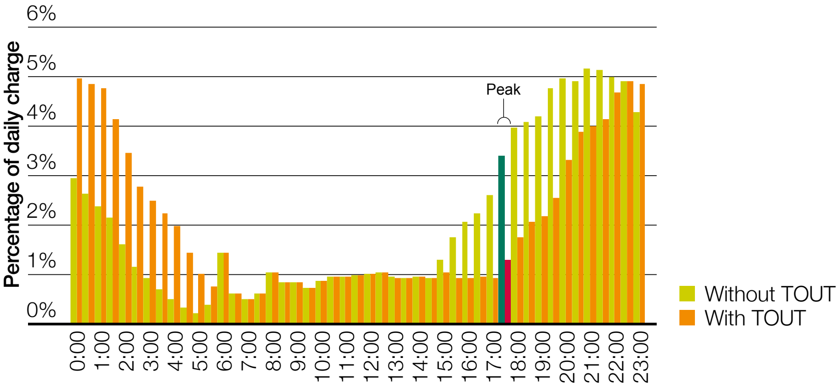
Figure 54
Power: peak demand contribution from electric vehicles (excluding losses)



The uninhibited profile, based on findings from the Consumer-led Network Revolution trials[1], assumes that consumer will charge their vehicles when it is convenient to them and that is when they arrive home, or work finishes, adding a significant load during the peak period.

The constrained profile applies a TOUT element in the early evening period, in order to encourage displacement of demand by two hours. Consequently the constrained demand at 17:30hrs is reduced to 38% of the uninhibited value.

Figure 55
Electric vehicle charging profile for a January day



[1] http://www.networkrevolution.co.uk/project-library/insight-report-electric-vehicles/

Transport

4.7.3
Natural gas vehicles

NGV are defined as vehicles that use natural gas, predominantly methane, as part of their drive chain. This could be a hybrid system running with diesel, or running only from gas. Gas is stored for use in the vehicle in two types: liquefied or compressed natural gas. Liquefied natural gas (LNG) is either taken by tanker to the pump or liquefied on-site while compressed nature gas (CNG) is gas stored at a high pressure, around 200 bar, compressed at the fuelling station. Typically CNG vehicles are attractive for back to depot applications (logistics, public transport fleets) where they can be regularly refuelled at a purpose built location. LNG is more attractive for long haulage vehicles due to the higher energy density which leads to additional range.

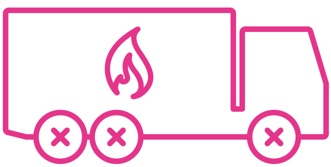
Advantages of NGVs include:

- lower price of natural gas vs diesel
- quieter engines, allowing for earlier deliveries in residential areas
- lower emissions for CO_2, NOx and particles i.e. enhanced air quality benefits

Disadvantages include:

- shorter ranges
- lack of fuelling infrastructure.

The biggest take up of NGVs occurs in **Gone Green** and **Consumer Power**. The need for decarbonisation in **Gone Green** drives the conversion of the fleets, while in **Consumer Power** motives are driven by the economics of changing fleets to NGVs to take advantage of the lower gas prices. **Slow Progression** has a slower rate of take up due to lower availability of investment capital but with the same market drivers as **Gone Green** for decarbonisation. **No Progression** has the lowest take up, with less intervention and less capital available for investment, the infrastructure isn't built, preventing NGVs being viable options other than within private refuelling infrastructure.



4.7.4
Rail demand

Our stakeholder engagement suggests that there will be continued growth in the demand from trains but there are two potential trajectories. In **Gone Green** and **Slow Progression** a growth rate greater than the historical average is predicted; that is 2.5% year on year. This increases today's demand of 4.1 TWh/year to 2035's value of 7.1 TWh/year. This increase is driven by policy decisions to invest more in the electrification of the network. In **No Progression** and **Consumer Power** we have adopted the historical average of 1.5% percent which in 2035 gives a demand of 5.7 TWh/year.

Transport

Method

Our transport analysis is built on feedback from our stakeholder engagement. Using historic figures from The Society of Motor Manufacturers and Traders (SMMT) and Driver and Vehicle Licensing Agency (DVLA) we have applied growth rates for pure electric and plug-in hybrids. This has given us total numbers of vehicles in each year. Then data on the average number of miles driven per year and kWh/mile from the current tranche of EVs is applied to calculate the energy demands for those vehicles. We asked our stakeholders what level they thought EV sales would reach in 2030 and used their feedback to calibrate the growth rates. The feedback was that our growth rates from the FES 2014 analysis were in line with expectations and the 2014 actual numbers were in our scenario's envelope so there is only a small change in the numbers from year to year.

Last year we had assumed that London would be a very high growth area for EVs. This has now changed to reflect the data that London is a lower growth area for EVs at this time and therefore we have lowered the proportion of EVs in London. With shorter distances of travel in London this meant that we had calculated slightly lower power demands.

For the within-day charging profiles we use data from the Customer-Led Network Revolution trials[2] to inform us of the likely within-day charge profile for a system peak day.

We have added NGVs to our analysis this year and have followed a similar approach to our EV analysis. We asked stakeholders at what level they thought NGVs would be in the GB fleet in 2030 and used this to calibrate growth rates. With total numbers of vehicles we then considered drivetrains (LNG, CNG and hybrid) and their suitability to different size, and modes of vehicles. This, along with data on diesel consumptions for vehicles, is used to calculate gas demands to effectively offset diesel demands.

There is very little data on NGVs at this time as the market is at an early stage. We will look to see what new data will be collected in the future that can influence our methodology.

For railways we have used National Rail's published business plans and energy consumption in the UK's Transport data tables[3] as our start point.

[2] http://www.networkrevolution.co.uk/wp-content/uploads/2014/08/CLNRL077-TC6.zip

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338678/transport.xls

Chapter eight

Appendix 1
Government policy

CRC Energy Efficiency Scheme (CRC)
The Carbon Reduction Commitment (CRC) Energy Efficiency Scheme[1] is a mandatory scheme aimed at improving energy efficiency and cutting emissions in large public and private sector organisations. The scheme features a range of reputational, behavioural and financial drivers, which aim to encourage organisations to develop energy management strategies that promote a better understanding and more efficient use of energy.

Electricity Market Reform (EMR)
Electricity Market Reform[2] includes the introduction of new long-term contracts: Contracts for Difference (CfDs) for new low carbon generation projects, a Carbon Price Floor[3] (in place since April 2013) and a Capacity Market, to include demand response, interconnectors and generation. EMR also includes an Emissions Performance Standard (EPS), set at 450gCO_2/kWh, to reinforce the requirement that no new coal-fired power stations are built without carbon capture and storage (CCS) and to ensure necessary investment in gas can take place. The Energy Act of 2013 gave the Secretary of State for Energy and Climate Change the power to introduce these elements of EMR (to work alongside the Carbon Price Floor[1]).

National Grid as the National Electricity Transmission System Operator (NETSO) has been appointed as the Delivery Body for EMR. This involves administering the Capacity Market and CfDs on behalf of DECC, as well as providing key analysis to inform decision making.

Our analysis of EMR is ongoing. We have taken account of the main themes in deriving our power supply backgrounds, shown in chapter 5. We assume that the mechanisms will play a part in maintaining adequate plant margins and will ensure that there is sufficient renewable and low carbon generation to meet the renewable and carbon targets in the **Gone Green** scenario.

Feed-In Tariffs scheme (FIT)
The Feed-In Tariffs scheme[4] aims to encourage small scale renewable and low carbon electricity generation by paying users for each unit of electricity generated, as well as a payment for each unit exported to the grid. The scheme is applicable to a number of technologies (solar PV, wind, hydro, and anaerobic digestion) up to a maximum capacity of 5MW of total installed capacity (TIC). Micro combined heat and power (mCHP) plants are also eligible up to 2kW.

Green Deal Energy Company Obligation (ECO)
Green Deal[5] replaces the Carbon Emissions Reduction Target[6] (CERT). It allows individuals and businesses to make energy efficiency improvements to their buildings at no upfront cost through access to the finance needed for the improvements with repayment, in instalments, attached to the electricity bill. Research conducted by GfK NOP showed that in November 2013, 23% of consumers were aware of the Green Deal[7]. It is estimated that 26 million homes could be eligible for Green Deal financing. By the end of March 2015, over 530,000 Green Deal assessments had been carried out, 184 authorised Green Deal providers had been registered and 2,258 organisations were signed up to carry out installations[8].

[1] https://www.gov.uk/crc-energy-efficiency-scheme-qualification-and-registration#overview
[2] https://www.gov.uk/government/policies/maintaining-uk-energy-security--2/supporting-pages/electricity-market-reform
[3] The carbon price floor was legislated for in the 2011 Finance Act
[4] https://www.gov.uk/feed-in-tariffs
[5] https://www.gov.uk/green-deal-energy-saving-measures
[6] http://webarchive.nationalarchives.gov.uk/20121217150421/www.decc.gov.uk/en/content/cms/funding/funding_ops/cert/cert.aspx
[7] https://www.gov.uk/government/publications/green-deal-household-tracker-wave-3
[8] https://www.gov.uk/government/collections/green-deal-and-energy-company-obligation-eco-statistics

Energy Company Obligation (ECO)

The Energy Company Obligation (ECO) commenced in 2013 and will operate until March 2017. It places a legal obligation on energy suppliers to satisfy energy efficiency and fuel saving targets to households. ECO is primarily focused on households unable to achieve significant energy savings from Green Deal without an additional or different measure of support. ECO is directed towards vulnerable and low-income households, community schemes, and those living in harder to treat properties, such as those with solid walls.

Industrial Emissions Directive (IED)

The Industrial Emissions Directive[9] is a European Union directive which commits member states to control and reduce the impact of industrial emissions on the environment post-2015 when the Large Combustion Plant Directive (LCPD) expires.

Under the terms of the IED, affected plant can:

- Opt out and continue running under previous (LCPD) emission limits.
- Opt in under the Transitional National Plan (TNP), which will impose a cap on annual mass nitrogen oxide emissions and a decreasing cap on annual mass sulphur dioxide emissions on all plants operating under a country's TNP until mid-2020. At that point they will have to decide whether to fit appropriate emission-reducing equipment to comply with the directive, be limited to run a maximum of 1,500 hours a year or close.
- Opt in and comply fully from 1 January 2016. This will mean fitting selective catalytic reduction equipment or additional flue-gas de-sulphurisation technology for some plants.

Large Combustion Plant Directive (LCPD)

The Large Combustion Plant Directive[10] is a European Union directive which introduced measures to control the emissions of sulphur dioxide, oxides of nitrogen and dust from large combustion plant. Large power stations (installed capacity greater than 50MW) in the UK must comply with the LCPD. Plants that 'opt out' of meeting the new standards must close by 2015 or after 20,000 hours of operation.

Levy Control Framework (LCF)

The Levy Control Framework[11] caps the annual amount of money that can be levied on bills to support UK low carbon generation at £2.35bn in 2012/13, rising to £7.6bn in 2020/21. This covers Feed-in Tariffs (FITs), Renewables Obligation (RO) and Contracts for Difference.

Renewable Heat Incentive (RHI)

The Renewable Heat Incentive[12] scheme provides payments for heat generated from renewable technologies including biomass boilers, solar thermal and heat pumps. There are three distinct phases of financial support:

- RHI Phase 1 – for commercial, industrial, public, not-for-profit and community generators of renewable heat
- RHI Phase 2 – a renewable heat premium payment (RHPP) to householders who have no access to the gas network and who generate renewable heat. Under RHPP householders receive a single payment for the installation of renewable heat technology
- RHI Phase 3 – for householders generating renewable heat. Householders will receive regular annual or quarterly payments for heat generated.

[9] http://www.official-documents.gov.uk/document/hc1012/hc16/1604/1604.pdf (page 12)

[10] https://www.gov.uk/government/publications/environmental-permitting-guidance-the-large-combustion-plants-directive

[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48244/3290-control-fwork-decc-levyfunded-spending.pdf

[12] https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi

Appendix 1
Government policy

Renewables Obligation (RO)
The Renewables Obligation[13] (RO) is the main support mechanism for renewable electricity projects in the UK. Smaller scale generation is mainly supported through the Feed-in Tariff scheme (FITs).

The RO came into effect in 2002 in England and Wales, and Scotland, followed by Northern Ireland in 2005. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources.

Renewables Obligation Certificates (ROCs) are green certificates issued to operators of accredited renewable generating stations for the eligible renewable electricity they generate. Operators can trade ROCs with other parties. ROCs are ultimately used by suppliers to demonstrate that they have met their obligation.

Where suppliers do not present a sufficient number of ROCs to meet their obligation, they must pay an equivalent amount into a buy-out fund. The administration cost of the scheme is recovered from the fund and the rest is distributed back to suppliers in proportion to the number of ROCs they produced in respect of their individual obligation.

Energy Saving Opportunities Scheme (ESOS)
The government established ESOS[14] to implement Article 8 (4-6) of the EU Energy Efficiency Directive (2012/27/EU). The ESOS Regulations 2014 give effect to the scheme.

ESOS is a mandatory energy assessment scheme for organisations in the UK that meet the qualification criteria. The Environment Agency is the UK scheme administrator.

Organisations that qualify for ESOS must carry out ESOS assessments every 4 years. These assessments are audits of the energy used by their buildings, industrial processes and transport to identify cost-effective energy saving measures.

Organisations must notify the Environment Agency by a set deadline that they have complied with their ESOS obligations, the first of which is 5 December 2014.

[13] https://www.ofgem.gov.uk/environmental-programmes/renewables-obligation-ro
[14] https://www.gov.uk/energy-savings-opportunity-scheme-esos

Appendix 2 – Meet the Energy, Strategy & Policy team

Balancing and Markets
We explore the future electricity balancing challenges and opportunities relating to changing generation and demand. We consider the role that technologies such as interconnectors, electricity storage, demand side response and other innovative solutions may play in the future balancing toolkit. Engagement with stakeholders is vital to the development of ourinterconnector scenarios and through industry groups and bilateral meetings we ensure all perspectives are taken into consideration. We welcome your views on balancing the electricity system over coming decades.

Emma Carr
Balancing and Markets Manager

Dave Wagstaff
EMR Network Cost Analyst

Iain Ashworth
Balancing Analyst

Matthew Speedy
Balancing Analyst

Rhiannon Grey
Balancing Analyst

EMR Modelling
Our team was set up to fulfil part of National Grid's obligations as Electricity Market Reform (EMR) Delivery Body. Our responsibilities include analysis used to recommend the capacity to procure in the Capacity Market that is published annually in our Electricity Capacity Reports and modelling to inform the setting of strike prices for Contracts for Difference (CfDs) as illustrated by our report for the EMR Delivery Plan. We also carry out related modelling work outside of our EMR responsibilities, for example to inform the volume of the new balancing services (SBR and DSBR) required in the mid-decade years.

Duncan Rimmer
EMR Modelling Manager

Ajay Pandey
EMR Senior Data Officer

Gareth Lloyd
EMR Analytical Manager

Simon Geen
EMR Analytical Manager

Gas Demand
As the gas demand team we project the usage of gas for both the Industrial and Commercial markets and the residential sector. We utilise various modelling tools and techniques to support our analysis alongside taking part in several industry discussion groups to balance our statistical analysis with innovative thinking on the future of gas. Heat forms a significant part of our analysis as this is currently dependent on gas in addition to transport which has the potential to become more reliant on gas. Amongst our stakeholders, we engage with gas providers and distribution networks to ensure we're using the most up to date information. If you can share any views on gas demand, please get in touch.

Iain Shepherd
Energy Demand Analyst

Phil Clough
Gas Demand Analyst

Rob Nickerson
Senior Gas Demand Analyst

Appendix 2 – Meet the Energy, Strategy & Policy team

Gas Supply
We take gas demand projections from our colleagues in the Gas Demand team and work out how much gas will have to come from different sources to meet the demand. Our work depends very much on detailed industry knowledge rather than complicated mathematical modelling, and is helped by the 70 years of industry experience that we have between us. During the year we talk to major industry players, producers, terminal operators, other network operators and potential developers. We also attend industry discussions, all to make sure that we are working with the best possible information when we come to make our supply to demand match. If you have anything that you think we should know about possible gas supplies we'd be very interested to hear from you.

Simon Durk
Gas Supply Manager

Nigel Bradbury
Primary Energy Analyst

Chris Thompson
Senior Gas Supply Analyst

Christian Parsons
Gas Supply Analyst

Market Outlook
We bring together expert thinking, market data, industry experts, stakeholder feedback and indepth analysis to create a rounded view of the future of energy. Our publications cover the short, medium and longer-term including the Winter and Summer Outlook Reports, the Winter Consultation, the Safety Monitors Report and, of course, the Future Energy Scenarios (FES). Our role is to extract the key messages from the inputs and analysis to give a clear direction to National Grid and the industry on energy trends, landscapes and the future energy challenges. We also produce the Stakeholder Feedback document that summarises views from interested parties on the FES document and provides a commentary of how these responses have been used to develop and progress the scenarios. We welcome your views on the content of all these documents.

Catherine Lange
Market Outlook Manager

Andy Dobbie
Energy Security Analyst

Caroline Kluyver
Content Officer

Chris Thackeray
Content Officer

Duncan Sluce
Energy Security Analyst

Faye Relton
Strategy Analyst

Power Demand
We spend much of our time striving to understand electricity usage once it's been generated. Our models are concerned with what people do with electricity in their day-to-day lives, from the home to the office and beyond, from an annual basis right down to an understanding of within day usage profiles. This considers the future landscape for transport, heating and lighting. To understand potential electricity usage, we engage with members of Britain's society, including homeowners, business people, academics and journalists. We also regularly attend a wide range of industry events and conferences along with reading a wide range of publications and annual reports. Please let us know your thoughts and opinions on power demand and how this may change into the future.

Russell Fowler
Power Demand Manager

Huw Thomas
Power Demand Analyst

Kein-Arn Ong
Senior Power Demand Analyst

Orlando Elmhirst
Senior Power Demand Analyst

Power Supply
We consider the sources of generation that will be used to meet power demand now and in the future. We consider all sources of generation (both established and emerging technologies) irrespective of where and how they are connected. We consider how the political ambition, environmental legislation, the economic climate, technological advancements and social engagement influence electricity generation. We look forward to discussing with you our power supply scenarios and will be delighted to hear from you if you have any information on power supply which could be included in our analysis.

Lilian MacLeod
Power Supply Manager

Dr Giuliano Bordignon
Senior Power Economics Analyst

Greg Hunt
Senior Power Supply Analyst

Janet Coley
Senior Power Supply Analyst

Luke Cutler
Power Supply Analyst

Mark Perry
Senior Power Supply Analyst

Secondments

Liana Cipcigan
Seconded from Cardiff University

Leadership team

Roisin Quinn
Head of Energy, Strategy and Policy

Janet Mather
Demand and Supply Manager

Kirsty Martin
PA to Head of Energy, Strategy and Policy

Marcus Stewart
Energy Supply Manager

Nigel Fox
Strategy Development Manager

Appendix 3 Glossary

Acronym	Word	Description
ACT	Advanced conversion technology	Gasification, pyrolysis or anaerobic digestion, or any combination of those.
ASHP	Air source heat pump	Air source heat pumps absorb heat from the outside air. This heat can then be used to produce hot water or space heating.
ARA	Amsterdam Rotterdam and Antwerp (Coal Price)	The cost of coal in the major NW Europe coal importing ports of Amsterdam/Rotterdam/Antwerp (ARA). http://www.worldcoal.org/resources/coal-statistics/shipping-terms-glossary/
AD	Anaerobic digestion	Bacterial fermentation of organic material in the absence of free oxygen.
	Ancillary services	Services procured by a system operator to balance demand and supply and to ensure the security and quality of electricity supply across the transmission system. These services include reserve, frequency control and voltage control. In GB these are known as balancing services and each service has different parameters that a provider must meet.
	Annual power demand	The electrical power demand in any one fiscal year. Different definitions of annual demand are used for different purposes.
ACS	Average cold spell	Average cold spell: defined as a particular combination of weather elements which gives rise to a level of winter peak demand which has a 50% chance of being exceeded as a result of weather variation alone. There are different definitions of ACS peak demand for different purposes.
BBL	Balgzand Bacton Line	A gas pipeline between Balgzand in the Netherlands and Bacton in the UK. http://www.bblcompany.com
	Baseload electricity price	The cost of wholesale electricity paid for baseload power.
bcm	billion cubic metres	Unit or measurement of volume, used in the gas industry. 1 bcm = 1,000,000,000 cubic metres
	Biogas	Biogas is a naturally occurring gas that is produced from organic material and has similar characteristics to natural gas.
	Biomethane	We use the term biomethane specifically for biogas that is of a suitable quality to be injected into distribution or transmission networks. http://www.biomethane.org.uk/
	Boil-off	A small amount of gas which continually boils off from LNG storage tanks. This helps to keep the tanks cold.
CM	Capacity Market	The Capacity Market is designed to ensure security of electricity supply. This is achieved by providing a payment for reliable sources of capacity, alongside their electricity revenues, ensuring they deliver energy when needed.
CCS	Carbon capture and storage	Carbon (CO_2) Capture and Storage (CCS) is a process by which the CO_2 produced in the combustion of fossil fuels is captured, transported to a storage location and isolated from the atmosphere. Capture of CO_2 can be applied to large emission sources like power plants used for electricity generation and industrial processes. The CO_2 is then compressed and transported for long-term storage in geological formations or for use in industrial processes.
CO_2	Carbon dioxide	Carbon dioxide (CO_2) is the main greenhouse gas and the vast majority of CO_2 emissions come from the burning of fossil fuels (coal, natural gas and oil).
CPF	Carbon price floor	A price paid by UK generators and large carbon intensive industries for CO_2 emissions.
CPS	Carbon price support	A price paid by UK generators and large carbon intensive industries in addition to the EU ETS to guarantee a minimum floor price for CO_2 emissions.
CRC	Carbon Reduction Commitment	See appendix on government policy. The Carbon Reduction Commitment is a mandatory scheme aimed at improving energy efficiency and cutting emissions in large public sector and large private sector organisations.
	Cash out	Prices that are used to settle the difference between contracted generation or consumption and the amount that was actually generated or consumed in each half hour trading period

Acronym	Word	Description
	Climate change targets	Targets for share of energy use sourced from renewable sources. The 2020 UK targets are defined in the Directive 2009/28/EC of the European Parliament and of the Council of the European Union, see http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0028&from=EN#ntc1-L_2009140EN.01004601-E0001
CBM	Coal bed methane	Coal bed methane is methane that is extracted from un-mined coal seams by drilling wells directly into the seams to release the gas. http://www.worldcoal.org/coal/coal-seam-methane/coal-bed-methane/
COP	Coefficient of performance	The ratio of heating (or cooling) provided per electrical energy consumed.
CCGT	Combined cycle gas turbine	Gas turbine that uses the combustion of natural gas or diesel to drive a gas turbine generator to generate electricity. The residual heat from this process is used to produce steam in a heat recovery boiler which in turn, drives a steam turbine generator to generate more electricity.
CHP	Combined heat and power	A system whereby both heat and electricity are generated simultaneously as part of one process. Covers a range of technologies that achieve this.
CFL	Compact fluorescent light	A lighting technology introduced to replace traditional incandescent bulbs. Commonly referred to as energy saving bulbs.
CWV	Composite weather variable	A measure of weather incorporating the effects of both temperature and wind speed. We have adopted the new industry wide CWV equations that take effect on 1 October 2015.
CNG	Compressed natural gas	Compressed natural gas is made by compressing natural gas to less than 1 percent of the volume it occupies at standard atmospheric pressure.
CfD	Contract for Difference	See appendix on government policy. Contract between the Low Carbon Contracts Company (LCCC) and a low carbon electricity generator designed to reduce its exposure to volatile wholesale prices.
DBSR	Demand side balancing reserve	Demand side balancing reserve (DSBR) is a balancing service that has been developed to support National Grid in balancing the system during the mid-decade period when capacity margins are expected to be tight. DSBR is targeted at large energy users who volunteer to reduce their demand during winter week-day evenings between 4 and 8pm in return for a payment. Along with supplemental balancing reserve (SBR), this service will act as a safety net to protect consumers, only to be deployed in the event of there being insufficient capacity available in the market to meet demand.
DSR	Demand side response	A deliberate change to an industrial and commercial user's natural pattern of metered electricity or gas consumption, brought about by a signal from another party.
DECC	Department of Energy and Climate Change	A UK government department: The Department of Energy & Climate Change (DECC) works to make sure the UK has secure, clean, affordable energy supplies and promote international action to mitigate climate change.
	Deterministic	A modelling approach that produces a single view or outcome. This approach has no random elements as all outcomes and inputs are completely determined.
DUKES	Digest of UK Energy Statistics	A DECC publication which contains historic information on energy in the UK.
	Dispatch (aka economic dispatch)	The operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities.
	Distributed generation	Generation connected to the distributed networks which is equal or greater than 1 MW in size, up to onshore transmission areas' mandatory connection thresholds. The thresholds are 100 MW in NGET transmission area, 30 MW in Scottish Power (SP) transmission area and 10 MW in Scottish Hydro-Electric Transmission (SHET) transmission area.
	Distribution losses	Power losses that are caused by the electrical resistance of the distribution system.
DNO	Distribution network operator	Distribution network operators own and operate gas or electricity distribution networks.

Appendix 3 Glossary

Acronym	Word	Description
EV	Electric vehicle	An electric vehicle has an electric motor to drive the vehicle. It can either be driven solely off a battery, as part of a hybrid system or have a generator that can recharge the battery but does not drive the wheels. We only consider EVs that can be plugged in to charge in this report.
EMR	Electricity Market Reform	See appendix on government policy. A government policy to incentivise investment in secure, low-carbon electricity, improve the security of Great Britain's electricity supply, and improve affordability for consumers.
ELSI	Electricity scenario illustrator	ELSI is a National Grid tool used to model network constraint costs and interconnector flows.
	Electricity storage technologies	Mechanical (for example, pumped hydro and compressed air), thermal (for example, molten salt), electrical (for example, supercapacitors), electrochemical (various battery types), chemical (for example, hydrogen). Each technology has different characteristics, such as speed and duration of response, scale and maturity status.
ETYS	Electricity Ten Year Statement	The ETYS illustrates the potential future development of the National Electricity Transmission System (NETS) over a ten year (minimum) period and is published on an annual basis.
ETL	Electricity Transmission Licence	A permit which allows transmission companies to own and operate electricity transmission assets. Conditions within the licence place rules on how holders can operate within their licence.
	Embedded generation	Power generating stations/units that don't have a contractual agreement with the National Electricity Transmission System Operator (NETSO). They reduce electricity demand on the National Electricity Transmission System.
ECO	Energy Company Obligation	See appendix on government policy. The scheme places a legal obligation on energy suppliers to help households meet energy efficiency and fuel savings targets.
ECUK	Energy Consumption in the UK	A UK government publication which reviews historic energy consumption and changes in efficiency, intensity and output since the 1970s.
ENA	Energy Networks Association	The Energy Networks Association is an industry association funded by gas or transmission and distribution licence holders.
ESOS	Energy Savings Opportunity Scheme	See appendix on government policy. The Energy Savings Opportunity Scheme is a mandatory energy assessment scheme for qualifying organisations in the UK.
	Error correcting model	A model with the characteristics that the deviation of the current state from its long-run relationship will be fed into its short-run dynamics.
EU ETS	EU Emissions Trading Scheme (EU ETS)	A European Union trading scheme that allows participants to buy and sell carbon emissions allowances. https://www.gov.uk/eu-ets-carbon-markets
ENTSO-E	European Network of Transmission System Operators – Electricity	ENTSO-E is an association of European electricity TSOs. ENTSO-E was established and given legal mandates by the EU's Third Legislative Package for the Internal Energy Market in 2009, which aims at further liberalising electricity markets in the EU.
EU	European Union	A political and economic union of 28 member states that are located primarily in Europe.
FiT	Feed-in Tariffs	See appendix on government policy. Government programme designed to promote the uptake of a range of small-scale renewable and low-carbon electricity generation technologies
FIDER	Final Investment Decision Enabling for Renewables	Scheme to help developers of low carbon electricity projects make final investment decisions ahead of the Contract for Difference regime.
FFR	Firm Frequency Response	Firm Frequency Response (FFR) is the firm provision of Dynamic or Non-Dynamic Response to changes in Frequency. http://www2.nationalgrid.com/uk/services/balancing-services/frequency-response/firm-frequency-response/
	Foot room	The ability for a generation plant to allow output to decrease without going below its minimum output level and disconnecting from the system.

Acronym	Word	Description
	Frequency controlled demand management	Frequency control demand management (FCDM) provides frequency response through interruption of demand customers. The electricity demand is automatically interrupted when the system frequency transgresses the low frequency relay setting on site. http://www2.nationalgrid.com/uk/services/balancing-services/frequency-response/frequency-control-by-demand-management/
	Frequency response	An ancillary service procured by National Grid as system operator to help ensure system frequency is kept as close to 50Hz as possible. Also known as frequency control or frequency regulation.
FES	Future Energy Scenarios	The FES is a range of credible futures which has been developed in conjunction with the energy industry. They are a set of scenarios covering the period from now to 2050, and are used to frame discussions and perform stress tests. They form the starting point for all transmission network and investment planning, and are used to identify future operability challenges and potential solutions.
GTYS	Gas Ten Year Statement	The GTYS illustrates the potential future development of the (gas) National Transmission System (NTS) over a ten year period and is published on an annual basis.
GW	Gigawatt	1,000,000,000 watts, a measure of power
GWh	Gigawatt hour	1,000,000,000 watt hours, a unit of energy
gCO_2/kWh	Gram of carbon dioxide per kilowatt hour	Measurement of CO_2 equivalent emissions per kWh of energy used or produced
GB	Great Britain	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.
	Green Deal	See appendix on government policy. A scheme that allows individuals and businesses to make energy efficiency improvements to their buildings.
GDHIF	Green Deal Home Improvement Fund	See appendix on government policy. A scheme that allows individuals to get financial support for qualifying energy efficiency improvements to homes.
GHG	Green house gases	A gas in the atmosphere that absorbs and emits radiation within the thermal infrared range.
GDP	Gross Domestic Product	An aggregate measure of production equal to the sum of the gross values added of all resident, institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs).
GVA	Gross Value Added	The value of goods and services produced in a sector of the economy
GSHP	Ground source heat pump	Ground source heat pumps absorb heat from the ground. This heat can then be used to produce hot water or space heating.
	Head Room	The operation of generation plant below its minimum output levels to allow output to increase at times of need.
	Heat pump	A heat pump is a device that provides heat energy from a source of heat to a destination called a “heat sink”.
HGV	Heavy goods vehicle	A truck weighing over 3,500kg.
HHDI	Household disposable income	Household income minus tax.
IED	Industrial Emissions Directive	See appendix on government policy. The Industrial Emissions Directive is a European Union directive which commits member states to control and reduce the impact of industrial emissions on the environment post-2015 when the Large Combustion Plant Directive (LCPD) expires.
ITPR	Integrated Transmission Planning and Regulation	Ofgem’s Integrated Transmission Planning and Regulation (ITPR) project examined the arrangements for planning and delivering the onshore, offshore and cross-border electricity transmission networks. Ofgem published the final conclusions in March 2015.
IUK	Interconnector (UK)	A bi-directional gas pipeline between Bacton in the UK and Zeebrugge Belgium. http://www.interconnector.com

Appendix 3
Glossary

Acronym	Word	Description
	interconnector, gas	Gas interconnectors connect gas transmission systems from other countries to the National Transmission System (NTS) in England, Scotland and Wales. There are currently three gas interconnectors which connect to the NTS. These are: – IUK interconnector to Belgium – BBL to the Netherlands – Moffat to the Republic of Ireland, Northern Ireland and the Isle of Man.
	interconnector, power	Electricity interconnectors are transmission assets that connect the GB market to Europe and allow suppliers to trade electricity between markets.
IRR	Internal Rate of Return	The annualised rate of return, independent of inflation, for the net present value of an investment of zero in a given time frame.
IEA	International Energy Agency	The International Energy Agency is an intergovernmental organisation that acts as an energy policy advisor to member states.
LCPD	Large Combustion Plant Directive	See appendix on government policy. The Large Combustion Plant Directive is a European Union Directive which introduced measures to control the emissions of sulphur dioxide, oxides of nitrogen and dust from large combustion plant.
LCF	Levy Control Framework	See appendix on government policy. The Levy Control Framework caps the annual amount of money that can be levied on bills to support UK low carbon generation at £2.35bn in 2012/13, rising to £7.6bn in 2020/21. This covers Feed-in Tariffs (FITs), Renewables Obligation (RO) and Contracts for Difference.
LED	Light emitting diode	An energy efficient electronic lighting technology which is increasingly being adopted in UK homes and businesses.
LNG	Liquefied natural gas	LNG is formed by chilling gas to -161˚C so that it occupies 600 times less space than in its gaseous form. www2.nationalgrid.com/uk/Services/Grain-lng/what-is-lng/
	Load Factor	the average power output divided by the peak power output over a period of time.
LDZ	Local Distribution Zone	A gas distribution zone connecting end users to the (gas) National Transmission System.
LOLE	Loss of load expectation	LOLE is used to describe electricity security of supply. It is an approach based on probability and is measured in hours/year. It measures the risk, across the whole winter, of demand exceeding supply under normal operation. This does not mean there will be loss of supply for X hours/year. It gives an indication of the amount of time, across the whole winter, which the system operator (SO) will need to call on balancing tools such as voltage reduction, maximum generation or emergency assistance from interconnectors. In most cases, loss of load would be managed without significant impact on end consumers.
LCCC	Low Carbon Contracts Company	Private company owned by the Department of Energy and Climate Change (DECC) that manages the Contracts for Difference (CFD) scheme introduced by government as part of the EMR programme.
LCHT	Low carbon heating technology	A heating technology that has a lower carbon intensity for heating homes than an A rated condensing gas boiler
LCNF	Low Carbon Network Fund	A fund established by Ofgem to support projects sponsored by the distribution network operators (DNOs) to try out new technology, operating and commercial arrangements.
	Marine technologies	Tidal streams, tidal lagoons and energy from wave technologies (see http://www.emec.org.uk/)
	Medium range storage	These commercially operated sites have shorter injection/withdrawal times so can react more quickly to demand, injecting when demand or prices are lower and withdrawing when higher. http://www2.nationalgrid.com/UK/Our-company/Gas/Gas-Storage/
MWe	Megawatt (electrical)	1,000,000 Watts, a measure of power.
MWh	Megawatt hour	1,000,000 Watt hours, a measure of power usage or consumption in 1 hour.
	Merit Order	An ordered list of generators, sorted by the marginal cost of generation.
mCHP	Micro-Combined Heat and Power	A subset of CHP, designed for domestic use.

Acronym	Word	Description
	Micro generation	Defined within this document as generation units with an installed capacity of less than 1 MW.
mcm	Million cubic meters	Unit or measurement of volume, used in the gas industry. 1 mcm = 1,000,000 cubic metres.
Mte CO_2	Million tonnes of CO_2 equivalent	Carbon dioxide equivalency is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential (GWP), when measured over a specified timescale (generally, 100 years).
	N-1	Refers to the European Commission security of supply test, where total supply minus the largest single loss is assessed against total peak demand. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:295:0001:0022:EN:PDF
NBP	National balancing point	The wholesale gas market in Britain has one price for gas irrespective of where the gas comes from. This is called the national balancing point (NBP) price of gas and is usually quoted in pence per therm of gas.
	National balancing point (NBP) gas price	Britain's wholesale NBP Gas price is derived from the buying and selling of natural gas in Britain after it has arrived from offshore production facilities. https://www.ofgem.gov.uk/gas/wholesale-market/gb-gas-wholesale-market
NETS	National Electricity Transmission System	It transmits high-voltage electricity from where it is produced to where it is needed throughout the country. The system is made up of high voltage electricity wires that extend across Britain and nearby offshore waters. It is owned and maintained by regional transmission companies, while the system as a whole is operated by a single system operator (SO).
NTS	National Transmission System	A high-pressure gas transportation system consisting of compressor stations, pipelines, multijunction sites and offtakes. NTS pipelines transport gas from terminals to NTS offtakes and are designed to operate up to pressures of 94 barg.
NGV	Natural gas vehicle	A vehicle which uses compressed or liquefied natural gas as an alternative to petrol of diesel.
NOx	Nitrous oxide	A group of chemical compounds, some of which are contributors to pollution, acid rain or are classified as green house gases.
OFGEM	Office of Gas and Electricity Markets	The UK's independent National Regulatory Authority, a non-ministerial government department. Their principal objective is to protect the interests of existing and future electricity and gas consumers.
	Oil & Gas UK	Oil & Gas UK is a representative body for the UK offshore oil and gas industry. It is a not-for-profit organisation, established in April 2007. http://www.oilandgasuk.co.uk
OCGT	Open Cycle Gas Turbine	Gas turbines in which air is first compressed in the compressor element before fuel is injected and burned in the combustor.
	Passivhaus	A Passivhaus is a building, for which thermal comfort can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air.
	Peak demand, electricity	The maximum power demand in any one fiscal year: Peak demand typically occurs at around 5:30pm on a week-day between December and February. Different definitions of peak demand are used for different purposes.
	Peak demand, gas	The 1-in-20 peak day demand is the level of demand that, in a long series of winters, with connected load held at levels appropriate to the winter in question, would be exceeded in one out of 20 winters, with each winter counted only once.
pa	Per annum	per year.
PV	Photovoltaic	A method of converting solar energy into direct current electricity using semi-conducting materials.
PHEV	Plug-in hybrid electric vehicle	Has a battery which can be charged by plugging it in as well as a regular engine.
	Power supply background (aka Generation background)	The sources of generation across Great Britain to meet the power demand.

Appendix 3
Glossary

Acronym	Word	Description
	Pumping demand	The power required by hydro-electric units to pump water into the reservoirs.
PEV	Pure electric vehicle	Has only a battery for energy storage.
RHI	Renewable Heat Incentive	See appendix on government policy. A payment incentive owned by Ofgem which pays owners of certain, renewable heating technologies per unit of heat produced. There is a domestic and a non-domestic version.
ROC	Renewable Obligation Certificate	See appendix on government policy. Green certificates issued to operators of accredited renewable generating stations for the eligible renewable electricity they generate. ROCs are ultimately used by suppliers to demonstrate that they have met their obligation.
RO	Renewables Obligation	See appendix on government policy. Main support mechanism for renewable electricity projects in the UK. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources.
R&D	Research and development	A general term for activities which involve improvements to goods or processes, or research into new goods or processes.
	Seasonal storage or long-range storage	There is one long-range storage site on the national transmission system: Rough, situated off the Yorkshire coast. Rough is owned by Centrica and mainly puts gas into storage (called 'injection') in the summer and takes gas out of storage in the winter. http://www2.nationalgrid.com/UK/Our-company/Gas/Gas-Storage/
	Self-consumption	Where an end user consumes the electricity they generate, commonly from solar generation. This reduces the need to import electricity from grid but does not necessarily mean an end user is self-sufficient.
	Shale gas	Shale gas is natural gas that is found in shale rock. It is extracted by injecting water, sand and chemicals into the shale rock to create cracks or fractures so that the shale gas can be extracted. https://www.gov.uk/government/publications/about-shale-gas-and-hydraulic-fracturing-fracking
SRMC	Short run marginal cost	The instantaneous variable cost for a power plant to provide an additional unit of electricity. The short run marginal cost (SRMC) is derived from the cost of fuel, the cost of CO_2 emissions, the share of operating and maintenance (O&M) costs that varies with the plant electricity output and any income from incentives and the provision of heat associated to the plant electricity output.
STOR	Short term operating reserve	Short term operating reserve (STOR) is a service for the provision of additional active power from generation and/or demand reduction.
	Smart appliances	Residential power consuming goods which are able to reduce their power demand at defined times of the day either by reacting to a signal or by being programmed.
	Smart meter	New generation gas and electricity meters which have the ability to broadcast secure usage information to customers and energy suppliers, potentially facilitating energy efficiency savings and more accurate bills.
	Station demand	The onsite power station requirement, for example for systems or start up.
	Summer minimum	The minimum power demand off the transmission network in any one fiscal year: Minimum demand typically occurs at around 06:00am on a Sunday between May and September.
SBR	Supplemental balancing reserve	Supplemental balancing reserve (SBR) is a balancing service that has been developed to support National Grid in balancing the system during the mid-decade period when capacity margins are expected to be tight. SBR is targeted at keeping power stations in reserve that would otherwise be closed or mothballed. Along with demand side balancing reserve (DSBR), this service will act as a safety net to protect consumers, only to be deployed in the event of there being insufficient capacity available in the market to meet demand.
	System inertia	The property of the system that resists changes. This is provided largely by the rotating synchronous generator inertia that is a function of the rotor mass, diameter and speed of rotation. Low system inertia increases the risk of rapid system changes.
	System operability	The ability to maintain system stability and all of the asset ratings and operational parameters within pre-defined limits safely, economically and sustainably.

Acronym	Word	Description
SO	System operator	An entity entrusted with transporting energy in the form of natural gas or power on a regional or national level, using fixed infrastructure. Unlike a TSO, the SO may not necessarily own the assets concerned. For example, National Grid operates the electricity transmission system in Scotland, which is owned by Scottish Hydro Electricity Transmission and Scottish Power.
TWh	Terawatt hour	1,000,000,000,000 watt hours, a unit of energy
TOUT	Time Of Use Tariff	A charging system that is established in order to incentivise residential consumers to alter their consumption behaviour – usually away from high power demand times.
tCO^2	Tonne of carbon dioxide	A fixed unit of measurement commonly used when discussing carbon dioxide emissions.
TEC	Transmission entry capacity	The maximum amount of active power deliverable by a power station at its grid entry point (which can be either onshore or offshore). This will be the maximum power deliverable by all of the generating units within the power station, minus any auxiliary loads.
	Transmission losses	Power losses that are caused by the electrical resistance of the transmission system.
TSO	Transmission system operators	An entity entrusted with transporting energy in the form of natural gas or power on a regional or national level, using fixed infrastructure.
	Triad	Triad demand is measured as the average demand on the system over three half hours between November and February (inclusive) in a financial year. These three half hours comprise the half hour of system demand peak and the two other half hours of highest system demand which are separated from system demand peak and each other by at least ten days.
UKCS	UK Continental Shelf	The UK Continental Shelf (UKCS) comprises those areas of the sea bed and subsoil beyond the territorial sea over which the UK exercises sovereign rights of exploration and exploitation of natural resources.
UK	United Kingdom of Great Britain and Northern Ireland	A geographical, social and economic grouping of countries that contains England, Scotland, Wales and Northern Ireland.
UCL	University College London	A UK university based in London.
	Weather corrected	The actual demand figure that has been adjusted to take account of the difference between the actual weather and the seasonal normal weather.

Annual data in FES

Where a single year is referred to in FES, e.g. 2020, we are referring to that calendar year.

Where data is across split years, e.g. 2020/21, we are referring to power years. These run from 1 April to 31 March. For example, 2020/21 refers to 1 April 2020 to 31 March 2021.

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