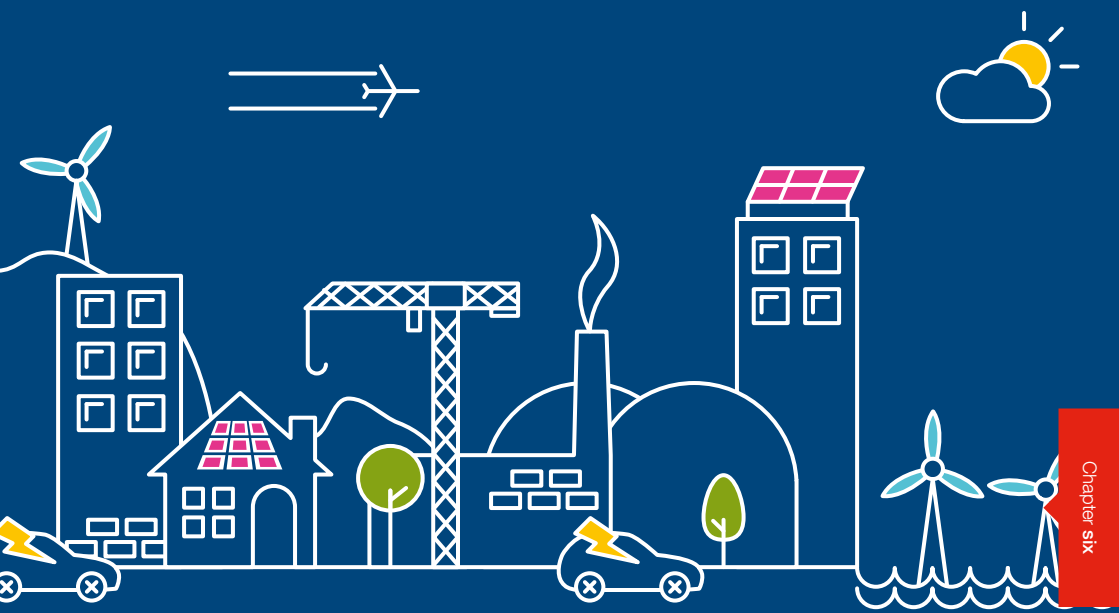
nationalgrid

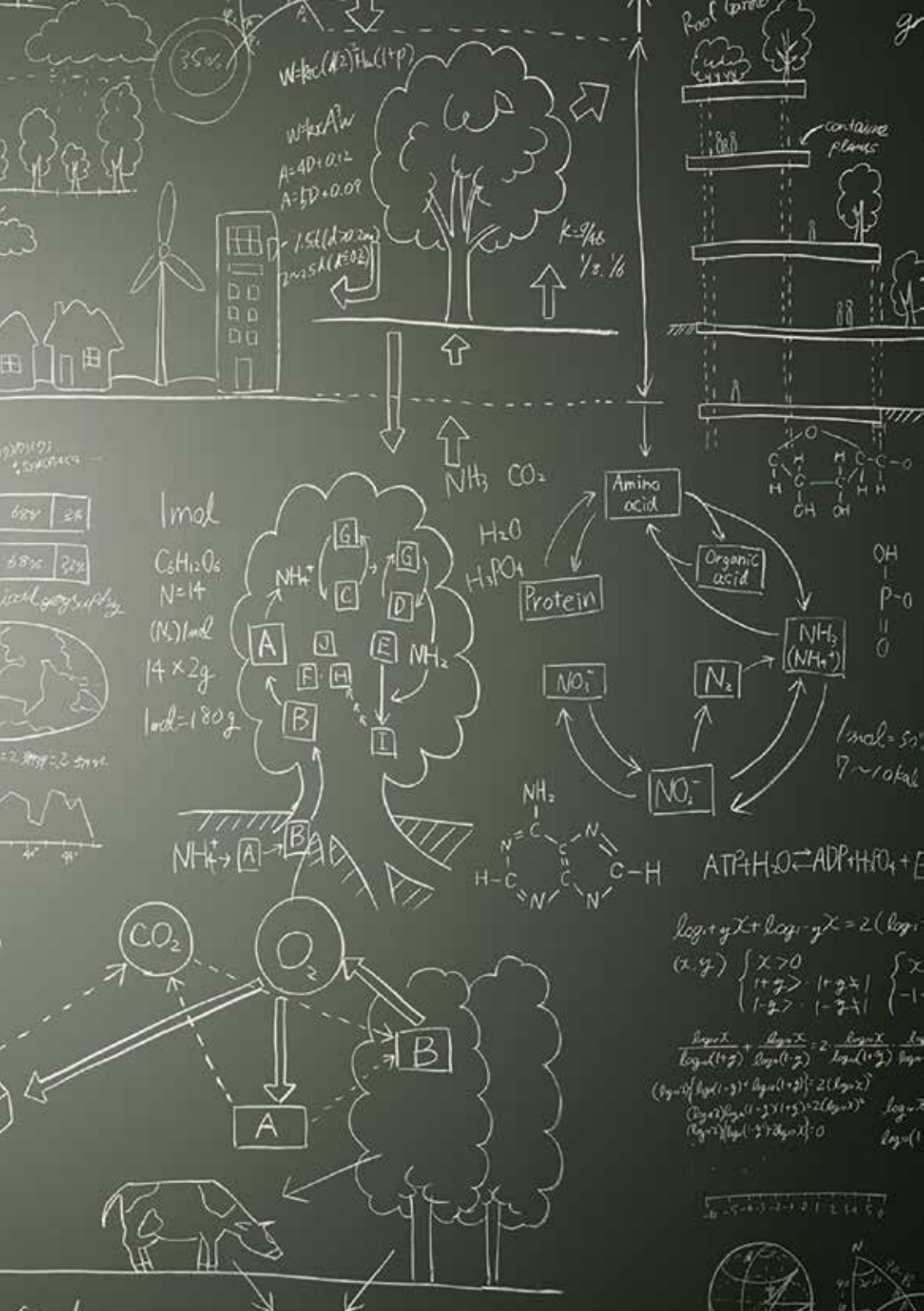
Future Energy Scenarios

UK gas and electricity transmission



Chapter six

JULY 2015


Amino acid
Organic acid
Protein
NH_3 CO_2
H_2O
H_3PO_4
NH_3 (NH_4^+)
NO_3^-
N_2
NO_2^-
1mol
$C_6H_{12}O_6$
N=14
180g
CO_2
O_2
A
B
ATP+H₂O⇌ADP+H₃PO₄
container plants

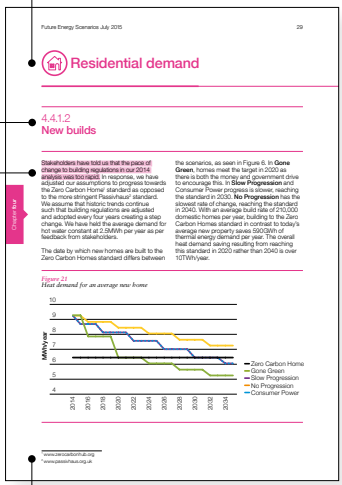
How to use this document

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.

The main text is divided into sections by subheadings.

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

4.4.1.2
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' standard as opposed to the more stringent 'Passivhaus' standard. We have also delayed the timing of change 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 2.9MWh 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 6. 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 this process is slower, reaching the standard in 2050. **No Progression** has the slowest rate of change, reaching the standard in 2043. 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.

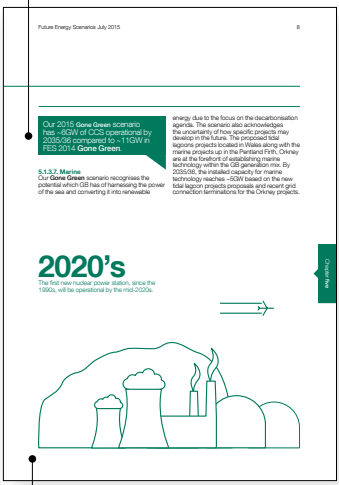
Figure 21
Heat demand for an average new home

www.zerocarbonhub.org
www.passivhaus.org.uk

Chapter Four

Footnotes are used for citations and further commentary.

Key pieces of information are highlighted in boxes.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Our 2015 **Gone Green** scenario has ~6GW of CCS operational by 2035/36 compared to ~11GW in FES 2014 **Gone Green**.

5.1.3.7. Marine
Our **Gone Green** scenario recognises the potential which GB has of harnessing the power of the sea and converting it into renewable energy due to the focus on the decarbonisation agenda. The scenario also acknowledges the uncertainty of how specific projects may develop in the future. The proposed tidal lagoons projects located in Wales along with the marine projects up in the Pentland Firth, Orkney are at the forefront of establishing marine technology within the GB generation mix. By 2035/36, the installed capacity for marine technology reaches ~5GW based on the new tidal lagoon projects proposals and recent grid connection terminations for the Orkney projects.

2020's
The first new nuclear power station, since the 1990s, will be operational by the mid-2020s.

Chapter Five

Key data is emphasised with an image.

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

Chapter six

2050 and environmental targets

2050 and environmental targets

6.1
2050 and environmental target progress

Renewable electricity, mainly from wind, contributes most to reaching the 2020 renewables target. To progress towards the 2050 target, low carbon electricity is needed to underpin the electrification of heat and transport. In Gone Green, heat pumps become the largest provider of heat in 2050, but there is still an essential role for gas to provide top-up heat. Without gas, meeting peak heating demand would be considerably more expensive, as power stations and networks would be built and used infrequently.

Gone Green is the only scenario which achieves all of the environmental targets on time. The other scenarios miss them by varying degrees.

Key statistics

- To achieve our 2050 carbon target in **Gone Green** almost all electricity is decarbonised by 2040.
- In all scenarios, electricity generation carbon intensity approximately halves by 2020, due to a combined reduction in coal generation and increase in renewable generation.

2020

In all scenarios, electricity generation carbon intensity approximately halves by 2020, due to a combined reduction in coal generation and increase in renewable generation.

This section describes the outcome of our 2050 modelling and analysis of our scenarios against environmental targets.

The FES scenarios are evaluated on a granular basis up to 2035. Beyond this date they are extended out to 2050 using a longer term modelling technique. A separate, whole energy system model is required to assess performance of energy scenarios against renewable and carbon targets.

For the 2050 analysis, an optimisation model is used which swaps energy demands (heat, transport and electricity) between energy sources. It is constrained to align with our pre-2035 analysis in every aspect possible. Due to the different nature of the two modelling techniques, some minor discrepancies are unavoidable.

This section describes progress against targets for our scenarios. As our **Gone Green** scenario is the only one to achieve all the environmental targets on time, this section discusses **Gone Green** in more detail. Other scenarios are described for comparison in the section. Full details of all scenarios are in our associated data workbook publication.

Environmental targets

There are currently two relevant environmental targets that we consider for our scenarios.
2050 greenhouse gas target – This target is to reduce annual UK emissions of carbon dioxide and carbon dioxide equivalent gases by 80% from 1990 levels in 2050. We have assumed progress towards this in line with UK carbon budgets.

2020 renewables target – The 2009 Renewable Energy Directive (RED) set a target for the UK to achieve 15% of its energy consumption from renewable sources by 2020.

There is currently no renewables target beyond 2020 but the EU is currently working towards reaching agreement on new targets for 2030. Therefore, we have extended the renewables target out to 2030 based on the Green Alliance analysis of a potential UK 2030 renewable energy target. A linear extrapolation of this target from 2020 has been used to generate a 2050 renewables target. The renewables target for the UK in 2020 is 15%. We use 23% and 39% for 2030 and 2050 respectively.

Figure 84
Environmental targets used in scenarios

Consumer Power

Environmental targets are missed, and no new environmental targets introduced.

2050 greenhouse gas reduction target: on target until around 2030 when progress stalls, ultimately missing 2050 target

2020 renewables target: missed

No new renewables targets for 2030 and 2050 are introduced

Gone Green

All environmental targets are achieved, including assumed new European targets post-2020.

2050 greenhouse gas reduction target: hit

2020 renewables target: hit

Assumed 2030 renewables target: hit

Assumed 2050 renewables target: hit

No Progression

Environmental targets are missed, and no new environmental targets introduced.

2050 greenhouse gas reduction target: missed and progress stalls

2020 renewables target: missed

No new renewables targets for 2030 and 2050 are introduced

Slow Progression

All environmental targets missed but achieved later. New European targets post-2020 introduced.

2050 greenhouse gas reduction target: missed but achieved later

2020 renewables target: missed but achieved later

Assumed 2030 renewables target: missed but achieved later

Assumed 2050 renewables target: missed but achieved later

2050 and environmental targets

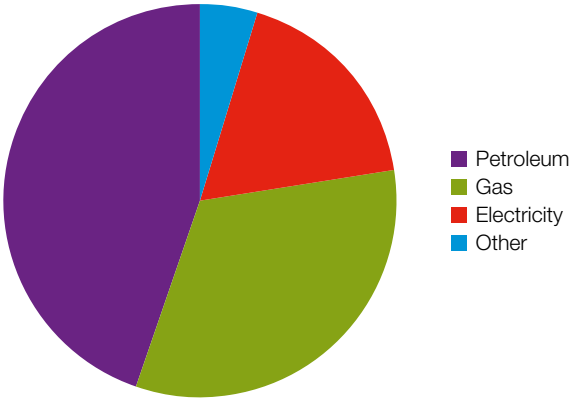
Gone Green achieves all environmental targets on time due to high green ambition in a high prosperity economy. **Slow Progression** achieves the targets but at a later date, generally achieving around 80% of the target on time and projected to reach the 2050 carbon target around 10-15 years late. **Consumer Power** misses the 2050 carbon target by our design, but in 2030 its trajectory is still on a pathway that could achieve 2050 target if environmental ambition increases. **No Progression** misses all environmental targets due to the lack of green ambition and low prosperity.

Energy background

UK energy demand is divided into three primary sectors: heat, transport and electricity.

Figure 85 shows the breakdown of end user demand by fuel type in 2013. The total annual demand is 1,746TWh. Conventionally, petroleum is mainly used for transport, gas mainly for heat and electricity for power. However, there is interchangeability between these fuels for their end use, which becomes the key to achieving environmental targets. The category 'other' includes coal, manufactured fuels, renewables, waste, and heat sold.

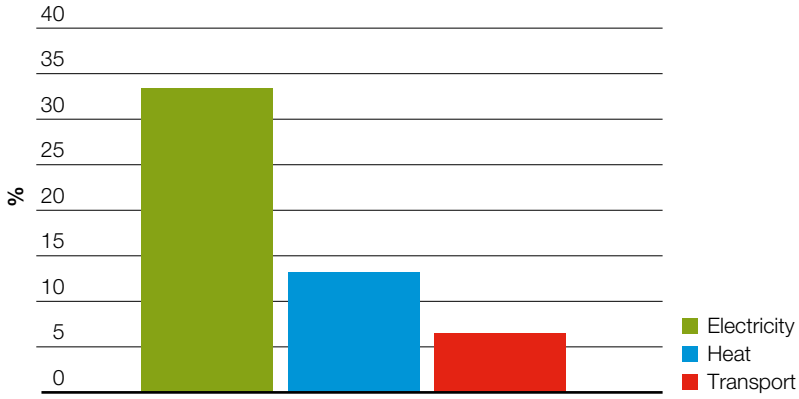
Figure 85
Final energy consumption by fuel, 2013



Whilst most progress towards environmental targets occurs in the electricity generation sector, improvements are also made in the heat and transport sectors. This is because, in comparison with other sectors, it is relatively less difficult to decarbonise electricity supply by utilising low carbon and renewable generation sources. Once this supply has been decarbonised, low carbon electricity can be utilised in the transport and heating sectors, to begin decarbonising these sectors too.

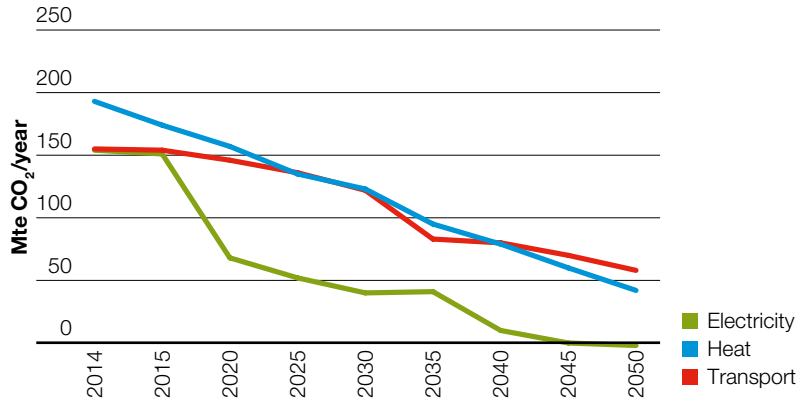
In 2020, in our **Gone Green** scenario, around 33% of electricity generation is renewable. Around 13% of heat demand is met from renewable sources and around 7% of transport fuel is renewable. This equates to electricity generation contributing around 110TWh/year, while heat and transport contribute around 90 and 40TWh/year respectively.

Figure 86
***Gone Green:** 2020 renewable percentage of energy supply*



By 2050, in our **Gone Green** scenario, electricity produces almost zero emissions, falling steadily from 60Mte CO_2 per year in 2020. Heat and transport emissions fall across the same period, both reaching approximately 50Mte CO_2 per year by 2050.

Figure 87
***Gone Green:** emissions from each sector*



2050 and environmental targets

Energy scenarios
This section details how our **Gone Green** scenario reaches the 2050 carbon target. It shows details of **Gone Green** with the other scenarios for comparison. The full detail for all scenarios is available in the associated FES data workbook publication.

To achieve the 2050 targets, **Gone Green**:
1. Decarbonises electricity generation, then
2. Increases decarbonised electricity supply.
3. Electrifies large quantities of heat and transport and uses decarbonised electricity to power this.
4. Explores other options for heating and transport such as hydrogen.

The subsequent gas demands are the result of the remaining heat, power and transport requirements.

The detail of this is illustrated in this order in the subsequent sections.

6.1.1 Power supply

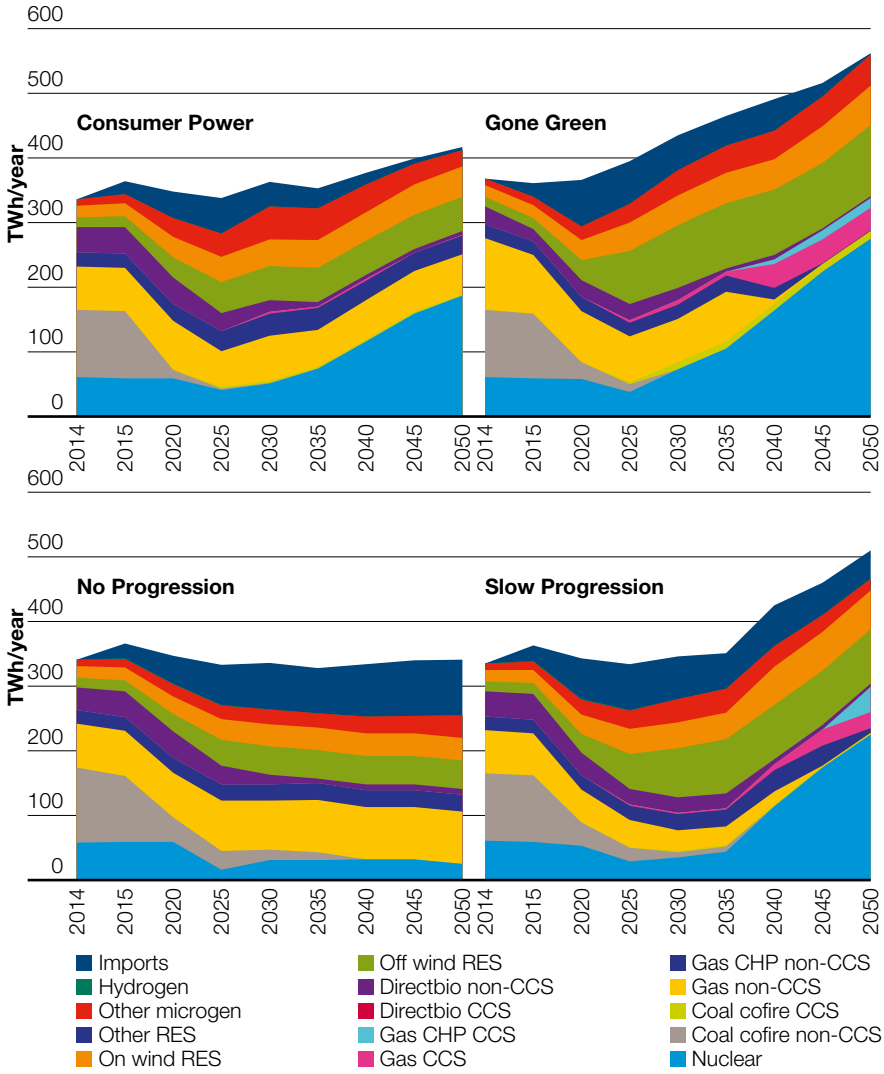
In **Gone Green**, annual renewable electricity supply increases up to 2030 mainly from wind power, with a lesser contribution from other renewables. This offsets a decline in electricity generation from gas and the complete decommissioning of unabated coal based generation. Interconnection forms a considerable part of GB gross supply due to the renewable generation mix. Whilst solar PV has a large capacity and impact at its peak output, it has relatively little contribution to annual supply due to its low annual load factor of approximately 10%. Further into the period, from around 2030, CCS and nuclear generation increases, increasing supply from low carbon sources. The culmination of these factors results in the electricity system being almost fully decarbonised by 2050. This occurs concurrently with electricity supply rising to meet the demand for the electrification of heat and transport, aiding the decarbonisation of these sectors.

Slow Progression has similar supply changes but with less renewables, more gas and less low carbon growth beyond 2030. Overall supply is lower than in **Gone Green** in 2050 as less heat and transport is electrified. The slower changes in the generation mix, along with the slower electrification of heat and transport mean that environmental targets are met after the 2050 deadline.

Consumer Power and **No Progression** have little ambition to achieve environmental targets after 2020 hence the cheapest form of electricity generation is chosen. Additionally, the prosperity in our **Consumer Power** scenario facilitates investment in embedded renewables, particularly solar. This also enables later capital investment in nuclear power, as this is seen as the longer term cost efficient option. Less affluence leads to a greater reliance on gas and imports in our **No Progression** scenario.

Consumer Power is a high embedded scenario characterised by high solar, with 31GW installed by 2035.

Figure 88
Annual power generation by supply type to 2050



2050 and environmental targets

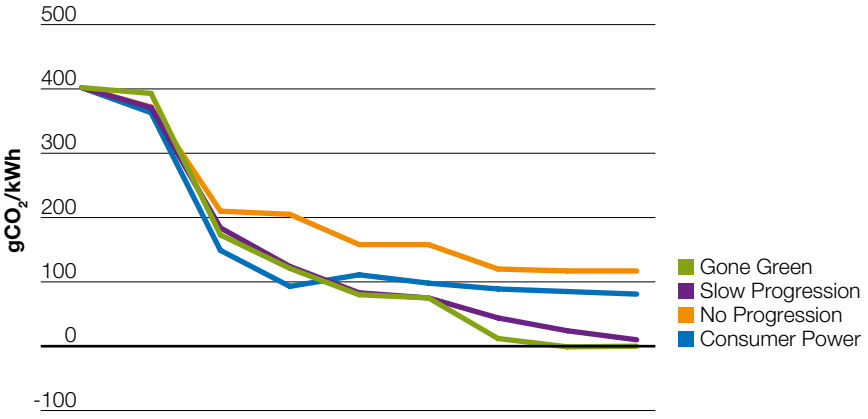
The carbon intensity of power generation decreases considerably in all scenarios to relatively similar extents up to 2020. This is because we have relatively high confidence in changes to power supply over the next few years. The most important of these changes is the reduction of coal fired power generation combined with varying degrees of increasing renewables.

In the medium term all scenarios except **No Progression** continue to decarbonise at similar rates. Our **Consumer Power** scenario is close to both **Gone Green** and **Slow Progression** as it has high renewables from embedded generation (notably high solar).

This shows that in 2030 **Consumer Power** is still on a pathway that could achieve later carbon targets. The lower renewable ambition has greater impact from this point, leading to limited further progress.

In 2050 the carbon intensity of electricity generation is lowest in **Gone Green** and **Slow Progression**, with **Gone Green** reaching zero emissions earlier. **No Progression** experiences the least change from today's level, but still falls by around two thirds by 2050. The minimal fall in emissions in **Consumer Power** beyond 2030 is mostly due to increases in nuclear generation.

Figure 89
Power: $C0_2$ intensity



All scenarios have reductions in coal generation, combined with increases in renewable generation. This results in carbon intensity of electricity generation roughly halving by 2020.

6.1.2 Power demand

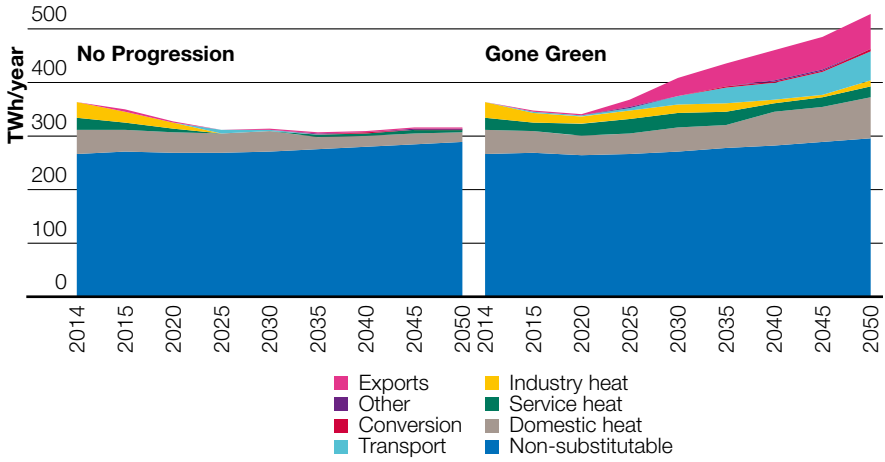
In **Gone Green**, the decarbonisation of electricity generation and increases in low carbon supply facilitate electrification of heat and transport. This consequently starts to decarbonise these sectors. High renewable generation creates a greater need for energy balancing due to the inherent variability of supply. Increased interconnector capacities help facilitate this. Excess generation is exported via the interconnectors. In stark contrast to this, **No Progression** has few drivers to decarbonise, causing total demand to be much lower. The lack of excess generation from renewables causes exports to be much lower.

Slow Progression follows similar trends to **Gone Green** but has fewer increases in electricity demand for transport and heating as there is less low carbon generation supply. Gross exports are smaller due to less excess generation being available.

Consumer Power has similar demands to **No Progression**, but higher overall generation means some electricity can be used for transport and some is exported.

Demand in **Gone Green** is nearly 50% higher in 2050 than today's levels; driven largely by demand from heat pumps and electric vehicles.

Figure 90
*Power demand: **No Progression** and **Gone Green***

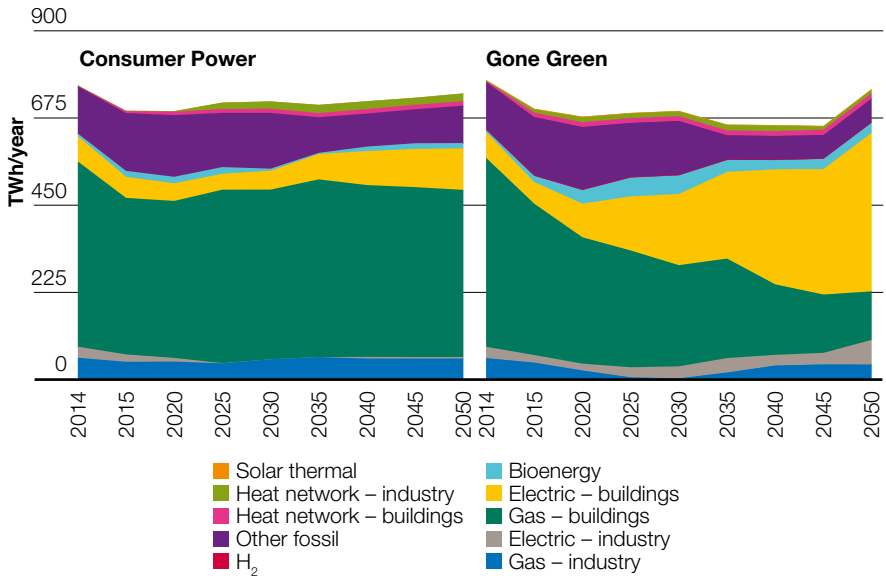


2050 and environmental targets

6.1.3 Heat demand

In **Gone Green**, high levels of low carbon generation enables heat to become electrified and there is a significant drive from both the government and energy users to alter demand patterns. In **Consumer Power**, the lack of drive towards environmental targets means little heat is electrified, with gas appliances continuing to dominate the market. This shows the two extremes for heat demand in our scenarios. Our **No Progression** scenario is very similar to **Consumer Power**, as they share a lack of green ambition. **Slow Progression** has similar yet slower trends to **Gone Green** as there is less advancement towards the carbon targets.

Figure 91
Heat demand: ***Consumer Power*** *and* ***Gone Green***



6.1.4 Transport demand

All our scenarios assume the same overall numbers of vehicles and transport miles. The differences between scenarios for energy demands arise entirely due to the inherent efficiencies of different fuels used.

In **Gone Green**, high levels of low carbon generation enables transport to become electrified, which helps to decarbonise the sector. Significant electrification of cars occurs, with just over 90% of cars on the GB roads being electric in 2050. This is split evenly between pure EVs and plug in hybrids in 2050. As electric vehicles are approximately three times more efficient than internal combustion engines, total demand for transport decreases. Additionally, gas and hydrogen become the main fuels for HGVs after 2030. Gas use is partially due to its renewable benefits but mainly due to cost credentials. Hydrogen is utilised heavily in this sector mainly due to the renewable credentials that arise from how it is created, and the fact that HGVs are less suitable for electrification. It is assumed to be used in fuel cells in HGVs. In our assumptions, hydrogen is produced from gasification of biomass (with CCS), further helping decarbonise the transport sector. Some steam methane reformation of natural gas is also employed to generate hydrogen from 2045.

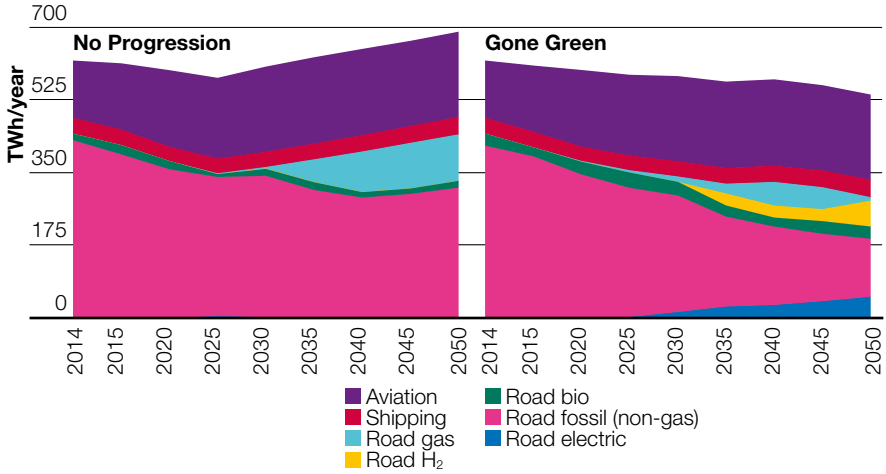
The contrasting scenario to **Gone Green** is **No Progression**. In this scenario there is minimal electrification of transport and no further development of hydrogen technology. There is still a move to change fuel use of HGVs to gas as it is the most cost efficient option on a long-term basis. Whilst efficiency improvements in conventional transport are accounted for, greater efficiencies of electrification are not realised. As a result, transport demand increases as do carbon emissions from the sector.

Our **Consumer Power** scenario has very similar trends to **No Progression** for the same reasons. The difference between these scenarios is due to electric vehicles, which are relatively high in **Consumer Power**. This reduces overall transport demand due to their increase efficiency.

Slow Progression follows similar trends to **Gone Green** but the reduced performance against environmental targets means much less hydrogen is used for HGVs from 2030, with the remaining using natural gas.

2050 and environmental targets

Figure 92
Transport demand: ***No Progression*** *and* ***Gone Green***



6.1.5 Gas demand

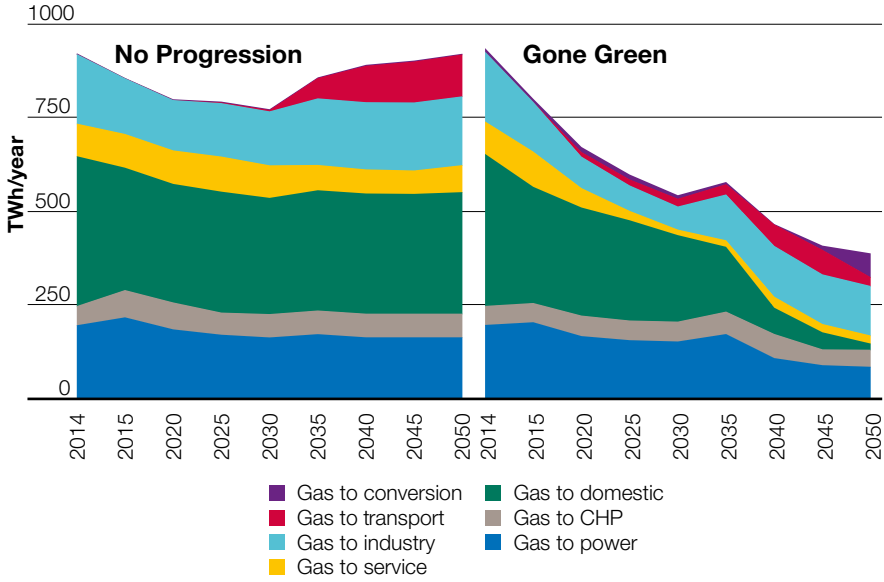
In **Gone Green**, gas demand reduces to around half today's level in 2050, mainly due to the annual reduction in gas for heating in domestic and commercial applications. Gas is still heavily relied on for cold weather periods for top-up heating in these sectors, as a large proportion of domestic and commercial heating systems are hybrid gas/electric systems. This is detailed in Figure 93. The high temperatures of industrial applications mean this sector is difficult to electrify, so industrial gas demand remains relatively unchanged. Gas used for power generation falls, and almost all remaining gas CCGTs use CCS (with or without CHP). Some additional gas is used beyond 2030 for HGVs and later for hydrogen production.

Again the contrasting scenario is **No Progression**, where gas boilers dominate the residential heating market and CCGT demand remains high without CCS. This results in total annual gas demands that are similar in 2050 to today's levels.

Our **Consumer Power** scenario has very similar gas demand to **No Progression**, as demand from heat, transport and power stations are alike. **Slow Progression** again has a similar but slower trend in gas demand to **Gone Green** due to the reduced performance against environmental targets.

With very high electrification of heat, significant gas is still required for top-up in times of cold weather to keep costs down, otherwise significant power generation capacity will need to be built to manage extra peak electricity demand.

Figure 93
*Gas demand: **No Progression** and **Gone Green***



2050 and environmental targets

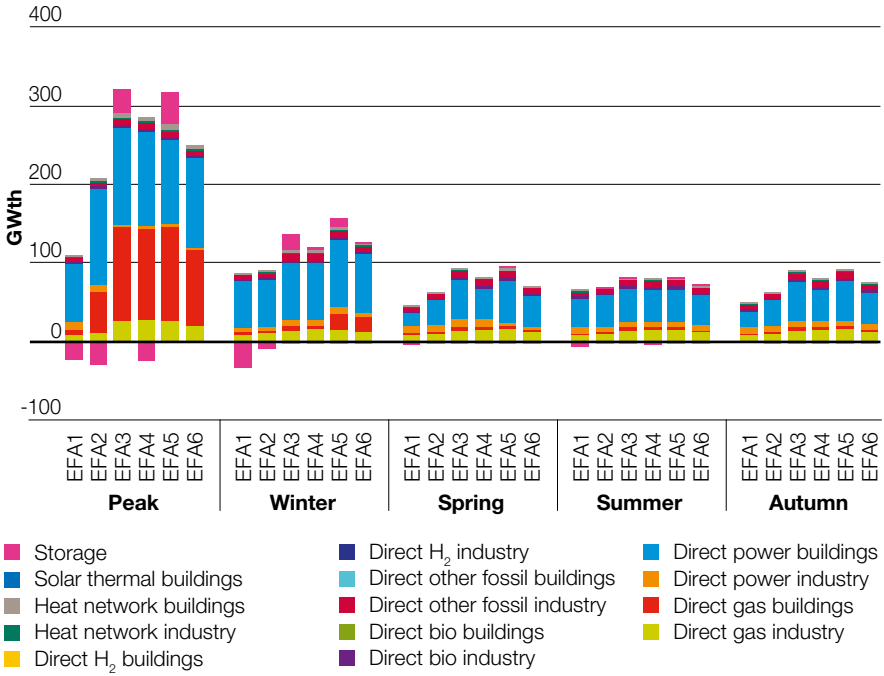
The optimal way of heating GB across seasons and at peak times has been analysed. This is illustrated in Figure 94 with the seasonal heat requirements from the **Gone Green** scenario in 2050. Demand for heat has a large seasonal and within-day variation, much more so than electricity.

By 2050, electric heat pumps are used to supply the majority of the heat load, but to electrify the entire load would require significant investment in generation and electricity network capacity.

Figure 94 illustrates how heat is supplied over a peak day and an average day for each season.

Each Electricity Forward Agreement (EFA – 4 hourly time periods into which an electricity day is split) timescale represents 4 hours of the day (EFA1 is 23:00–03:00hrs, EFA2 is 03:00–07:00hrs, etc). This chart shows that whilst the majority of heat is met by non gas heating in warmer periods, on colder days and at peak a significant amount of gas is required for heating. The same conclusion occurs when looking at **Slow Progression** in 2050, hence hybrid systems are included in both these scenarios. **No Progression** and **Consumer Power** need gas for heating all year around, as this scenario has little electrification of heating in 2050.

Figure 94
***Gone Green:** heat duration supply curve for 2050*



6.1.6
Areas for further investigation

The 2050 modelling highlights some requirements which are necessary in order to meet the 2050 targets. To meet the targets electricity generation needs to be almost fully decarbonised by 2050. Additionally, this decarbonised electricity generation will be used to meet increased demand from heating and transport. Increased decarbonised electricity generation requires extra flexibility which increased interconnection can aid via diversification of supply and demand.

There are other areas which are less clear past 2030. For example it is unclear how much bioenergy can be used and whether it is used to meet heating demand or for hydrogen fuel. There is also a question as to how the electricity system is balanced; what the role will be for DSR, TOUTs, smart appliances and electricity storage. The role and use of hydrogen is also less prescribed; whether it be for HGV transport (as it is in our scenarios) or for energy balancing. We have engaged with our stakeholders to ensure the amount of hydrogen produced in our scenarios is aligned with industry perspectives.

Heat networks can have a role to play in the future, and do feature in our scenarios. Uncertainties exist around the potential size of heat networks, costs, potential carbon implications and who the customers are likely to be. Our Future of Heat case study in chapter 7 elaborates on our current thoughts.

National Grid is committed to build knowledge in these areas to improve our whole energy system modelling. We aim to do this through our FES process and further engagement. We will be holding workshops to establish exactly what is known and what is less so, and what options exist in the areas of high uncertainty. These workshops are currently planned for autumn 2015. They are intended to be the precursor to a wider 2050 document, analysing some of the pathways towards achieving 2050 carbon targets.

2050 and environmental targets

Method

We use a cost optimisation model for our 2050 and target analysis, which was developed by Baringa. This model is known as RESOM (Redpoint Energy Systems Optimisation Model). RESOM is a whole energy model which selects the least cost solution which balances on a seasonal, annual and peak basis.

Approximately 5,000 constraints are used for each model run to produce a set of 2050 scenarios which align to our pre-2035 analysis.

The model inputs and constraints are evaluated against external benchmarks, including the ETI (Energy Technologies Institute).

We will build our knowledge of 2050 options via FES engagement and 2050 workshops.

Chapter eight


Government policy


Meet the team


Glossary

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 3,500 kg.
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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