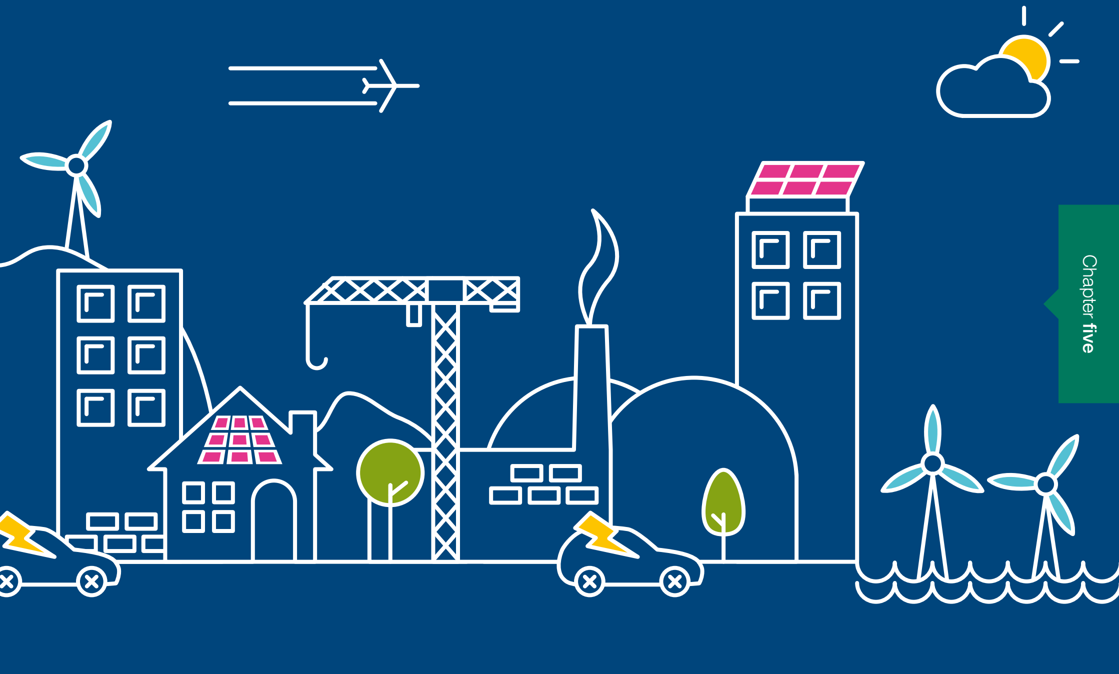
nationalgrid

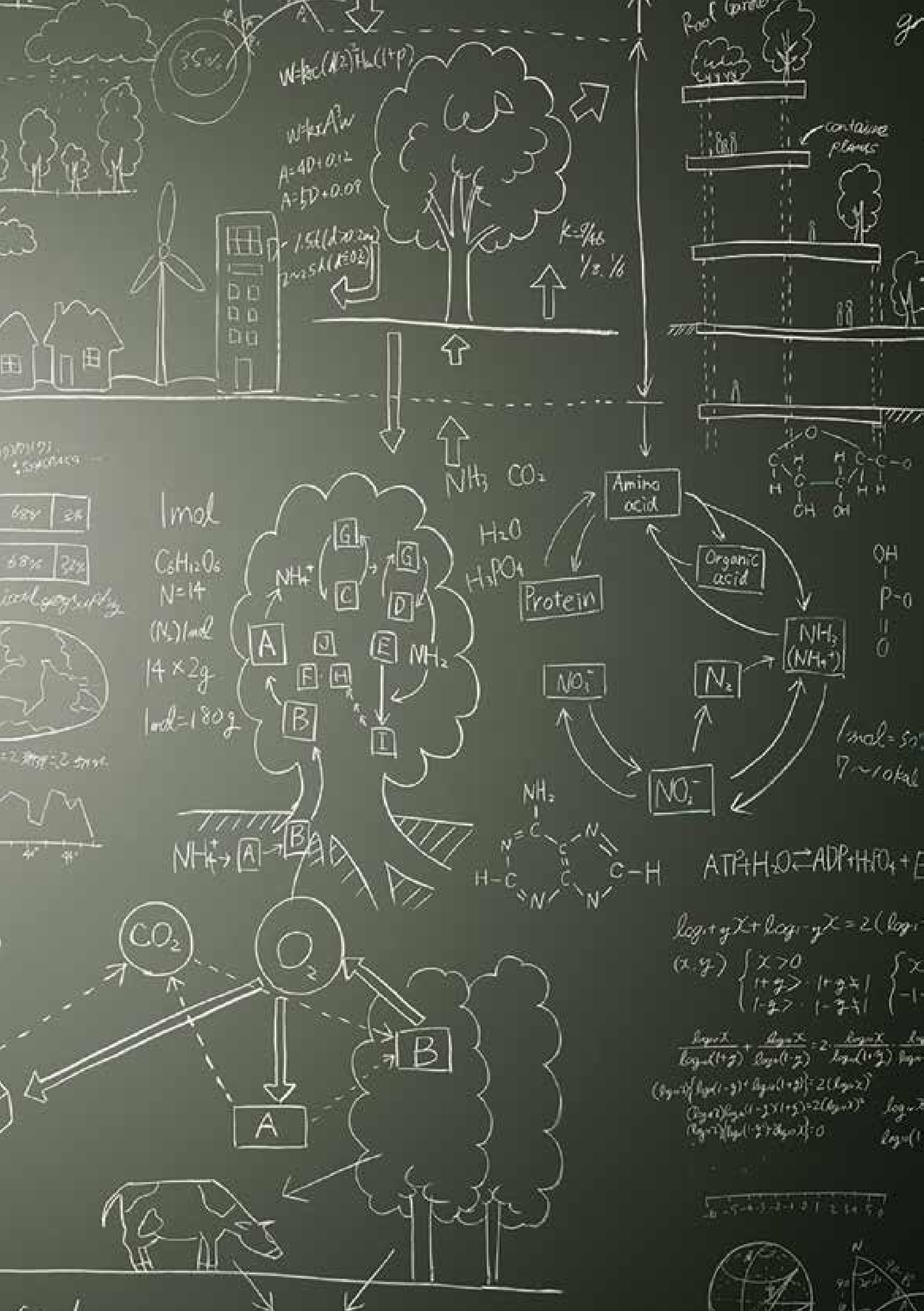
Future Energy Scenarios

UK gas and electricity transmission



Chapter **five**

JULY 2015



1mol
C6H12O6
N=14
14×2g
1mol=180g
NH3 CO2
H2O
H3PO4
Amino acid
Organic acid
Protein
NO3-
NO2-
N2
NH3 (NH4+)
ATP+H2O⇄ADP+H3PO4
CO2
O2
A
B

How to use this document

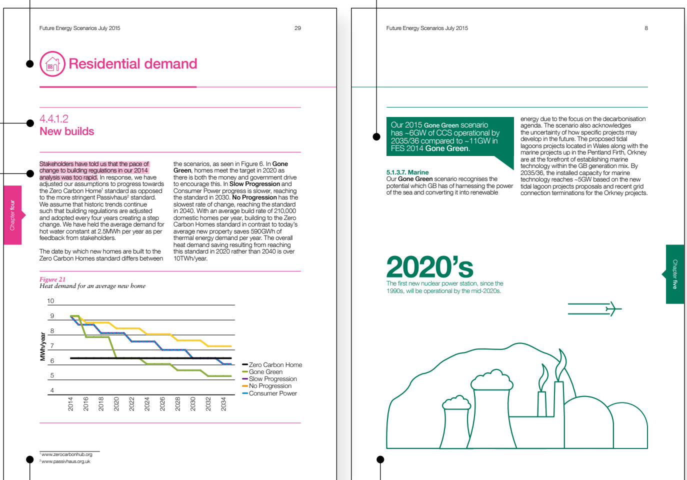
This document has been designed to present information in easily digestible sections, with the subject matter clearly defined in colour-coded chapters.

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 five

Power supply

Interconnectors

Gas supply

Power supply

5.1 Power supply

Our power supply scenarios consider the sources of generation that will be used to meet power demand now and into the future.

The Capacity Market (CM) auction results and the Contracts for Difference (CfD) awards have provided some certainty around the sources of power supply in the medium term. However the long-term evolution of the power supply background remains uncertain given the ever changing political, environmental, social and technological landscape.

Our **Gone Green** scenario meets the climate change targets facilitated by a strong green agenda and underlying growth in the economy. In **Slow Progression**, the transition to low carbon and renewable technologies is delayed by financial constraints, resulting in a slower deployment of these technologies compared to **Gone Green**. In **Consumer Power**, significant volumes of generation connect at local level facilitating emerging technologies to make their mark on the power supply landscape. Our **No Progression** scenario is dominated by established and comparatively cheaper forms of generation given the financial constraints and lack of focus on decarbonisation of the economy.

Key statistics

- In **Gone Green** renewable technologies generate 34% of power supplied, facilitating the government's ambitions of sourcing 15% of energy from renewable technologies by 2020.
- In **Consumer Power** small scale generation represents 40% of installed generation capacity by 2035/36.
- Thermal generation remains the backbone of the supply portfolio, providing flexibility to the market and electricity network requirements.

The power supply scenarios provide four alternative outlooks of how the power supply landscape may evolve in the future. The scenarios consider how political ambition, environmental legislation, the economic climate, technological advancements and social engagement influence electricity generation. Our scenarios consider all sources of generation irrespective of where and how they are connected. They show the total Great Britain (GB) power supply capacity connected to the national (transmission) and local (distribution) networks together with generation installed on domestic dwellings and industrial and commercial buildings (micro generation).

5.1.1
Rules and assumptions

Our scenarios have been developed to be consistent with the rules and assumptions applicable to power supply, please refer to chapter 3.

Security of supply reliability standard

All four of our scenarios have been developed to meet the security of supply reliability standard from 2018/19 onwards, when the CM becomes operational. The reliability standard has been set by the Department of Energy and Climate Change (DECC) at 3 hours per year based on the loss of load expectation (LOLE) metric[1,2], please refer to Chapter 7 – Security of Supply case study for more information.

Levy control framework

Our scenarios also consider the amount of financial support available for low carbon and renewable generation. The amount spent on low carbon and renewable generation, as depicted by each of our scenarios out to 2020/21, must stay within the budget as specified by the Levy Control Framework (LCF)[3].

Levy control framework

DECC and HM Treasury have established the LCF which places a financial cap on levy-funded spending.

An upper limit of £7.6 billion (2011/12 prices) was set for 2020/21 on the combined cost of levy-funded electricity policies within the LCF: Renewables Obligation (RO), Feed-in Tariff (FiT) and CfD including the Final Investment Decision Enabling for Renewable (FIDER).

Levy Control Framework – upper expenditure profile

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
£m	3,300	4,300	4,900	5,600	6,450	7,000	7,600

Although the cumulative spend is within the LCF budget, there are three separate occasions where our scenarios (**Gone Green** and **Consumer Power**) exceed the year on year spending currently allocated by the government: 2016/17 in **Consumer Power**, and 2019/20 and 2020/21 in **Consumer Power** and **Gone Green**.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/238867/Consultation_on_the_draft_Delivery_Plan__amended_.pdf - Chapter 3

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223653/emr_consultation_annex_c.pdf

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223654/emr_consultation_annex_d.pdf

Power supply

For 2019/20 and 2020/21, this can be attributed to the profile of the budget not accounting for the recent slippages in projects timeline. This has resulted in projects commissioning later than anticipated which is not accounted for within the annual budget allocation.

The overspend in **Consumer Power** in 2016/17 is due to an increase in the level of potential projects connecting to the electricity network by March 2017 as developers seek to acquire RO qualification before the scheme closes.

Our analysis indicates that a review of how the LCF allocates the money, between the different schemes (as described in the support mechanism overview below), in each year may be required. Given recent deployment rates, a review will ensure that the available money has been apportioned appropriately within the framework, whilst kept within the overall budget.

Low carbon technologies support mechanism overview

FiT is a payment that a renewable or low-carbon generator receives for each MWh of electricity generated. FiTs apply to small scale generation projects (<5MW) and set a payment level based on the technology and the size of the plant. This payment is a premium added to the wholesale electricity price. An optional export tariff is available for electricity exported to the grid.

Renewable Obligation Certificates (ROC) are certificates issued to eligible generators for the renewable electricity they produce. For each MWh of electricity generated, a generator receives a number of ROCs depending on the technology and the project size. Similar to the FiT scheme, ROCs are a premium added to the wholesale electricity price. The RO scheme was closed in March 2015 for solar photovoltaic (PV) and is set to close in March 2017 for all other eligible technologies[4].

CfD is a private law contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC). It requires generators to sell energy to the market. To reduce exposure to fluctuating electricity prices a variable top-up from the market price to a pre-agreed 'strike price' is provided. At times when the market price exceeds the strike price, the generator is required to pay back the difference.

[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/367365/statutory_security_of_supply_report.pdf – Pages 19 and 20

5.1.2
Changing energy landscape

Our 2015 scenarios have been shaped by important political, economic and technological developments which took place during 2014/15 in addition to comments received from our stakeholders.

2018/19 Capacity Market auction results
The 2018/19 CM[5] auction, as described in the support mechanism overview below, has provided some clarity regarding the future generation mix, with the results favouring existing over new and small over large generation.

The results of the 2018/19 CM are included in all of our 2015 power supply scenarios, for the minimum duration of the awarded contract[6].

Capacity Market overview

CM contracts are awarded for the provision of capacity to the electricity system. These contracts ensure that at times of peak demand there is enough available capacity to meet the security of supply standard determined by the Secretary of State. Eligible providers are new and existing thermal power stations and pump-storage plants, existing nuclear and hydro power stations, DSR providers and interconnectors (from 2019/20). The allocation of CM contracts and payment level for each MW of capacity is determined through a competitive auction among the eligible providers. The clearing price for the 2018/19 auction was £19.40/kW/year.

Contracts for Difference
CfD allocation round one results provided clarity on the deployment of renewable generation over the next few years although additional renewable generation will be required to achieve the 2020 climate change targets. The awards allocated through round one are included in all of our 2015 power supply scenarios[7].

Thermal generation – challenging economic conditions
The current challenging economic conditions for thermal generation have resulted in earlier than anticipated plant closures, power stations mothballing or reducing their capacity (~2GW reduction in transmission connected capacity, for 2015/16, when compared to FES 2014). The electricity market is not providing the necessary signals required for large scale investment. As a result, all of our scenario have only one large scale Combined Cycle Gas Turbine (CCGT) power station under construction.

[5] https://www.gov.uk/government/collections/electricity-market-reform-capacity-market
[6] https://www.gov.uk/government/statistics/capacity-market-location-of-provisional-results
[7] https://www.gov.uk/government/statistics/contracts-for-difference-cfd-allocation-round-one-outcome

Power supply

Environmental legislation

Environmental legislation will continue to shape the construction of new thermal plant and the operational lifespan of existing fossil fuel power stations. The introduction of the Industrial Emissions Directive (IED)[8] will impact coal-fired generation and a considerable portion of the existing gas-fired power stations. The new environmental standard may result in further capacity reduction by the end of this decade, as power stations owners decide to opt-out from the IED requirements.

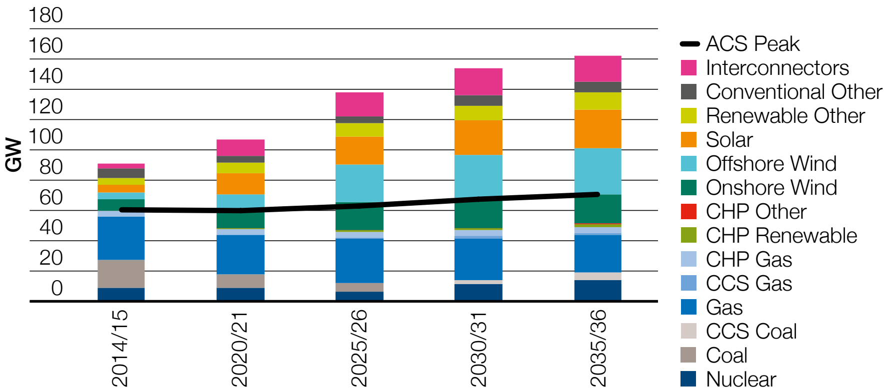
5.1.2.5. Interconnectors

Compared to FES 2014, there has been an increase in interconnector capacity. GB remains a net importer of electricity with only our **Gone Green** scenario showing net exports by mid 2030s. The contribution to security of supply from interconnectors increases while flows at winter peak remain dependent on variable generation and relative prices between GB and Europe. For further information on our 2015 interconnector assumptions, please refer to chapter 5.2.

5.1.3 Gone Green

Our **Gone Green** scenario meets the climate targets facilitated by a strong green agenda and underlying growth in the economy. The achievement of the climate change targets requires the deployment of significant volumes of renewable generation, changing the energy landscape to one shaped by low carbon and renewable technologies, as illustrated in Figures 56 and 57. Table 1 shows the installed capacity and output levels for our **Gone Green** scenario.

Figure 56
***Gone Green:** installed capacity*



[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/367365/statutory_security_of_supply_report.pdf – Pages 19 and 20

Figure 57
***Gone Green:** power output*

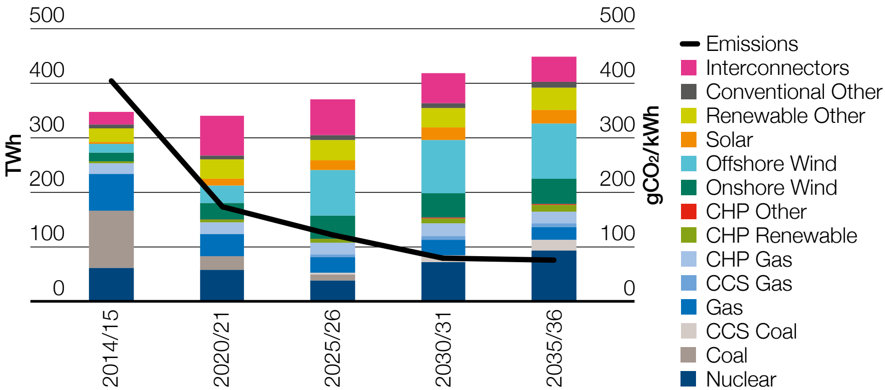


Table 1
***Gone Green** installed capacity and electricity outputs*

Technology	2020/21		2030/31	
	Capacity(GW)	Output (TWh)	Capacity (GW)	Output (TWh)
Nuclear	9.0	57.7	11.3	72.7
Coal	8.7	25.5	0.0	0.0
Gas	26.1	40.3	27.6	28.8
CCS	0.0	0.0	3.9	18.8
CHP	4.7	26.0	5.6	32.6
Onshore Wind	12.7	30.1	18.7	44.4
Offshore Wind	9.5	31.4	29.3	97.4
Solar	13.8	13.3	23.3	22.5
Renewable Other	7.0	35.7	9.4	35.4
Conventional Other	4.4	6.7	6.8	9.9
Interconnectors	10.8	72.1	17.7	54.4

Focus on 2020

Our **Gone Green** scenario illustrates the levels of renewable generation required to meet the 2020 climate change targets. Given the maturity of the technology and the opportunity for large scale and rapid deployment, the growth in renewable generation is centred on wind (onshore and offshore) and solar PV.

The deployment of wind and solar PV out to 2020 results in the installation rates and energy output doubling by the end of this decade.

Power supply

Flexible generation

Our **Gone Green** scenario is heavily influenced by the establishment of low carbon technologies and greater integration with Europe (refer to chapter 5.2). The traditional forms of generation (coal, gas and pumped storage) will continue to play a key role in ensuring security of supply (refer to chapter 7 – Security of Supply case study) and providing flexibility to the GB electricity market and system. Power stations will be required to adapt to the ever changing generation landscape whilst providing the backbone around which the system is operated.

By 2035/36 the gas-fired contribution to annual GB electricity supplies reduces by 43% from today's levels as low carbon generation and increased European integration shape where we source our electricity from.

Environmental legislation

Compliance with the Large Combustion Plant Directive (LCPD)[9] and the forthcoming IED legislation results in reduced capacity from the existing coal, gas and oil power stations as owners decide how they will operate under the tighter emissions regulation. The closure of fossil fuelled power stations requires additional generation to connect in order to maintain security of supply. **Gone Green** shows a substantial volume of CCGT power stations connecting to the system (~9GW) over the next decade before the next generation of nuclear and other low carbon technologies become operational.

Decarbonisation agenda

The decarbonisation agenda is shaped by the successful construction and commissioning of the next generation of nuclear power stations and the commercial scalability of emerging technologies like carbon capture and storage (CCS) and marine over the next 20 years.

Nuclear

The commissioning of the first new nuclear power station, during the first part of the 2020s, is a cornerstone of the **Gone Green** generation mix as the country continues on its pathway to achieve the 2050 environmental targets. Our **Gone Green** scenario has the highest level of installed capacity (~14GW) and output (~20% of the electricity produced) from the nuclear fleet by 2035/36, reinforced by a robust new build programme which also offsets the decommissioning of the majority of the existing nuclear power stations.

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

Carbon capture and storage

The commercial breakthrough of CCS within GB will be shaped by the success of the two proposed demonstration projects which are anticipated to be commissioned within the next decade.[10]

Our FES 2015 CCS projections are based on stakeholder feedback received from our FES 2014 consultation. Stakeholders highlighted the uncertainty regarding the commercial scalability of the technology and the limited amount of potential projects. However they also acknowledged the important role it may have in the future as GB strives to achieve its long-term ambition regarding a low carbon economy. We also received queries regarding how plausible it was to have significant amounts of nuclear and CCS included in the same scenario, as predicted in our FES 2014 **Low Carbon Life** scenario.

Our 2015 FES projections for CCS incorporate the comments received from our stakeholders in terms of commercial scalability uncertainty whilst acknowledging the importance of the technology in achieving the long-term decarbonisation agenda.

[9] http://www.whiteroseccs.co.uk/ http://www.shell.co.uk/energy-and-innovation/the-energy-future/peterhead-ccs-project.html

[10] http://www.whiteroseccs.co.uk/ http://www.shell.co.uk/energy-and-innovation/the-energy-future/peterhead-ccs-project.html

> Our 2015 **Gone Green** scenario has ~6 GW of CCS operational by 2035/36 compared to ~11 GW in FES 2014 **Gone Green.**

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 ~5 GW based on the new tidal lagoon projects proposals and recent grid connection terminations for the Orkney projects.

2020s

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

Power supply

5.1.4
Slow Progression

Our **Slow Progression** scenario is shaped by the transition to low carbon and renewable technologies. The constraints on finance result in a slower deployment of these technologies compared to **Gone Green** as illustrated in Figures 58 and 59 and Table 2.

Figure 58
***Slow Progression:** installed capacity*

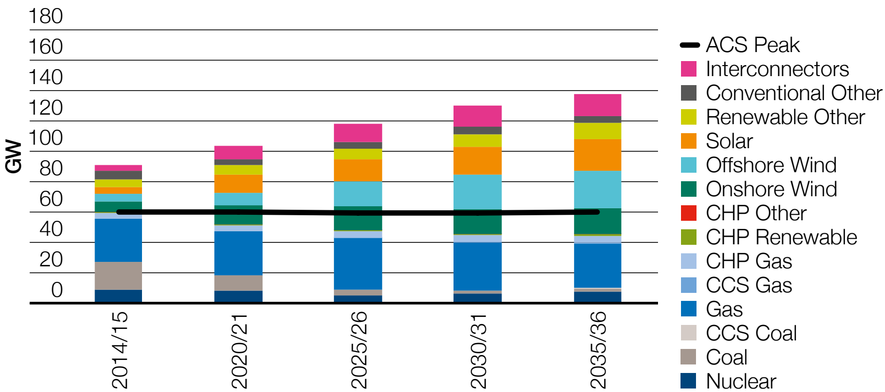


Figure 59
***Slow Progression:** power output*

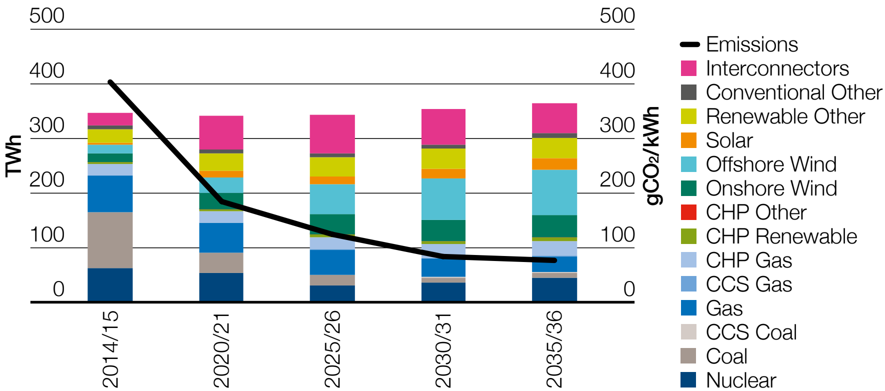


Table 2
***Slow Progression** installed capacity and output levels*

Technology	2020/21		2030/31	
	Capacity (GW)	Output (TWh)	Capacity (GW)	Output (TWh)
Nuclear	8.0	52.9	6.0	35.3
Coal	9.9	36.2	1.9	8.4
Gas	29.5	54.9	31.5	32.3
CCS	0.0	0.0	0.8	4.1
CHP	4.7	26.0	5.6	31.6
Onshore Wind	12.4	29.4	16.3	38.6
Offshore Wind	8.6	28.5	23.0	76.5
Solar	11.8	11.3	18.3	17.6
Renewable Other	6.2	32.7	8.5	36.0
Conventional Other	4.4	6.7	4.9	7.3
Interconnectors	8.4	62.9	14.2	66.1

Power supply

Focus on 2020

Our **Slow Progression** scenario has an increasing volume of renewable generation, with the deployment focused on established technologies, notably wind and solar PV technologies.

> By 2020/21, solar PV and wind account for one third of power generation capacity, meeting a fifth of the annual power demand.

The deployment of solar PV increases 150% by 2020/21 as developers benefit from lower capital costs and continued financial support for this technology. This period also has a strong deployment of wind, with an additional 9GW connecting by 2020/21.

Flexible generation

The reduction in traditional forms of generation remain focused on gas and coal as the fleet comply with the IED requirements. **Slow Progression** shows a slight increase in the gas-fired generation by 2025/26, maintaining the security of supply standard. It also provides stability to the GB market and system, given the increase in the volumes of variable generation. There is a limited new build programme post 2025 as alternative low carbon technologies are connected to the electricity network given the long-term decarbonisation ambitions.

Decarbonisation agenda

The focus on the longer-term decarbonisation agenda results in the continued deployment of renewable generation out to 2035/36 with renewable generation representing 54% of power supply.

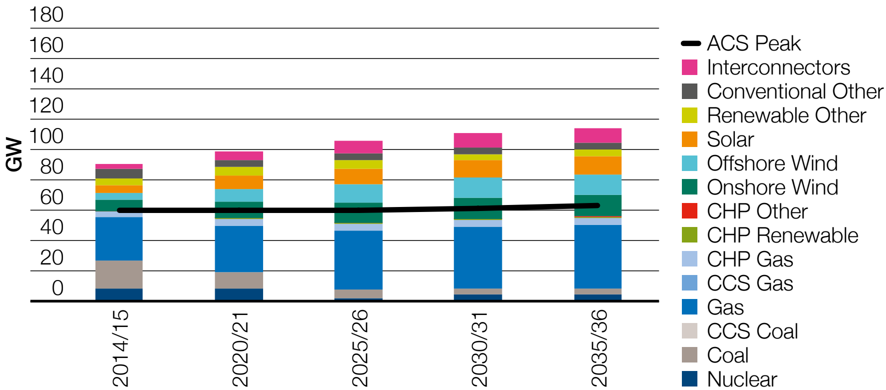
> Wind and solar PV provide the largest contribution of renewable energy by 2035/36, making up 46% of the supply mix and contributing 40% of annual power demand.

The deployment of low carbon based technology strengthens from 2025. In the last 10 years of the period (2025/26 to 2035/36), our **Slow Progression** scenario sees the next generation of nuclear power stations become operational and the introduction of CCS technologies. This period also achieves greater European integration. This leads to a corresponding increase in interconnector capacity to Europe, while GB maintains its position as a net importer of electricity.

5.1.5
No Progression

Our **No Progression** scenario is dominated by established and comparatively cheaper forms of generation given the financial constraints and lack of focus on decarbonisation of the economy, as shown in Figures 60 and 61 and Table 3. The current environmental legislation impacts the sources of generation by the end of this decade.

Figure 60
***No Progression:** installed capacity*



Power supply

Figure 61
***No Progression:** power output*

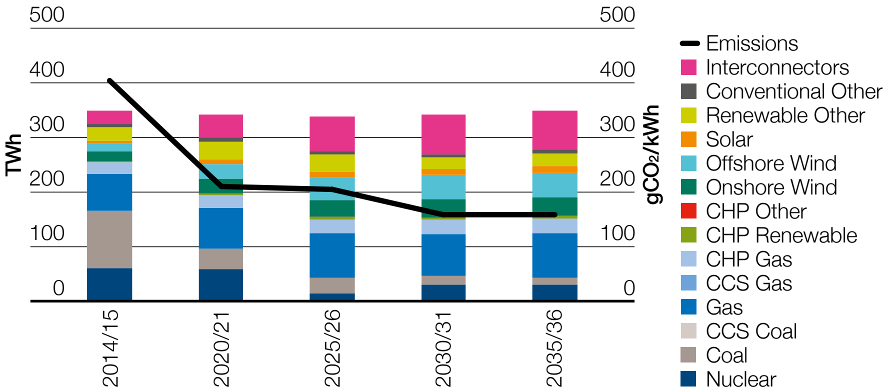


Table 3
***No Progression** installed capacity and output levels*

Technology	2020/21		2030/31	
	Capacity(GW)	Output (TWh)	Capacity (GW)	Output (TWh)
Nuclear	9.0	59.4	4.6	31.3
Coal	10.4	37.8	3.9	15.5
Gas	30.9	74.6	41.0	77.0
CCS	0.0	0.0	0.0	0.0
CHP	4.6	25.5	5.4	30.2
Onshore Wind	11.3	26.7	13.9	33.1
Offshore Wind	8.1	26.9	13.4	44.4
Solar	8.6	8.3	11.3	10.9
Renewable Other	6.0	31.9	3.7	19.9
Conventional Other	4.4	6.7	4.2	6.7
Interconnectors	6.0	43.0	9.8	72.1

Focus on 2020

Our **No Progression** scenario shows gas-fired generation as the dominant fuel source, representing ~35% of installed capacity by 2020/21. The emphasis on gas-fired generation is required to maintain the security of supply standard due to the higher levels of power demand and the closure of coal-fired power stations for environmental reasons.

Our **No Progression** scenario has an increase in the installed levels of renewable technologies out to 2020/21, particularly for solar PV and wind. This has been supported by the recent CfD round one allocation and the rush to access the ROC scheme before it closes. This has provided more certainty around the deployment of renewable generation out to 2020.

Flexible generation

Our **No Progression** scenario is shaped by established forms of generation, particularly gas-fired generation and solar PV.

By 2035/36, gas-fired generation represents ~40% of the generation capacity and ~30% of the electricity produced.

The emphasis on gas-fired generation continues out to 2035/36 providing stability to the GB electricity market and system, offsetting the closure of coal-fired generation and the decommissioning of the majority of the existing nuclear fleet.

Decarbonisation agenda

The lack of focus on the green agenda and the limited financial support available for low carbon generation results in a limited new build programme for nuclear and minimal deployment of less established technologies.

By 2035/36, solar PV and wind generation represents ~35% of the generation capacity and ~25% of the electricity produced.

Our **No Progression** scenario has no CCS and minimal marine generation as emerging technologies are hindered by the financial constraints and lack of green ambition. The deployment of low carbon generation is focused on solar PV, wind and the commissioning of a nuclear power station in the late 2020s.

Power supply

5.1.6
Consumer Power

Our **Consumer Power** scenario has a significant volumes of generation connected at a local level, facilitating emerging technologies to make their mark on the power supply landscape. Large scale generation is dominated by established technologies, as illustrated in Figures 62 and 63 and Table 4. The lack of focus on the long-term decarbonisation agenda hinders the commercial scalability of new low carbon technologies.

Figure 62
***Consumer Power:** installed capacity*

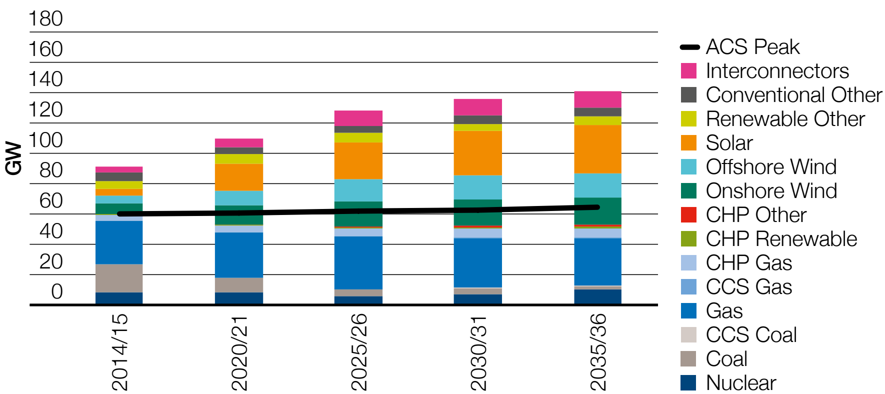


Figure 63
***Consumer Power:** power output*

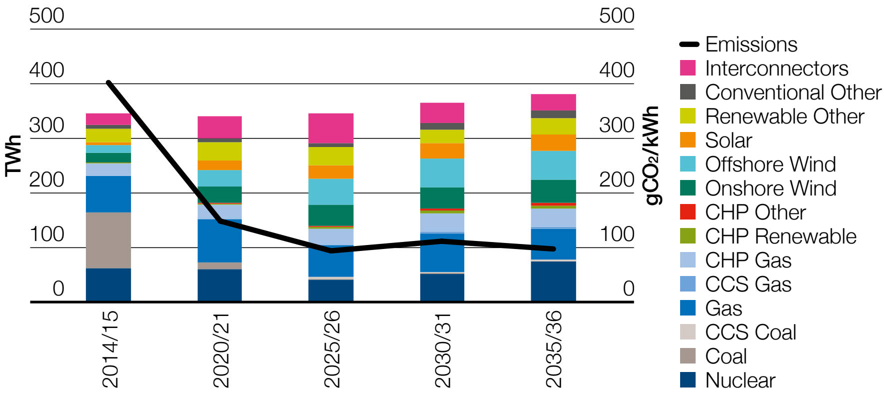


Table 4
***Consumer Power** installed capacity and output levels*

Technology	2020/21		2030/31	
	Capacity (GW)	**Output (TWh)**	**Capacity (GW)**	**Output (TWh)**
Nuclear	9.0	59.3	7.4	51.5
Coal	9.4	12.6	3.9	0.6
Gas	29.5	80.3	32.7	70.5
CCS	0.0	0.0	0.8	5.7
CHP	5.2	28.9	7.8	42.2
Onshore Wind	13.0	30.7	17.1	40.1
Offshore Wind	9.3	30.7	15.9	52.8
Solar	18.0	17.3	29.1	28.1
Renewable Other	6.3	33.3	4.9	25.2
Conventional Other	4.4	6.7	5.5	10.9
Interconnectors	6.0	40.6	10.8	38.5

Power supply

Focus on 2020

The increase of small scale generation is supported by the rapid deployment of solar PV, with installed capacity nearly quadrupling by 2020 and contributing 5% to the annual power demand. The favourable economic conditions and existing environmental legislation results in a near doubling of installed wind capacity within the next six years.

By 2020/21, small scale generation accounts for one third of the power generation capacity, meeting over a fifth of the annual power demand.

Flexible generation

Our **Consumer Power** scenario is shaped by growth in small scale generation. However traditional forms of generation (coal, gas and pumped storage) will continue to have a key role in providing flexibility to the GB electricity market and stability to the wider electricity system.

Coal and oil generation decline as environmental legislation influences how fossil fuel technologies operate under the new emission requirements. The closure of the majority of the remaining coal power stations requires additional generation to maintain security of supply, resulting in the commissioning of new gas-fired generation out to 2025/26.

By 2025/26, gas-fired generation represents ~30% of the generation capacity and ~25% of the electricity produced.

Consumer Power shows a decrease in the installed capacity of gas-fired generation by 2035/36. This is a result of the commissioning of the next generation of nuclear power stations and a decrease in power demand, offsetting the requirements for gas-fired generation.

Decarbonisation agenda

The lack of political consensus for centralised carbon reduction policy restricts the emergence of large scale low carbon and renewable technologies such as CCS and marine. These are limited to demonstration sites as commercial scalability remains unattainable. Large scale generation is dominated by established technologies such as nuclear and gas.

By 2035/36, nuclear and gas-fired generation represent 34% of generation capacity and contribute 44% of electricity produced.

The favourable economic conditions encourage the emergence of new technologies connecting to the lower voltage networks. These include generation from various waste technologies such as advanced conversion technologies and anaerobic digestion. The deployment of wind and solar PV continues, representing 46% of the generation capacity by 2035/36.

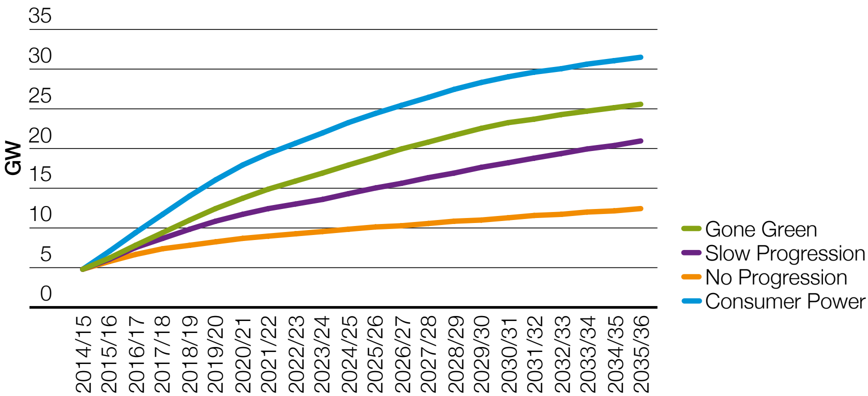
5.1.7
2020 focus: solar PV and wind

The achievement of 2020 renewable energy targets (15% of energy provided by renewable sources) is underpinned by the contribution from the power sector, with 34% of power coming from renewable technologies. The rapid deployment of renewable generation out to 2020 is led by the deployment of wind (onshore and offshore) and solar PV generation.

Solar PV
The emergence of solar PV in the GB energy landscape has been substantial (doubling over the last 12 months), as developers enter the GB market encouraged by government ambitions and support mechanisms, in addition to parallel reductions in technology costs.

Our 2015 solar PV projections, as shown in Figure 64, are based on increased stakeholder engagement with the solar industry and access to additional market information which has enhanced our knowledge for this technology.

Figure 64
Solar PV: installed capacity



Solar PV has benefited from a quicker deployment rate compared to other technologies mostly due to the planning regime and the shorter construction time. By keeping the size below 50MW, planning permission for solar PV projects are considered by the local planning authority, as set out by the Town and Country Planning Act 1990[11], rather than the Planning Inspectorate.[12]

[11] http://www.legislation.gov.uk/ukpga/1990/8/contents

[12] http://www.planningportal.gov.uk/planning/planninginspectorate – Pages 19 and 20

Power supply

So far the deployment of solar PV has been focused in the southern half of England, connecting either to the distribution network company or more locally at domestic dwellings (household roofs) as well as commercial and industrial buildings (tin roofs). There is growing evidence that the deployment of solar PV will extend further north as developers look for alternative locations and access to the electricity network.

National Grid's 2015 System Operability Framework document will assess the implication of substantial volumes of solar PV connecting to the electricity network when it is published in Q4 2015.

Solar PV sensitivity

Our solar PV figures have considered how the market has developed and expanded over the last 12 months whilst acknowledging the uncertainty regarding the sustainability of this rapid increase. Our 2015 solar PV projections were based on the information available at the beginning of January 2015. Since then the solar PV market has experienced another period of significant growth (nearly 2 GW of solar PV deployed in the first quarter of 2015) as developers progressed their projects before the closure of the ROC scheme on 31 March 2015.

We recognise that our 2015 scenarios may not fully capture the true potential of the deployment of solar PV in the short to medium term. Given this development, we have reviewed our 2015 solar PV projections and have developed a solar PV sensitivity. The impact on the electricity system of increased volumes of solar PV connecting is considered in our energy balancing challenges case study and in the System Operability Framework (SOF) document.

Chapter five

Solar PV sensitivity

The emergence of solar PV within the GB energy landscape has been considerable over recent years. The first quarter of 2015 resulted in a significant increase in the deployment of solar PV as developers progress their projects before the closure of the RO scheme on 31 March 2015. Given this we have reviewed our 2015 solar PV scenarios and have developed a sensitivity to enable us to capture this upturn in installation rates.

The 2014/15 baseline figure has been adjusted to the official DECC figures as of 31 March 2015. The increase in the projections represents the government's continued support for solar and the potential change to the support mechanism for other technologies (providing additional funding to solar PV) and the continued reduction in technology costs.

Solar PV Installed Capacity (MW)

2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
5,709	8,879	12,099	15,193	18,337	21,295	23,839	25,739	27,595	29,399	31,140	32,778

The impact on the electricity system of increased volumes of solar PV connecting is considered in our energy balancing challenges case study and in the System Operability Framework (SOF) document.

Wind

The significant deployment of solar PV generation over the last couple of years and the establishment of the market within GB has reduced the reliance on wind generation in achieving the 2020 climate change targets. However an additional 10GW of wind capacity is required by the end of decade, 5GW of which has already secured a CfD contract (including Final Investment Decision Enabling for Renewables)[13]. The pending closures of the Renewables Obligation (RO) scheme for onshore wind may encourage a strong deployment as developers strive to meet the eligibility criteria before the scheme is closed.

In our **Gone Green** Scenario, 18% of annual power demand will originate from wind by 2020/21.

The deployment of wind out to 2020/21 also has been supported by the recent CfD round one allocation. This has provided more certainty regarding how the wind profile will develop over the next few years as the country strives to meet its environmental aspirations and targets. As shown in Figure 65, there is very little divergence between our 2015 scenarios out to 2020/21.

Figure 65
Wind: onshore and offshore installed capacity

Wind deployment rates

Our stakeholders have asked whether the deployment rates, as depicted by our scenarios are credible given the current status of the projects. We have analysed whether the wind deployment rates for the period out to 2020 as shown by our **Gone Green** scenario are plausible given the important role which the technology has in the achievement of the 2020 renewable energy target.

Onshore wind

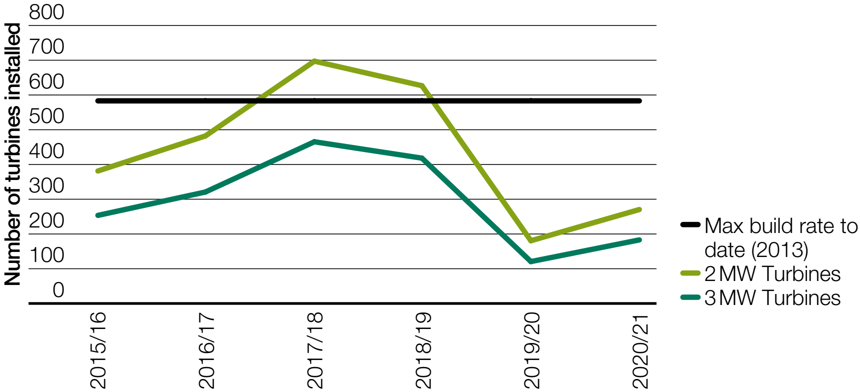
The annual onshore wind deployment rates as depicted by our **Gone Green** scenario is shown in Figure 66. For 2017/18 and 2018/19 the amount of additional capacity exceeds what we have previously seen installed annually in GB. This analysis is based on the installation of 2MW turbines which used the average size turbines deployed in 2013 when the maximum installation of onshore occurred.

[13] https://www.gov.uk/government/publications/increasing-certainty-for-investors-in-renewable-electricity-final-investment-decision-enabling-for-renewables

Chapter five

Power supply

Figure 66
***Gone Green:** onshore wind deployment*

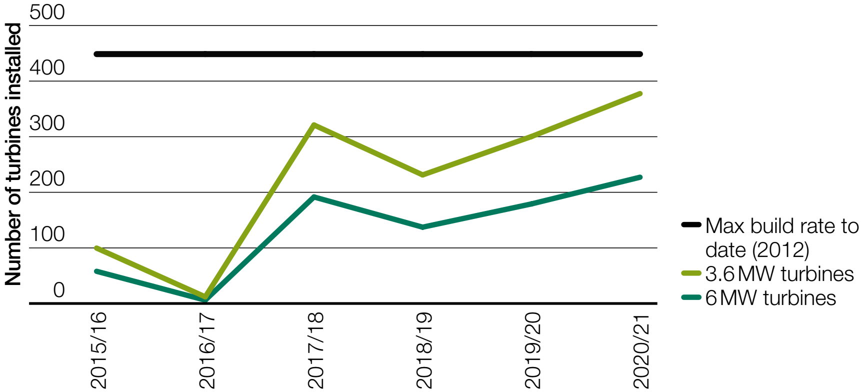


Since then technology advancement has seen the average size increase to 3MW. If this larger size is used for all onshore turbine installed going forward, then the number of actual turbine to be installed out to 2020 falls below the 2013 high as shown in Figure 66. With this increase in turbine size, the existing supply chain seems quite capable of supporting the level of additional onshore capacity required.

Offshore wind

For offshore wind, the largest annual increase in capacity occurred in 2012 when 1.6GW was installed. This is above the required annual threshold for turbine deployment as depicted by our 2015 **Gone Green** scenario, as illustrated in Figure 67. This maximum installation rate was achieved with an average turbine size of 3.6MW. Since then technology advancement has seen the average size increase to 6MW. If this larger turbine size is used for all offshore wind installation going forward then the number of turbines to be installed out to 2020, to meet the required capacity, greatly reduces.

Figure 67
***Gone Green:** offshore wind deployment*



Average offshore wind turbine sizes to be installed in the next six years are over 66% larger than the turbines sizes installed in 2012 (6MW as opposed to 3.6MW).

Our analysis indicated that it is possible to achieve our **Gone Green** wind deployment rates given recent advancement in turbine technology. However other parts of the supply chain will have their role to play in making **Gone Green** a reality, particular the planning process, access to financial support and certainty and clarity on government policy e.g. publication of strike prices for 2019/20 and 2020/21.

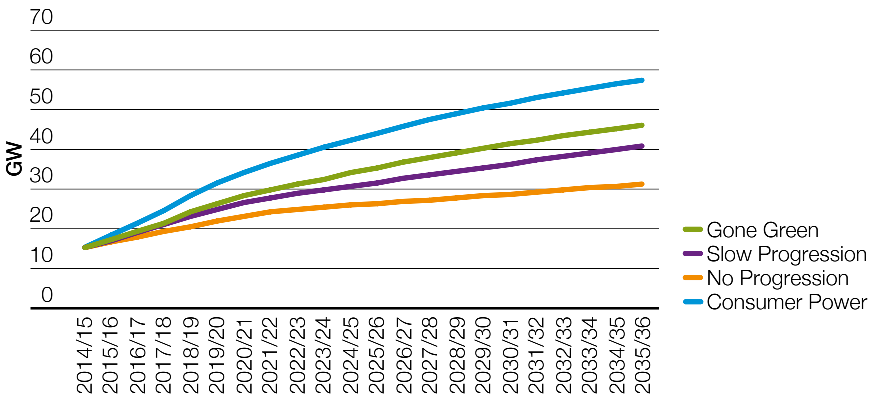
Power supply

5.1.8
Distributed and micro-generation

Generation connecting to the distribution networks, domestic dwellings and commercial and industrial buildings has been an area of significant growth in recent years, encouraged by government support for low carbon technologies.

All of our scenarios consider a potential growth in small scale generation, starting from ~15 GW in 2014/15 increasing to ~31 GW in **No Progression** and to ~57 GW (40% of total installed generation capacity) in **Consumer Power** as shown in Figure 68. The growth in small scale generation focuses on renewable sources with particular emphasis on solar PV.

Figure 68
Distributed and micro-generation: installed capacity



The development of distributed and micro-generation is an important part of our power supply scenarios. It will influence the wider electricity system as it reduces the demand on the National Electricity Transmission System (NETS), potentially resulting in energy balancing challenges (please refer to case study) and system operability issues.

Distributed generation

All of our distributed generation scenarios consider the potential for the development of generation plant connected to or making use of the distributed networks.

Our distribution scenarios consider a wide variety of technologies both fossil and renewable as shown in Table 5.

Distributed generation is defined as 'generation connected to the distributed networks which is ≥1 MW in size, up to onshore transmission areas mandatory connection thresholds'.

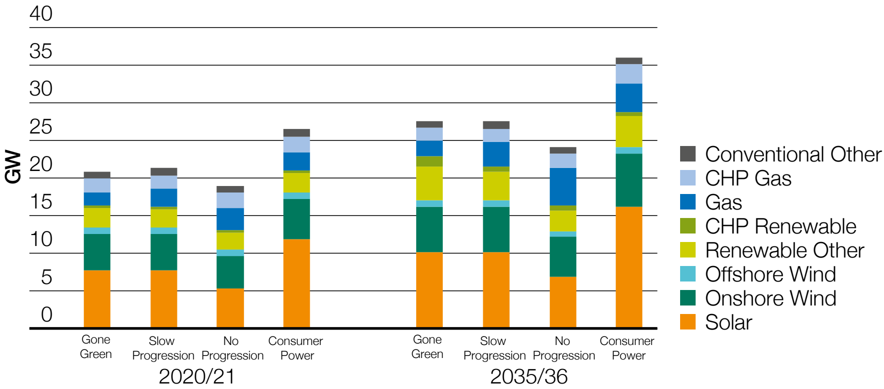
Table 5
Distributed generation technologies

Fossil	Renewable		
Coal CHP	Anaerobic Digestion CHP	Anaerobic Digestion (AD)	
Gas CHP	ACT CHP	Advanced Conversion Technology (ACT)	Solar
CCGT	Biomass CHP	Biomass	Tidal
Open Cycle Gas Turbine (OCGT)	Geothermal CHP	Geothermal	Wave
Diesel Engines	Sewage CHP	Landfill Gas	Onshore Wind
Fuel Oil	Waste CHP	Waste	Offshore Wind

We have developed three data sets which have different deployment rates (low, medium and high) for each of the technologies. These have been applied to our scenarios as depicted by their narrative and assumptions. **Consumer Power** has the highest levels of distributed generation whilst **Gone Green** and **Slow Progression** scenarios are dominated by renewable generation. Our scenarios incorporate the 2018/19 CM auction results for small scale generation and consider IED compliance for applicable plant.

Power supply

Figure 69
Distributed generation: installed capacity



> 834 MW of small scale OCGT and reciprocating engines were allocated 2018/19 CM contracts.

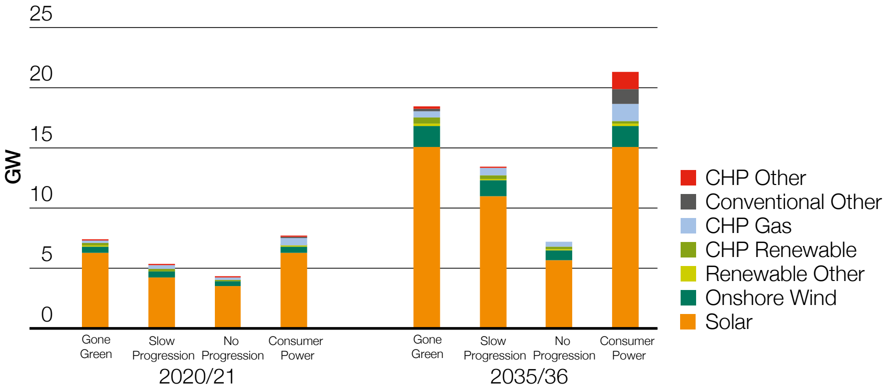
Figure 69 shows our distributed generation scenarios at 2020 and 2035.

The deployment rates for distributed generation have been developed from a variety of different information sources: from government data to information provided from trade associations and electricity distribution networks. There is currently no centralised source of all generation connected to the distribution networks. Given the limited visibility of future distributed generation deployment at an individual plant level, the scenarios have focused on the potential uptake of particular technologies.

Micro-generation

Our micro-generation scenarios consider the potential for the deployment of sub-1 MW generation. Our 2015 scenarios consider an extended set of technologies: solar PV (installed on domestic dwelling as well as commercial and industrial buildings), wind, hydro, CHP (gas, biomass, biogas and micro) and fuel cells. Figure 70 shows our installed micro-generation scenarios at 2020 and 2035.

Figure 70
Micro-generation: installed capacity



Our scenarios consider the potential uptake of micro-generation and how new technologies could emerge. This is dependent on favourable economic conditions and support mechanisms providing the desirable market conditions.

Power supply

Method

Power generation capacity

Our power supply scenarios are developed using a deterministic approach. The scenario narrative and assumptions provide the uncertainty envelope that determines the emphasis placed on the different types of generation technology within each scenario. The emphasis placed on a particular technology is determined by a number of factors such as market intelligence, government policy and legislation, project status and power station economics. The generation backgrounds are then developed to meet the security of supply standard for each of our power demand scenarios and stay within the budget as specified by the LCF.

Power generation output

The generation output from each power supply source is determined from the respective installed capacity and cost of generation. For large scale generation this is determined by the Short Run Marginal Cost (SRMC) at power station level. For each half hour of the year the available power stations are dispatched in line with their SRMC. Starting with the plant with the lowest SRMC, the generation is dispatched until the demand threshold for that half hour is met. The generation output is then aggregated at an annual level. Technologies can be broadly split into three tranches: zero SRMC, low SMRC and fossil fuel plants (high SMRC):

- Zero short run marginal costs – the first tranche of technologies have zero SRMC and typically include renewable technologies such as wind and marine. They are assumed to operate whenever they are able to e.g. when the wind is blowing. Each technology has an assumed load factor, as shown in Table 6.

Table 6
Renewable technology average annual load factors (transmission connected)

Technology	Average Availability
Onshore Wind	28%
Offshore Wind	38%
Marine	22%
Solar PV	11%
Hydro	33%

- Low short run marginal costs – the next tranche of technologies have either very low SRMC or receive income from another revenue stream. They include nuclear, biomass, CHP and CCS technologies. Each technology has an assumed availability figure which represents the percentage of time the power station could run for if required, as shown in Table 7.

Table 7
Low carbon technology average availabilities (transmission connected)

Technology	Average Availability
Biomass	70%
CHP	60%
CCS	85%
Nuclear	76%

- Fossil fuel plant (high SRMC) – the final tranche of technologies are fossil fuel plants. These include coal, gas and oil fuelled plant. The SRMC of these power stations is primarily determined by the cost of fuel (see chapter 3 for fuel price details) and CO_2 emissions.

Interconnectors

5.2 Interconnectors

For each scenario, we produce interconnector capacity levels and flows for peak and annual periods. This feeds into our power demand and generation modelling. The capacity levels for FES 2015 have increased from FES 2014 due to greater regulatory certainty as a result of Ofgem's cap and floor regime for interconnectors. For our annual flows, GB is a net importer of power, with the exception of Gone Green from 2031/32. For our peak flows, we have greater imports across all scenarios at times of GB system stress.

Key statistics

- The current interconnector capacity in GB is 3.8 GW. For **Gone Green** in 2020/21 the capacity level is 10.8 GW. This would meet the EU 2020 target for interconnection.
- Capacity levels in 2034/35 range from 9.8 GW for **No Progression** to 17.7 GW for **Gone Green**.
- GB remains a net importer. In 2020/21 the net import annual flows range from 39 TWh for **Consumer Power** to 68 TWh for **Gone Green**. From 2031/32, for **Gone Green**, GB becomes a net exporter reaching net exports of 11 TWh by 2035/36.
- In 2020/21, the net peak flows range from imports of 2.2 GW for **No Progression** to 4 GW for **Gone Green**. In 2035/36 the range is from 3.5 GW imports for **No Progression** to 6.5 GW for **Gone Green**.

Interconnectors

5.2.1
Capacity levels

Figure 71
Capacity level comparison in GW

	Gone Green		Slow Progression		No Progression		Consumer Power	
	FES 2015	FES 2014	FES 2015	FES 2014	FES 2015	FES 2014	FES 2015	FES 2014
2020	10.8	6.0	8.4	6.0	6.0	5.0	6.0	5.0
2025	15.7	7.4	12.2	7.4	8.4	6.0	9.8	7.4
2030	17.7	11.8	14.2	8.4	9.8	7.4	10.8	7.4
2035	17.7	11.8	14.2	11.8	9.8	7.4	10.8	7.4

Our capacity levels have increased considerably from FES 2014 and the table above offers a comparison. The current interconnector capacity level for GB is 3.8 GW and for **Gone Green** in 2020, the level is 10.8 GW. The increase over the next five years is due to Ofgem's decision to introduce the cap and floor regime in 2014 and the progression of those projects. The introduction of the regime has de-risked investment decisions in new interconnectors by placing a floor on investment losses. There is also a cap to protect consumers.

The EU has non-binding interconnector capacity targets for all members[14], which are set based upon a percentage of generation installed within that country. The GB non-binding target is currently 10% by 2020 which is approximately 10.2 GW of interconnector capacity. The EU is looking into raising the target to 15% for 2030 which is approximately 22.6 GW[15]. In **Gone Green** we have assumed that Ofgem will use the cap and floor regime to support the delivery of the 2020 capacity target.

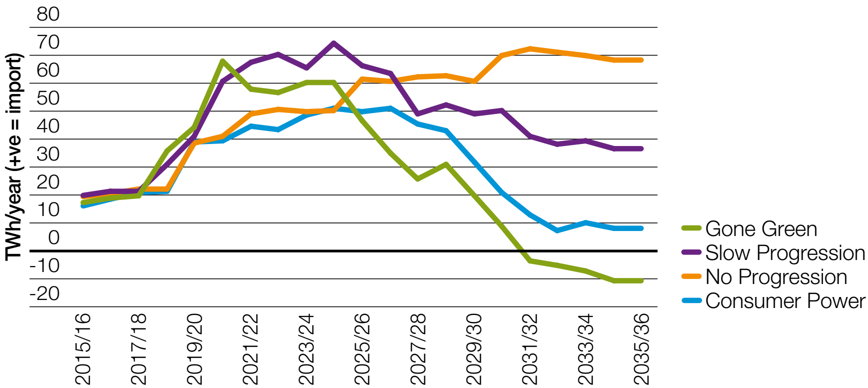
For 2030 **Gone Green** falls short of the capacity target due to a shortage of projects in the pipeline. This highlights the potential opportunities for additional interconnector projects in the future.

The highest interconnector capacities are in **Gone Green** followed by **Slow Progression**, **Consumer Power** and **No Progression**. Higher wind generation in **Gone Green** and **Slow Progression** creates a greater need for interconnectors to compensate for variable levels of generation. Greater prosperity means more money available to develop interconnectors in **Consumer Power** than **No Progression**.

[14] http://europa.eu/rapid/press-release_MEMO-15-4486_en.htm

[15] Includes micro and distributed generation

Figure 72
Net annual flows



In the short term, annual imports rise rapidly in line with the increase in capacity. Across all four scenarios GB remains a net importer of electricity due to the price differential with connected countries until the early 2030s. The carbon price support is a major factor in this price differential. Additional levels of both nuclear and variable generation increase the times when price differentials favour exports. This results in lower net imports from the mid-2020s onwards in three of the scenarios, with a shift to a net export position in **Gone Green** from 2031/32. Conversely, in **No Progression**, which has much lower levels of variable generation than **Gone Green**, net imports continue to increase until the 2030s. **Slow Progression** and **Consumer Power** have similar levels of exports. **Slow Progression** has more imports due to a higher gas price which results in higher net imports for this scenario compared to **Consumer Power**.

The **Gone Green** analysis highlights the benefits of greater interconnection in providing access to lower cost low carbon energy across Europe.

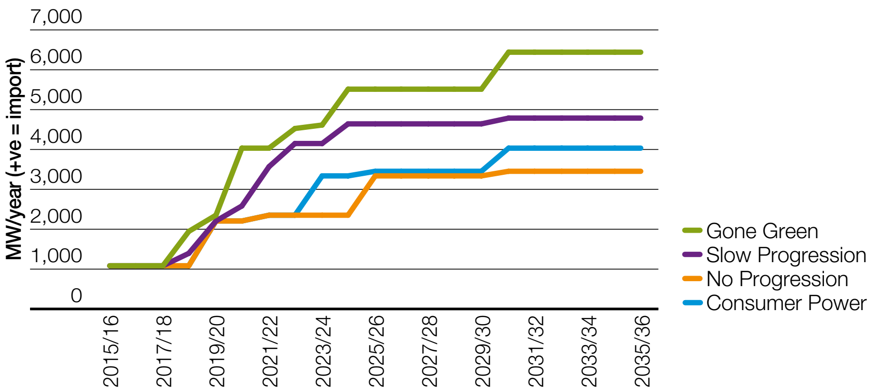
Interconnectors

5.2.2 Peak flows

Interconnector flows at peak demand levels will vary greatly depending on the level of generation and demand across Europe. The figures produced for FES 2015 show the typical flows that could be expected when the GB capacity margin is low.

This year we have changed our peak analysis following stakeholder feedback. Last year we assumed net float at peak with exports to Ireland exactly offset by imports from the continent. For FES 2015, the increased capacity in our scenarios enables much higher imports from the continent when we need it. We have retained exports to Ireland.

Figure 73
Aggregate peak flows



Chapter five

For FES 2015 the peak flows are the typical levels expected at times of low or negative GB capacity margin. However, actual flows at times of ACS peak demand could differ significantly from these figures. For example, if there was high wind generation we may even see net exports, particularly in the **Gone Green** scenario.

We calculated our peak flows by multiplying our capacity levels by assumed de-rating factors. These factors were based on Pöyry's analysis of historical de-rating factors for DECC[16]. This report recommended conservative values to act as a floor for the factors to be applied in the 2019/20 capacity market auction. Therefore, for FES, we have made a number of adjustments which are explained in more detail in the method section below.

Figure 73 reflects a correlation of greater net peak imports depending on the level of capacity in the scenario. **No Progression** sets the bottom of the range followed by **Consumer Power**, **Slow Progression** and **Gone Green** with the highest imports. Peak imports do not rise as fast as capacity because we have assumed that generation will not increase in line with interconnection. We have therefore applied a reduction to the peak imports we could expect from each additional interconnector to a country that is already connected to GB. This has the biggest impact on **Gone Green** and **Slow Progression**.

Our peak flows have a direct impact on the generation capacities in our scenarios. For instance, in **Gone Green**, imports of over 6GW from 2030 will reduce the level of generation capacity required in our scenario to meet security of supply standards.

[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404337/Final_historical_derating_of_IC_poyry_report.pdf

Interconnectors

Method

Capacity levels

Our capacity level analysis is driven by stakeholder engagement, Ofgem's cap and floor regime and the non-binding EU targets. Any project without a final investment decision is considered to be uncertain and the scenarios are used to reflect this uncertainty. We have included a number of the conceptual Projects of Common Interest produced by ENTSO-E's Ten-Year Network Development Plan, where feasibility studies and Transmission System Operator (TSO) sponsors are in place. These projects are identified to have socio-economic benefits but may not yet be fully viable or backed by investors/developers. Interconnector projects were grouped into short, medium and long, based on the length of cable. France, Belgium, Netherlands and Ireland were in the short group, Denmark and Norway in the medium group and Iceland and Spain in the long group. Long links are only included in **Gone Green**. **No Progression** was limited to a conservative assessment of the near-term projects up to the 2020 cap and floor projects, under the scenario assumptions of less prosperity and investor uncertainty. Further variation between the scenarios was created by staggering and delaying implementation of interconnector projects. The order of earliest to latest being **Gone Green**, **Slow Progression**, **Consumer Power** and **No Progression**.

Annual flow modelling

Annual flows were modelled using National Grid's Electricity Scenario Illustrator (ELSI)[17], an economic model used for assessing transmission investments. This is a significant development from FES 2014, and part of a series of improvements. We are looking to further develop our tools and capabilities in this area in our expanding role as EMR Delivery Body and under the Integrated Transmission Planning and Regulation (ITPR) project.
To enable ELSI to model interconnector flows, each connected country is represented as a single node with a static price. There are 12 prices in the year representing 3 seasons (winter, summer and spring/autumn) and 4 time periods. These European prices were purchased from Baringa, who ran their European model using their scenarios mapped to National Grid's FES 2014 scenarios and adjusted for FES 2015 fuel price assumptions. Interconnector modelling is the first stage of FES modelling so FES 2014 demand and generation figures had to be used, alongside FES 2015 interconnector capacities and fuel price assumptions.

[17] http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Electricity-Ten-Year-Statement/

Peak flow analysis

Our peak flows were calculated by multiplying the capacity levels for each scenario by assumed de-rating factors. These de-rating factors reflect the amount an interconnector is expected to be importing electricity to GB when it is required to provide security of supply. The variation in peak flows is driven by the interconnector capacity assumptions. The interconnector de-rating factors were based on Pöyry's report to DECC on historical interconnector de-rating factors[18]. This report recommended conservative values to act as a floor for the factors to be applied in the 2019/20 capacity market auction. Therefore, for FES, we have made a number of adjustments which are explained in more detail below:

- We have used the same de-rating factors for all scenarios except for one adjustment.
- We reduced the de-rating factors by 50% for each new interconnector added to countries that are already interconnected with GB. We have assumed that generation capacity will not increase in line with additional interconnector capacity. The impact is different de-rating factors for each scenario for France and Norway with **Gone Green** affected most significantly, due to the highest number of interconnectors, whilst there is minimal impact for **No Progression**.
- We based France on 2012 and 2013 only, increasing the de-rating factor from 29% to 62%. This is because the report contained a wide range for France depending on the period and type of analysis and we felt that the influence of market coupling on the 2012 and 2013 figures made the higher number more appropriate for this analysis.
- We reduced the de-rating factors for Belgium, Norway and Netherlands to adjust for technical availability. The 5% reduction value comes from the long cable (project 2) figures in the Sinclair Knight Merz (SKM) report to Ofgem[19].
- We applied a de-rating factor of 90% to Iceland reflecting an assumption of very high commercial availability tempered by an increased risk of technical unavailability due to the length of the line, and the potential risk of geological activity affecting the connection.
- For all scenarios we set peak exports to Ireland at 750 MW initially. This is in line with recent experience and our annual flow analysis. We reduced exports to 500 MW from 2019/20 onwards to reflect greater market efficiency and full market coupling following completion of the north/south transmission link.

[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404337/Final_historical_derating_of_IC_poyry_report.pdf

[19] https://www.ofgem.gov.uk/ofgem-publications/59247/skm-report-calculating-target-availability-figures-hvdc-interconnectors.pdf

Gas supply

5.3
Gas supply

Our gas supply scenarios include a wide range of possible supply patterns. Production from the UK's indigenous resources is aligned to the scenario axes of green ambition and prosperity. The gas market provides enough gas from Europe and beyond to make up the difference between indigenous supply and demand.

In response to positive stakeholder feedback we have once again chosen to represent a large part of our imported gas as 'generic import', which can be any mix of liquefied natural gas (LNG) or continental gas delivered through the IUK[20] and BBL[21] interconnectors. Although no new shale gas wells have been drilled in the last year, progress has been made in planning. We have included substantial development in **Consumer Power**, which combined with strong development on the UK continental shelf, drives imports down to below 40% of total supply in the mid-2020s.

As demand is lower in all scenarios than the maximum levels seen in recent years we do not see a requirement for new infrastructure simply to ensure that supply matches demand. This does not in any way preclude the possibility that new storage or import facilities may be built for sound commercial reasons.

Key statistics

- UKCS production peaks in 2018 in all scenarios, contributing between 39% and 49% of total supply in Slow Progression and Consumer Power respectively.
- Shale gas production ranges from zero in Slow Progression and Gone Green to 32 bcm/year in Consumer Power. This requires the development of 100 sites each with 10 vertical wells and 40 lateral wells.
- Import dependency rises to around 90% in Slow Progression by 2035. This could mean around 170 LNG deliveries throughout the year.

[20] Interconnector UK: an import and export pipeline between Bacton and Zeebrugge

[21] An import pipeline from Balgzand (Netherlands) to Bacton

5.3.1
Gas supply in each scenario

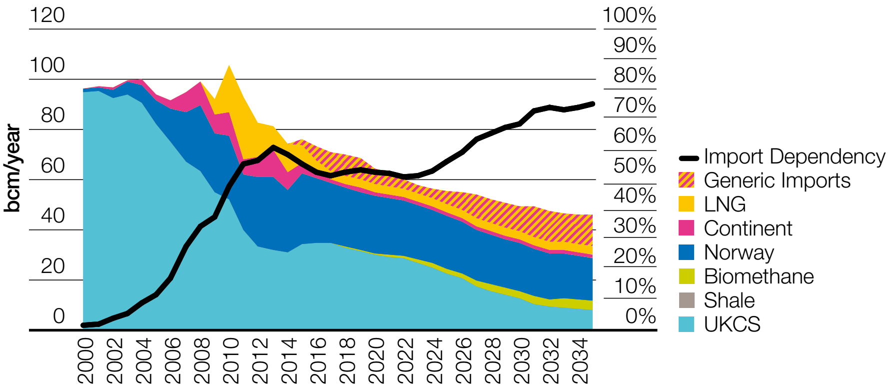
Gone Green

In **Gone Green** gas demand falls from 2015 onward and is the lowest in any of the scenarios. Production from the UKCS in this prosperous scenario is high in the early years, but declines later as investment is focused more on perceived greener technologies.

Some of our stakeholders expressed the view that in a world with high green ambition, especially a prosperous world, protest groups opposed to shale gas development would be well organised and well funded. In recognition of this, the government policy in **Gone Green** includes further restrictions on shale development and as a result we have not included any shale gas in the scenario. Injection of biomethane is currently supported by the Renewable Heat Incentive. In this scenario, with high green ambition, government policy increases support for the technology. Biomethane production is at its highest in this scenario, though the total volume is still only 4 bcm/year.

Although the UKCS production is only moderate, and there is no shale gas, demand is so low that the requirement for imported gas is also low up to the mid-2020s. Supplies from both Norway and the generic import are at the bottom end of our range of expectations. By 2035 however, the continuing decline in UKCS production means that import dependency rises to around 80%. The annual supply pattern for **Gone Green** is shown in Figure 74.

Figure 74
*Annual supply pattern in **Gone Green***



Gas supply

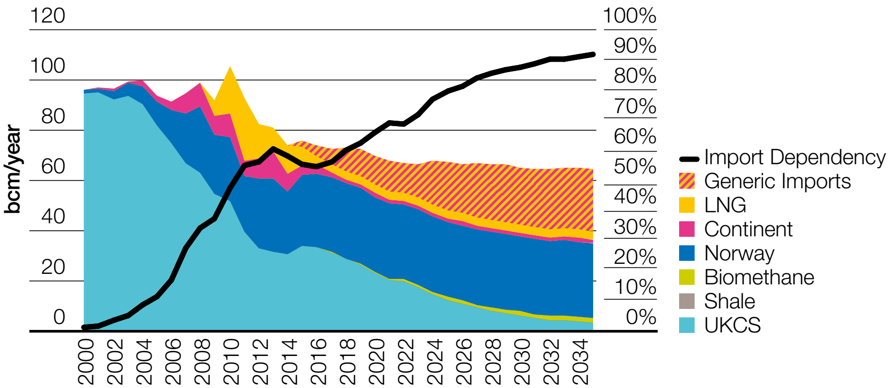
Slow Progression

In **Slow Progression**, gas demand is slightly higher than in **Gone Green**. In this scenario, conditions for development of UK indigenous production are poor. The economy is growing slowly and there is additional taxation on offshore production. As such, UKCS development is lower in **Slow Progression** than in any other scenario.

Government policy continues to support biomethane but not shale gas. In line with the green ambition in this scenario, the limited investment that takes place is concentrated on greener technologies. This results in some development of biomethane, but not shale gas. The limited indigenous production leaves room for the highest level of imports, with both Norwegian gas and the generic imports at the top end of our expected range. The generic import could be supplied in full by either LNG or pipeline gas from the continent with the existing infrastructure, though the volumes are sufficiently high that new capacity may be attracted to the market.

Our Gas Ten Year Statement document lists a number of proposed import projects that are progressing through planning but have not yet reached final investment decisions. It is therefore conceivable that some of these might move forward. The annual supply pattern for **Slow Progression** is shown in Figure 75.

Figure 75
*Annual supply pattern in **Slow Progression***

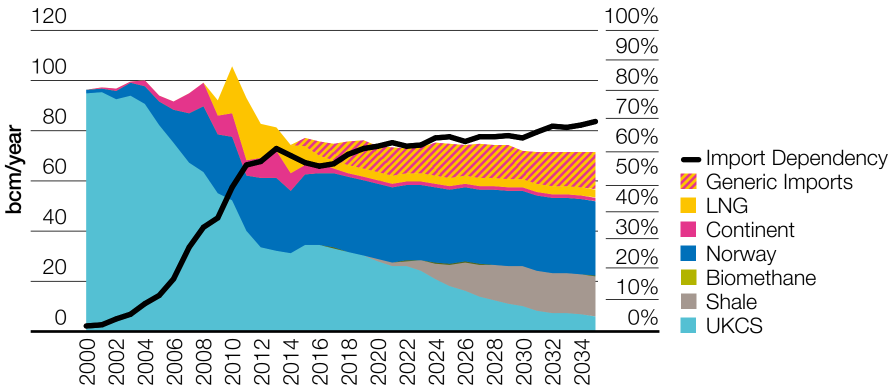


No Progression

In **No Progression** gas demand is higher than **Slow Progression**. In 2016 and 2017 demand is higher than in any other scenario. Government policy in **No Progression** is similar to today, so there is no additional taxation on offshore production. There is no extra support for, or supplementary restrictions on, shale gas production. Additionally there is no additional support for biomethane over and above the current Renewable Heat Incentive. The poor economic conditions rather than policy limit developments in **No Progression**.

There is not sufficient money available to encourage production in the more marginal UKCS fields, and shale gas and biomethane development is similarly restricted. The requirement for imported gas is relatively high with supplies from Norway at the top end of our expectations and the generic import also in the upper part of the expected range. The annual supply pattern for **No Progression** is shown in Figure 76.

Figure 76
Annual supply pattern in ***No Progression***



Gas supply

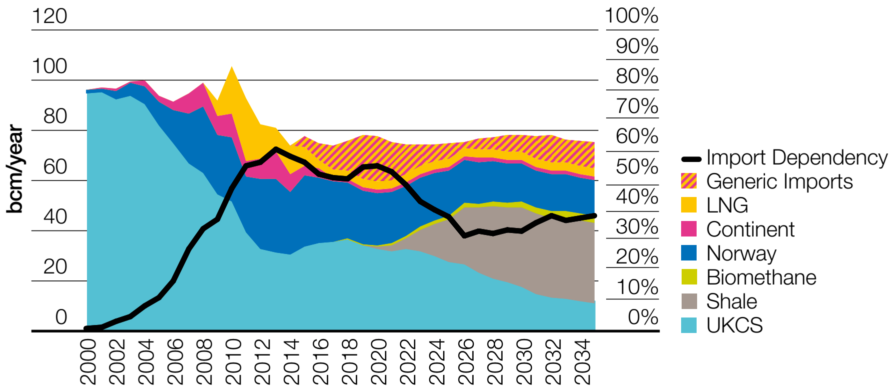
Consumer Power

In **Consumer Power** gas demand is high throughout the period, and from 2018 onwards is higher than in all the other scenarios. In this scenario the economy is growing and there is money available for investment. Government policies support offshore production with lower taxation and support shale gas with more favourable regulation.

Biomethane is still supported at the current level but, as this is a scenario with lower green ambition, no new support is offered. The positive investment climate and an environment with high technical innovation lead to the greatest production from the UKCS, with fields being developed that are too challenging in other scenarios. Shale gas development is similarly well supported, with production starting in around 2020 and rising to around 32 bcm/year by 2030. The high level of indigenous production means that the requirement for imported gas is low. Both Norwegian supplies and the generic import are at the bottom of our range of expectations.

The total import dependency falls to around 32% in the mid-2020s before rising to 39% by 2035. The annual supply pattern for **Consumer Power** is shown in Figure 77.

Figure 77
*Annual supply pattern in **Consumer Power***



5.3.2
UK continental shelf

Our UKCS projections continue to be based on information provided by producers through an annual process which is run in conjunction with Oil & Gas UK[22], combined with market intelligence and our own analysis. Following many years of decline, production in 2013 and 2014 was slightly higher, a trend which continues for a few years in the two more affluent scenarios, **Consumer Power** and **Gone Green**, before it declines again. In **Slow Progression** and **No Progression** supplies do not rise above the 2015 level and decline from 2017 onwards. Differences between the four scenarios are inevitably quite small in the first few years as our projections are based on fields that are already in, or close to, production.

In later years the UKCS sees greater expansion in **Consumer Power** and **Gone Green**. The growing economy and a high level of technical innovation support development of fields that are too difficult or too expensive for the poorer economic conditions of **Slow Progression** and **No Progression**.

We have not included a separate chart for UKCS production as the volumes can be seen in context in the annual supply patterns for each scenario, Figure 74 to Figure 77.

[22] Oil and Gas UK is a representative body for the UK offshore oil and gas industry.

Gas supply

5.3.3
Shale gas

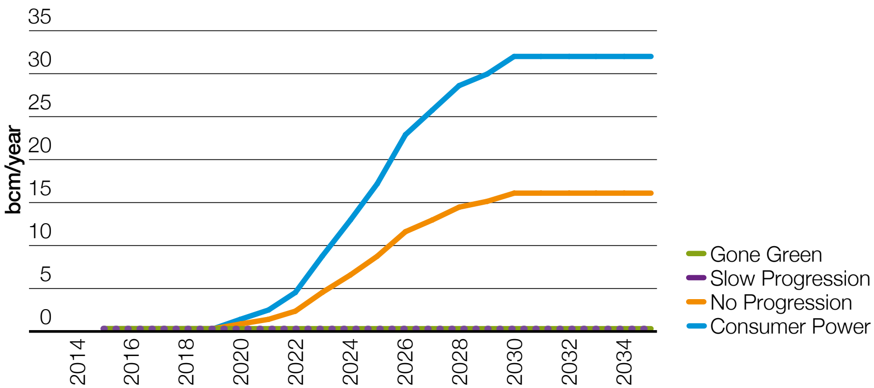
In the last year there has been continued financial support for shale gas development with a number of investments made by large gas and chemical industrial companies. The government has also promised to support the UK shale industry through tax incentives, sovereign wealth funds and changes to underground access rights. Additionally the government has promised community benefit packages and funding to help develop a national college specialising in onshore oil and gas.

In Scotland, a moratorium on planning permissions for all unconventional oil and gas projects was announced in January 2015. This is due to be maintained until a full public consultation is completed on the extraction of shale gas.

Results of the 14th onshore oil and gas licencing round are expected in the second half of 2015. A few test wells have been drilled in the North West of England, and planning applications have been submitted for further test wells in England. Although there has been some progress in a number of areas, the industry is still waiting for the results of the test wells. Following discussions with our stakeholders we have based our 2015 projections on last year's analysis and used a wide spread for shale gas production. These range from no development in **Gone Green** and **Slow Progression** to a peak of 32 bcm/year in **Consumer Power**, as shown in Figure 78.

Chapter five

Figure 78
Shale gas production



The high shale case represents a significant part of the total gas supply in **Consumer Power**, as shown in the annual supply pattern in Figure 77. Some of our stakeholders have asked what will be required to get to this level of production so we have outlined some indicative milestones that will be needed:

Milestones on the way to 32 bcm/year of shale

To achieve 32 bcm/year of shale gas by 2030 the following need to be in place:

- Cuadrilla are granted final planning permission this year (2015)
- Favourable results from test wells (2016)
- Apply for planning applications, licences and environmental permits for further shale gas wells (2016)
- Drilling of additional wells (2016/2017)
- Monitor flows for 12-18 months to assess volumes produced. Results favourable (2017/2018)
- Apply for production licences and environmental consents for shale gas wells (2018)
- Monitor seismic and environmental conditions for 12 months (2018/2019)
- Commercial production starts (2020)
- 100 sites (known as 'pads') (10 vertical wells 40 laterals per pad) developed to get to 32 bcm by 2030.

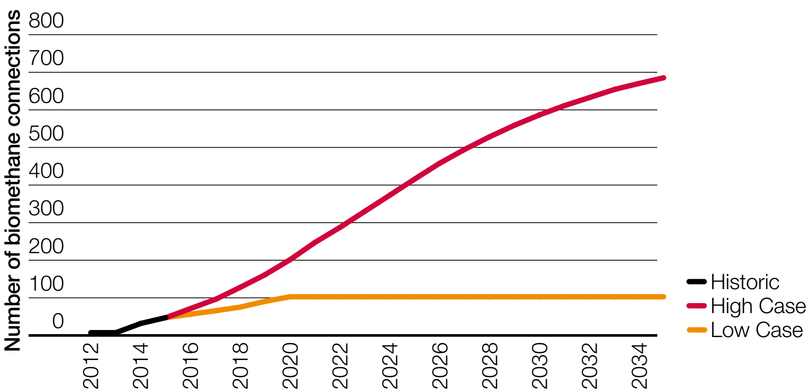
Gas supply

5.3.4
Biomethane

Injection of biomethane into the network is supported under the non-domestic RHI and contributes to meeting renewable energy targets. There is continuing interest in the field, and both the number of biomethane projects and the volume of gas entering the network from those projects has increased substantially in the last 12 months.

Our projections are based on the latest information available to us on the number of biomethane connections and flow rates. They show an increase of around 10% since our 2014 scenarios with a high case in **Gone Green** of around 4 bcm/year in 2035. The volume of biomethane can be seen in context in the annual supply patterns for each scenario, Figure 74 to Figure 77. The total number of connections is shown in Figure 79.

Figure 79
Total biomethane connections



5.3.5 Coal bed methane

We have removed the contribution from coal bed methane (CBM) from our 2015 scenarios, as we expect some of the CBM developments to be delayed or cancelled if shale gas applications are approved. We also expect gas produced from those CBM sites that are not delayed or cancelled to be used for on-site power generation rather than being connected to the gas network.

5.3.6 Norway

In making our projections of supplies of Norwegian gas to GB we consider two different aspects: total production of Norwegian gas and the proportion of the total that comes to GB. Our projections of production are based on data on reserves for the North Sea, Norwegian Sea and Barents Sea, held by the Norwegian Petroleum Directorate. We additionally use external forecasts for some key individual fields. A range of possible production is created by assuming different success rates for developing new fields. In 2014, GB received approximately 25 bcm of Norwegian exports. Supplies of Norwegian gas to GB in our scenarios are not pre-determined, but are derived as part of the process of matching supplies to demand. The difference in Norwegian flows between scenarios is not as marked as for other imported gas. This is based on stakeholder feedback and also reflects the fact that there are fewer opportunities for Norwegian gas to find alternative markets than for other import supplies.

We have not included a separate chart for Norwegian supply as the volumes can be seen in context in the annual supply patterns for each scenario, Figure 74 to Figure 77.

Gas supply

5.3.7
Imported gas: liquefied natural gas (LNG) and continental gas

In all scenarios we assume that there will be at least a minimum flow from both LNG and continental gas. These minimums are defined by boil-off[23] gas for LNG, contractual minimums for continental imports and our assessment of any additional flows which could be expected under the conditions in the scenarios. The remainder is assigned to generic imports which could be made up of either continental imports or LNG. The nature of the generic import depends on the world gas market and can be influenced by a wide range of factors. For example, the expected restarting of nuclear power stations in Japan reducing the Japanese demand for LNG imports and releasing more LNG into the market, or drought conditions in South America reducing hydro-generation and increasing the requirement for LNG imports.

5.3.8
Storage

Gas storage plays a useful role in supporting security of supply and providing flexibility in the operation of the gas network. Two new medium range storage projects were completed in the last year. However the economics, and in particular the price spread between winter and summer, have limited activity in the development of new seasonal storage.

Storage plays an important role throughout the year. During the winter, storage can provide baseload supplies through the seasonal storage sites. All sites can also provide cover at periods of high demand. The sites are active throughout the year, optimising injection and withdrawal patterns to help balance supply and demand.

[23] A small amount of gas continually boils off from LNG storage tanks. This helps to keep the tanks cold.

5.3.9
Peak gas supply

There is sufficient capacity in all scenarios to meet the peak demands, assuming that:

- Indigenous gas production (from UKCS, shale and biomethane) operates with a 20% swing factor
- All existing capacity remains available throughout the period.

In the assessment of peak gas supply, we compare peak demand with the maximum supply potential from all sources. For imports and storage this is defined by the maximum technical capacity of all existing[24] sites and those who have taken a final investment decision. We also assume these remain available for the duration of the scenarios unless an official announcement has been made that the site will close.

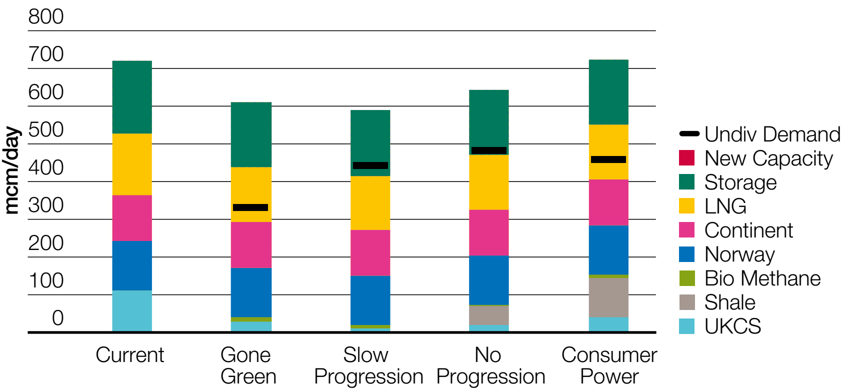
For the UKCS, the peak supply potential is determined by the level of annual production in each scenario with a swing factor applied. This reflects the fact that production is generally not the same on all days of the year but tends to be lower in summer, when maintenance is usually planned. Based on observations over recent years we have used a swing factor of 20%, indicating that production on a winter day is 20% higher than the annual average. There is little data to determine how shale gas or biomethane will behave at peak. We expect that maintenance will still be concentrated in the summer, so have used the same approach as for the UKCS, applying a 20% swing factor to the annual supplies.

The peak supplies follow a similar trend to the annuals. In both **Gone Green** and **Slow Progression** the potential peak supply falls as UKCS production drops and there is no development of shale gas. **No Progression** also falls as the limited shale development does not replace the fall in UKCS. **Consumer Power** ends the period with available supplies slightly higher than today. In all of our scenarios there is significantly more peak supply potential than peak demand.

[24] As of 1st June 2015, Avonmouth storage site to close on 30th April 2016.

Gas supply

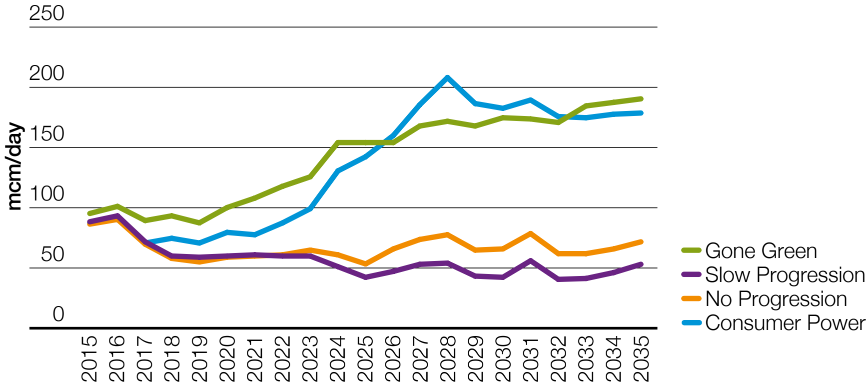
Figure 80
Peak gas supply in 2035



To ensure there is sufficient peak supply to meet demand we carry out the N-1 test as implemented by the European Commission. This assesses whether there is sufficient supply to meet demand when the largest single piece of infrastructure is removed. For all scenarios this represents losing supply from both LNG terminals at Milford Haven, a loss of 86mcm/day.

Figure 81 shows the margin by which supply exceeds demand, with the N-1 condition applied, and shows that all of our scenarios pass this test. In **Gone Green** and **Consumer Power** the margins grow from today. This is driven by the high peak supplies in **Consumer Power**, and the falling peak demands in **Gone Green**. In contrast, margins fall in **Slow Progression** and **No Progression** but remain greater than 40mcm/day.

Figure 81
N-1 margins



As all scenarios maintain a margin under the N-1 test, no additional capacity has been added in any of the scenarios, consistent with the gas rule described in section 3.1.3. We do not discount new import and storage projects being developed. We have seen projects developed for a variety of reasons such as to diversify a supply portfolio, to allow producers access to the optimum market or to support the power generation market in scenarios dominated by intermittent low carbon generation.

Gas supply

Method

Annual supply match

Indigenous gas production (UKCS/Shale/Biomethane) is driven by the primary assumptions and is allocated first. The minimum levels of LNG and continent are then applied along with Norwegian imports, which are determined by the conditions of the scenario. A match is then achieved by applying generic imports.

Locational supplies

The FES scenarios form the basis for our locational supply analysis; this is detailed further in the Gas Ten Year Statement (GTYS) and is the basis of our network analysis.

5.3.10 Scenario disruptors

In response to stakeholder feedback we have considered two potential disruptors to the scenarios. While the primary assumptions define many of the key variables which impact gas supply, there remain considerable market and physical uncertainties which have the potential to impact the supply mix across all scenarios.

For both disruptors we have looked at the impact on the **Consumer Power** scenario. The effect of the disruptors is greatest in this scenario; however, the other scenarios could also be affected.

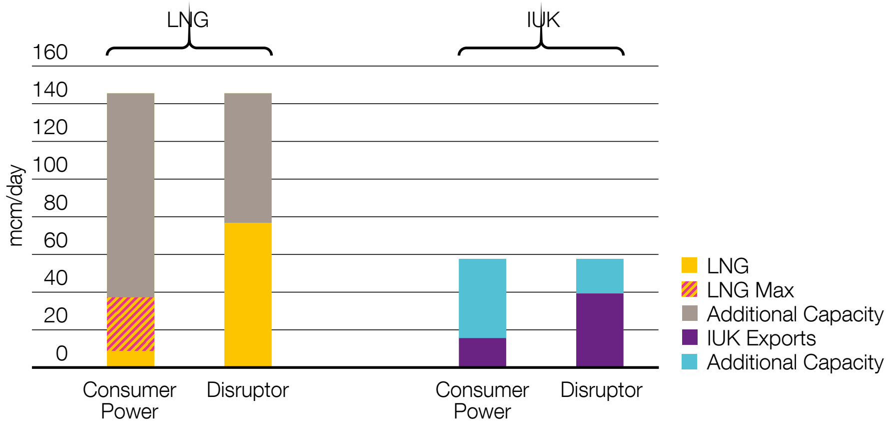
Disruptor 1 – transit GB

In this disruptor we assess the impact of GB becoming a transit hub to supply LNG to continental Europe.

With high levels of LNG available to European markets, LNG increases its market share as it becomes cheaper than developing other sources of imports. To enable the LNG to be utilised in both northern and central Europe the existing terminals in the Netherlands, Belgium and GB are used to land the gas which is then re-exported along existing export routes.

For GB this sees much higher utilisation of the LNG terminals, along with higher exports via IUK compared to **Consumer Power**. This grows throughout the duration of the scenario and is greatest in 2035, as can be seen in Figure 82.

Figure 82
2035 utilisation of IUK and LNG



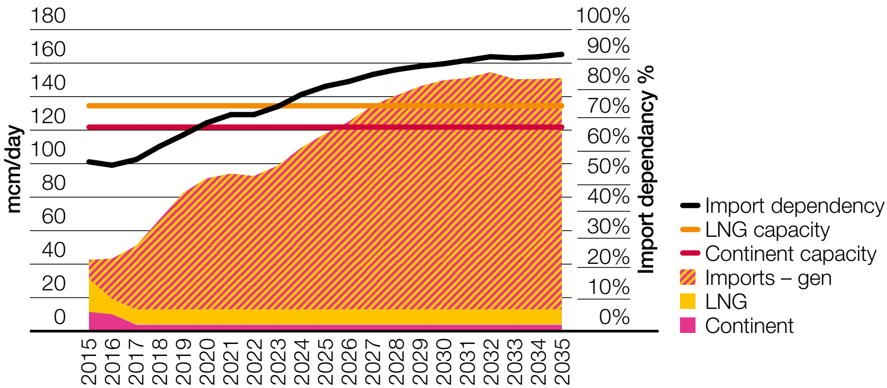
Disruptor 2 – low indigenous production
In this disruptor we assess the impact of lower production from both the UKCS and shale gas in the **Consumer Power** scenario.

There are no changes to the primary assumptions for this disruptor; the favourable conditions for high domestic production remain, as do those driving higher gas demands than our other scenarios. However, there remain significant uncertainties which are not driven by the primary assumptions; the overall level of reserves, the complexity of the reservoirs they are held in and the available technology to produce the gas. In addition to these there are several barriers required to realise the high levels of shale production as described in section 5.3.3.

To assess the impact of these uncertainties we have applied our low case for UKCS production from the **Slow Progression** scenario. For shale gas we have applied the zero case used in both **Gone Green** and **Slow Progression**. This results in a significantly higher import requirement than in **Consumer Power** without the disruptor, as can be seen in Figure 83.

Gas supply

Figure 83
Generic imports



While the import dependency, at around 90%, is similar to that in **Slow Progression**, the volume of imports is far greater. The existing sites would no longer have sufficient capability for all of these generic imports to be made up of either LNG or continental imports.

In order for the UK to ensure reliable imports at the levels required, the appropriate investment signals would need to be sent to upstream producers to ensure actions are taken to supply the GB market. These could be in the form of long-term contracts, as is typical in both Japan and much of Europe, or strategic partnerships with producers similar to the South Hook project.

It is also possible this could drive expansions to either continental import pipelines or LNG terminals. And while overall there is enough current capacity to supply the required gas, global market conditions could result in price differentials between imports from the continent and LNG. If these differentials are significant they could provide the signals to develop expansion projects to enable access to the cheaper source of gas.

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.

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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

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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.

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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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