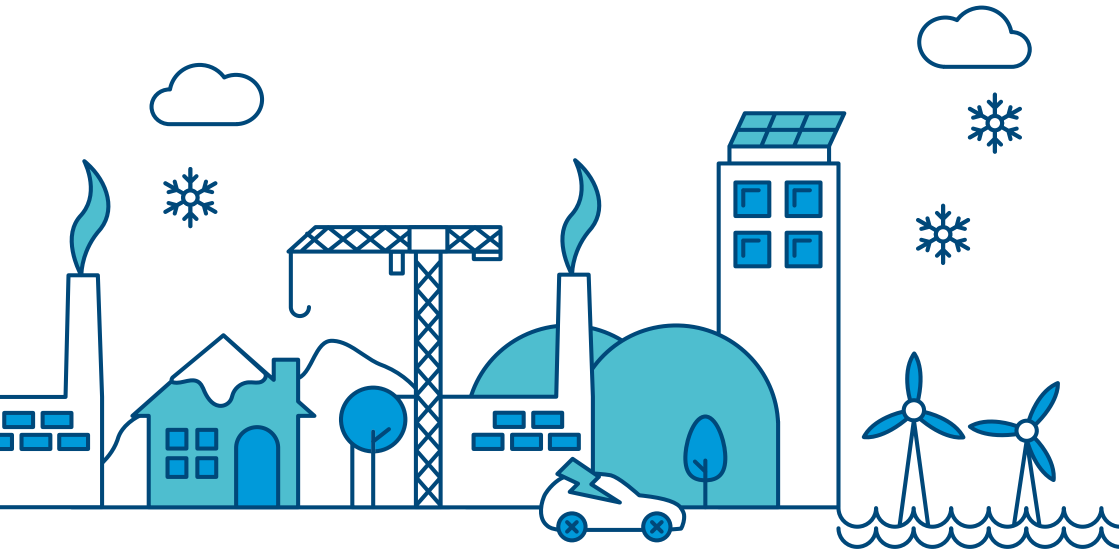
Winter **Review**

2016



26 May 2016

Contents

How to use this document

To help you find the information you need quickly and easily we have published the *Winter Review* as an interactive document.

Home
This will take you to the contents page. You can click on the titles to navigate to a section.

Arrows
Click on the arrows to move backwards or forwards a page.

A to Z
You will find a link to the glossary on each page.

Hyperlinks
Hyperlinks are highlighted in bold throughout the report. You can click on them to access further information.

Foreword

Cordi O'Hara
Director,
UK System Operator

Welcome to our *Winter Review*, where we share our analysis on the supply and demand of both electricity and gas for winter 2015/16.

Winter 2015/16 was one of the mildest winters in almost sixty years. This means we saw less challenging operational conditions than we anticipated. However, we know we cannot be complacent. Weather has a significant impact on how we balance the gas and electricity systems; now increasingly affecting available supply, as well as demand. In addition to considering temperatures, we need to continue to work hard to make sure that the natural variability of other weather factors, particularly wind and solar, is effectively accounted for in our forecasts. As we explored in our *Summer Outlook Report*, we are working to improve our weather forecasting and make sure we are ready for next winter, whatever the weather.

In November 2015, we dispatched our contingency balancing services for the first time to help us balance the electricity system. We believe these reserve services will be needed next winter, so we have already completed a successful tender for 2016/17. Procuring these services early makes sure that we have the correct tools in place to effectively operate the electricity system while continuing to ensure value for money for consumers.

Great Britain was well supplied with gas, from highly diverse and flexible sources, over winter 2015/16. Although this supply diversity benefits GB gas security, it can reduce the predictability of flows and present us with new challenges in operating the system. We are working with the gas industry to make sure we fully understand their flexibility requirements and how we can respond to them in the future.

Our analysis for winter was well informed thanks to the industry feedback and information we received. To help shape our analysis for 2016/17, we would welcome feedback from an even broader range of stakeholders. We hope you will be able to share your views when the consultation process is launched in June. This will also be your first chance to see the generation margins for electricity and a supply outlook for gas for next winter.

Our outlook reports are just one source of information in our suite of 'Future of Energy' publications. As the energy landscape continues to evolve, we encourage you to read our other documents, where you can learn more about the potential shape and scale of these developments, and how we're planning and building networks that are ready to respond. Please visit our website to find out more and register for email updates.

Thank you for taking the time to read this year's review. We hope that by sharing this with you earlier than we have done in previous years, it better helps you to begin preparing for next winter.

Executive summary

The *Winter Review* is an annual publication delivered by National Grid, which compares winter 2015/16 with our forecasts. It is designed to help the energy industry to understand what happened and begin to prepare for the winter ahead.

Overview: Electricity winter 2015/16

As anticipated in our *Winter Outlook Report*, there were sufficient generation and interconnector imports to meet demand across the winter. Demand was lower than both our forecast and the levels seen in 2014/15.

Weather corrected transmission system demand for 2015/16 was 1.0 GW lower at peak than forecast in our *Winter Outlook Report*. Demand was consistently lower throughout the winter in comparison to winter 2014/15. This difference was predominantly caused by an increase in the output of generation connected to the distribution networks and customer demand management.

Our gas and nuclear availability assumptions were broadly correct for winter 2015/16. Gas provided a greater proportion of the generation output than coal over the winter, as fuel prices made it more economical to run. As a result, coal availability was slightly less than we had forecast in the *Winter Outlook Report*. Commercial decisions and generators running down fuel stocks ahead of their announced closures, reduced coal output. Average wind output, at 33 per cent over the weekly demand peaks, was greater than the assumptions used in our forecast.

Interconnector flows were largely as expected in the *Winter Outlook Report*. GB typically received full imports of electricity from France and the Netherlands. However, narrowing prices resulted in some unpredictability of flow on the French interconnector, particularly during cold spells in France and early in the morning. As anticipated, there was a net flow of electricity from GB to Ireland over the winter.

Ahead of winter 2015/16, we procured 2.43 GW of contingency balancing reserve to support system balancing. In November 2015, we dispatched demand side balancing reserve (DSBR) for the first time to help us balance electricity supply and demand.

52.3 GW
Peak demand

2,000 MW
Net interconnector imports at peak periods

Overview: Gas winter 2015/16

As anticipated in our *Winter Outlook Report*, there was sufficient gas available from a variety of sources to meet demand across winter 2015/16. As the price of gas continued to fall, gas became the favoured fuel for electricity generation for much of the winter.

The total gas demand for winter 2015/16 was higher than forecast in our *Winter Outlook Report*. This was as a result of falling gas prices, which increased gas demand for electricity generation, and higher levels of exports to Europe. The mild temperatures resulted in lower demand from residential heating. Total gas demand for October 2015 to the end of March 2016 was 49.4 bcm.

Gas supplies from the UK Continental Shelf (UKCS) and Norway were within our forecast ranges. With greater global availability of liquefied natural gas (LNG), we saw more gas available for the European and GB markets. As a result, actual LNG flows turned out slightly higher than in winter 2014/15. Interconnector flows were slightly lower than expected, with low BBL imports and IUK exporting for most of the winter.

As the analysis in our *Winter Outlook Report* showed, the market was well placed to respond to potential lower interconnector imports and interruption to flows of Russian gas to the EU. The continuing tension between Russia and Ukraine did not lead to any disruption to supplies to GB over winter 2015/16.

Although diversity of supply benefits GB gas security, the varied sources can reduce the predictability of flows and require greater operational flexibility to manage. Within day supply and demand profiles were better aligned over the winter, which resulted in lower average daily linepack swings, reversing an upward trend seen in recent years. However, flows remain challenging to forecast. As a result, we are continuing to work with the industry to understand their flexibility requirements.

49.4 bcm
Total gas demand

369 mcm
Highest demand day

Stakeholder engagement

Our outlook reports present our short-term analysis of gas and electricity supply and demand. They are designed to stimulate a conversation with the energy industry. The feedback we receive from a broad range of stakeholders underpins the development of our outlooks.

In November 2015 we asked you to tell us what you thought of last year's outlook reports. You told us that you liked the presentation of our analysis and found the key terms and glossary helpful. So you can begin preparing for the winter ahead, you also told us you would like our *Winter Review* to be published earlier.

Based on your feedback, we have updated the presentation of this document so that it aligns with our *Winter Outlook Report*. You will find the big picture and key messages at the start of each section, before our detailed analysis. You can click on the link at the top of any page to be taken to the glossary, where you'll find definitions and links to further information.

In response to your feedback, we have also published this review of winter earlier than usual. We hope that our analysis of what happened in 2015/16 helps to inform your preparations for the year ahead.

We want to make sure our publications are as useful to you as possible, so please let us know what you think. You can provide your feedback via our **website**, or by emailing us at **marketoutlook@nationalgrid.com**. You can also join the debate on Twitter using **#NGWinterReview** or on our **LinkedIn Future of Energy** page.

Our publications

This report is one of our 'Future of Energy' publications for 2016. The illustration below shows our other publications. You can find out more about any of the documents on our **Future of Energy webpage**.

To help us understand the views of our stakeholders on supply and demand for next winter, we'll be launching our *Winter Consultation* in June. The feedback we receive from the consultation process will shape our analysis for winter 2016/17, from the assumptions underlying our forecasts to the layout and style of the report. We hope you'll be able to provide your views.

We'll be launching this year's *Future Energy Scenarios (FES)* in London on 5 July. *FES* presents a range of credible pathways for the future of energy out to 2050. You can find out more on our dedicated **FES website**.

The *FES* scenarios form the basis for much of our network design and planning. Our *Gas* and *Electricity Ten Year Statements* will be published in November 2016. These documents provide further detail on how we intend to plan and operate the transmission systems in the future.

Summer Outlook Report
April 2016

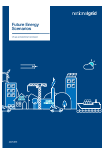
Our view of the gas and electricity systems for the summer ahead.

Winter Review
May 2016

A comparison showing how the past winter compared to our forecast.

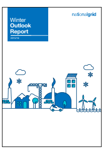
Winter Consultation
June 2016

An opportunity to share your views on the winter ahead.



Future Energy Scenarios
July 2016

A range of plausible and credible pathways for the future of energy from today out to 2050.



Winter Outlook Report
October 2016

Our view of the gas and electricity systems for the winter ahead.

Electricity Ten Year Statement
November 2016

The likely future transmission requirements on the electricity system.

Gas Ten Year Statement
November 2016

How we will plan and operate the gas network, with a ten year view.

System Operability Framework
November 2016

Outlines how the changing energy landscape will impact the operability of the electricity system.

Future Operability Planning
November/December 2016

Outlines how the changing energy landscape will impact the operability of the gas system.

Network Options Assessment
January 2017

The options available to meet reinforcement requirements on the electricity system.

National Grid's role

National Grid owns and manages the gas and electricity networks that connect homes and businesses to the energy they need.

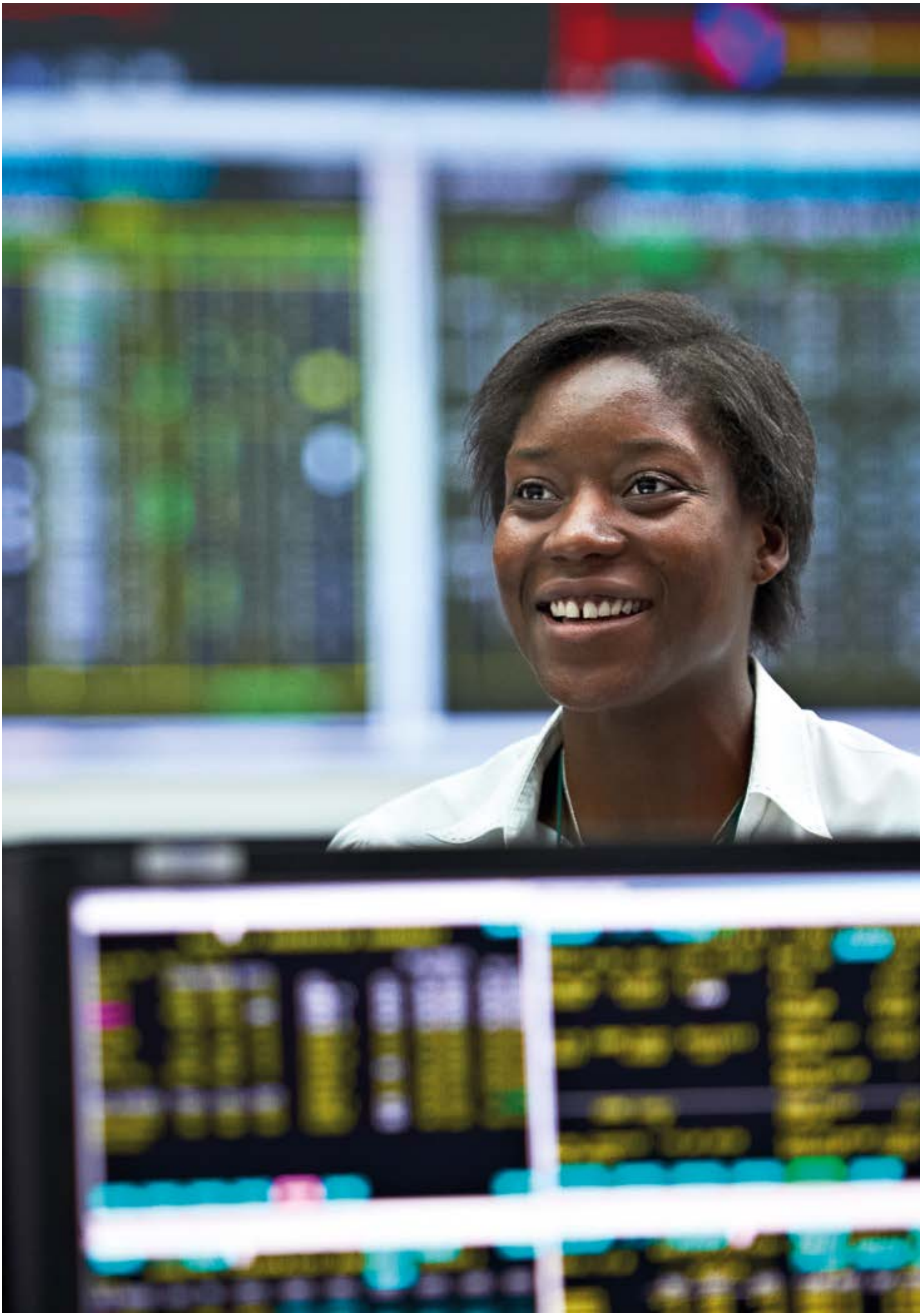
We own and manage the high voltage electricity transmission network in England and Wales. We are also the System Operator of the high voltage electricity transmission network for the whole of Great Britain, balancing the flows of electricity to homes and businesses in real time.

We don't generate electricity and we don't sell it to consumers. It is the role of energy suppliers to buy enough electricity to meet their customers' needs from the power stations and other electricity producers. Once that electricity enters our network, our job is to fine tune the system to make sure supply and demand are balanced on a second-by-second basis.

On the gas side, we own and operate the high pressure gas transmission network for the whole of Great Britain. We are responsible for managing the flow of gas to homes and businesses, working with other companies to make sure that gas is available where and when it is needed.

We do not own the gas we transport and neither do we sell it to consumers. That is the responsibility of the energy suppliers and shippers.

Together, these networks connect people to the energy they use.



Electricity review

This chapter sets out how electricity supply and demand in winter 2015/16 compared to our forecasts. It details our analysis of demand, generation and interconnector flows, and outlines the services that were in place to support system balancing.

The chapter contains the following sections:

- **Winter view**
- **Operational view**
- **Interconnected markets.**

Winter view

The winter view analysis in our *Winter Outlook Report* helped to inform the procurement of contingency balancing reserve. For the first time, demand side balancing reserve was dispatched in winter 2015/16.

Key messages

- **We procured contingency balancing reserve to assist in system balancing over winter 2015/16.**
- **Demand side balancing reserve was dispatched for the first time in November 2015.**

Key terms

- **Contingency balancing reserve:** there are two types of reserve services: demand side balancing reserve and supplemental balancing reserve. They were developed to support system balancing by enabling National Grid to access additional reserve, held outside of the market.
- **Demand side balancing reserve (DSBR):** provides an opportunity for large consumers or owners of small embedded generation to earn revenue by contracting to reduce demand or provide generation when required. During winter 2015/16, the service was available between 4pm and 8pm on weekday evenings between November and February.
- **Supplemental balancing reserve (SBR):** a balancing service where generators make their power stations available between 6am and 8pm on weekdays between November and February, when they would otherwise be closed or mothballed.
- **Notification of Inadequate System Margin (NISM):** a routine notification issued to generators, interconnected system operators and suppliers to advise there is a likelihood that there will be an inadequate margin of reserve capacity available. The purpose is to make the recipients aware and request that additional reserve capacity is made available.

Overview

Our winter view provided a probabilistic assessment of security of supply for the whole winter period. This helped to inform the procurement of contingency balancing reserve, in the form of demand side balancing reserve (DSBR) and supplemental balancing reserve (SBR).

Procurement of contingency balancing reserve

Contingency balancing reserves are balancing services that allow National Grid to access additional capacity. They are held outside the market and so a system notification must be issued before these services can be called upon. The services are therefore not included in our reserve calculations.

Based on our winter view analysis, the de-rated volume requirement of DSBR and SBR was determined as 2.5 GW. On 3 June 2015, we announced the procurement of 2.56 GW of additional reserve for winter 2015/16. Subsequent validation and participants withdrawing from the service resulted in a slight decrease in this volume to 2.43 GW. This was made up of 0.13 GW of DSBR and 2.29 GW of SBR. One potential SBR participant returned to the market, reducing our overall volume requirement.

Dispatching contingency balancing reserve

Winter 2015/16 was a mild winter, which contributed to a decrease in electricity demand. As a result, we did not need to use our contingency balancing reserve services more frequently. If operating conditions had been more challenging, these services were available to help balance supply and demand.

In November 2015, we dispatched DSBR for the first time, to help meet the evening peak demand. You can read more about this in the spotlight below.

Dispatching DSBR

On 4 November, forecasts indicated that there would be an inadequate system margin for the evening peak. This was as a result of a number of plant breakdowns plus generators returning late from outages. These occurred during an extended period of low wind.

At 1:30pm, a Notification of Inadequate System Margin (NISM) was issued to inform market participants of the forecasted position and request more capacity to be made available. The notification requested an additional 500 MW to be made available for the darkness peak (4:30pm to 6:30pm) to ensure sufficient levels of reserve could be maintained.

Following the notification, the market responded positively and a number of generators made additional megawatts available. Further megawatts were obtained via System Operator to System Operator trading on the EWIC interconnector.

In addition to these increases, we requested approximately 40 MW of demand side balancing reserve. Providers of this service responded and DSBR was run for the first time.

When the darkness peak occurred, sufficient generation was available to meet both demand and the reserve requirement. The NISM was therefore withdrawn at 5:45pm.

Operational view

Weather corrected demand was lower than forecast in our *Winter Outlook Report*. Generation and interconnector imports were sufficient to meet demand across the winter.

Key messages

- **Weather corrected transmission system demand was 52.3 GW. This is 1 GW less than our forecast in the *Winter Outlook Report*. The difference was caused by a number of factors, including increases in non-weather related embedded generation and customer demand management.**
- **Gas-fired generation provided a greater proportion of generation output than coal over the winter.**
- **Average wind output for the weekly demand peaks was higher than anticipated in our forecasts.**

Key terms

- **Transmission system demand (TSD):** demand that National Grid as System Operator see at grid supply points (GSPs), which are the connections to the distribution networks. It includes demand from power stations generating electricity (the station load) and interconnector exports.
- **Weather correction:** demand expected or outturned with the impact of weather removed. You can read more about how weather corrected demand is calculated in the glossary.
- **Embedded generation:** any generation that is connected directly to the local distribution network, as opposed to the transmission network. It includes combined heat and power schemes of any scale. Generation that is connected to the distribution system is not directly visible to National Grid and therefore acts to reduce demand on the transmission system.
- **Customer demand management (CDM):** where industrial or commercial users change their pattern of energy consumption. This may be to avoid using energy during peak times in order to reduce charges for using the system.

Overview

In our *Winter Outlook Report*, we expected normalised transmission system demand to peak in mid-December at 53.3 GW. Transmission system demand peaked in January and was lower than forecast. This was predominantly caused by an increase in non-weather related embedded generation, such as diesel or oil, and customer demand management.

As anticipated, there were sufficient generation and interconnector imports to meet demand across the winter. Although coal availability was less than expected, our gas and nuclear assumptions were broadly correct, while actual wind output was greater than the assumptions used in our forecast.

Demand

Table 1 shows the weather corrected transmission system demand for winter 2015/16, compared to our forecast. For information and comparison purposes, we have also included the average cold spell (ACS) demand, as used in our winter view analysis. Weather corrected peak transmission system demand for 2015/16 was 1.0 GW lower than forecast in our *Winter Outlook Report*, while ACS peak demand was 1.3 GW lower than forecast. There are a number of factors that appear to have caused this difference.

There was an increased level of customer demand management (CDM) over winter 2015/16 than anticipated in our forecasts. CDM occurs when industrial or commercial users change their pattern of energy consumption, typically to reduce energy use during peak periods in order to avoid transmission charges. The three half-hourly periods with the highest demand of winter are known as Triads[1]. In our *Winter Outlook Report*, our forecasts assumed CDM of 1.2 GW. Our analysis indicates that during winter 2015/16, CDM typically ranged between 0.7 and 1.5 GW, and on the highest demand days reached up to 2 GW.

There were also more Triad avoidance days than in previous winters, with industrial and commercial users reducing their demand more frequently to avoid peak periods. The number of Triad avoidance days increased from 24 in winter 2014/15, to 35 in 2015/16. This acted to reduce the level of demand seen on the transmission system over winter.

During winter 2015/16, there was an increase in the output of non-weather related embedded generation, compared to winter 2014/15. Non-weather related generation includes diesel, oil, gas and small biomass plants. As this generation is connected to the distribution network, it is not directly visible to National Grid and acts to further reduce the demand seen on the transmission system. This increased output may be as a result of low fuel prices and Triad avoidance. We are working with the industry to better understand what embedded generation ran over winter 2015/16 and how we can incorporate this into our future analysis.

[1] Triads are the three half-hourly settlement periods with the highest system demand. They are used by National Grid to determine charges for demand customers with half-hour metering, and payments to licence-exempt distributed generation. Triads can occur in any half-hour on any day between November and February. They must be separated from each other by at least ten full days.

Table 1

Peak demands for winter 2015/16

GW	2015/16	Our forecast
Weather corrected peak transmission system demand (used in the operational view)	52.3	53.3
ACS peak demand (used in the winter view)	52.9	54.2

Figure 1 provides a comparison of weekly weather corrected transmission system demand peaks for winter 2014/15 and 2015/16. It is evident from the chart that peak demands, after weather correction, were consistently lower in winter 2015/16 than the previous winter.

Figure 1

Weekly weather corrected peak transmission system demands

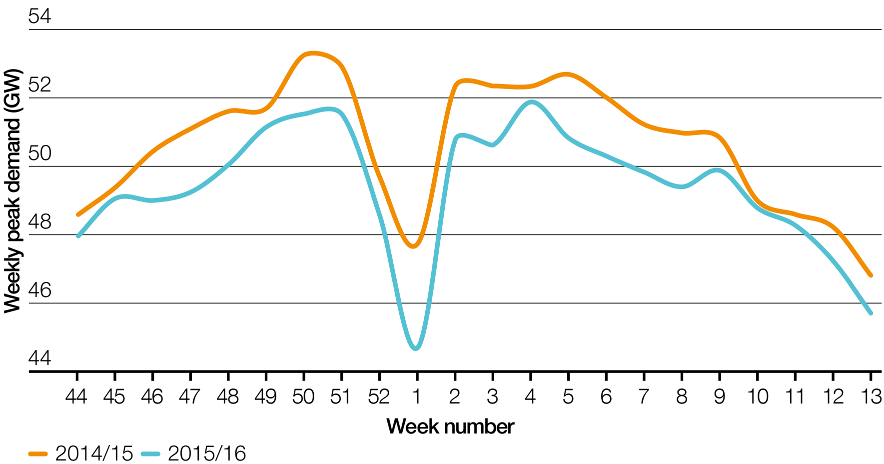


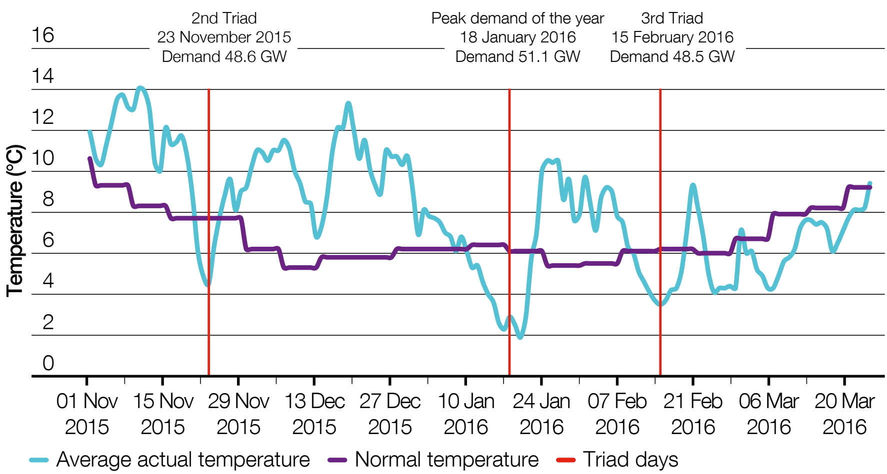
Figure 2 provides a comparison between average actual observed daily temperature during winter 2015/16 and normal daily temperatures, averaged over the previous 30 years.

Winter 2015/16 was relatively warm, particularly during periods that have historically been cold, and was the second warmest winter since 1960[2].

On the three Triad days[3] when demand peaked, temperatures were below the normal average, shown by the purple line in figure 2. However, temperatures on these days were still warmer than those typically observed over the previous ten years. At the actual peak demand of the year, on 18 January 2016, the temperature was 3 °C colder than the normal average. During this ten year period, the median temperature at peak demand has been 4.8 °C colder than the normal average.

Figure 2

Actual daily average temperature and normal daily average temperature



[2] This is based on the Met Office's Hadley Centre Central England Temperature (HadCET) dataset records, which began in 1960.

[3] The Triads in figure 2 are based on operational metering data. They refer to national demand. This is the demand that National Grid as System Operator see at grid supply points. Unlike transmission system demand, it excludes station demand, pumping demand and interconnector exports.

Actual generation availability

The level of generation and interconnector imports from Continental Europe were sufficient to meet demand throughout winter 2015/16. Figure 3 shows the expected weekly generation, from our *Winter Outlook Report*, and the actual generation availability.

Our forecast was based on three interconnector scenarios: low imports of 500 MW, a medium base case of 1,800 MW and full interconnector imports of 3,000 MW. In figure 3, these scenarios are compared to the actual generation available at the peak of each week for winter 2015/16, including actual interconnector imports. Actual imports were similar to the full import scenario used in our forecast.

Figure 3
Winter 2015/16 actual generation availability

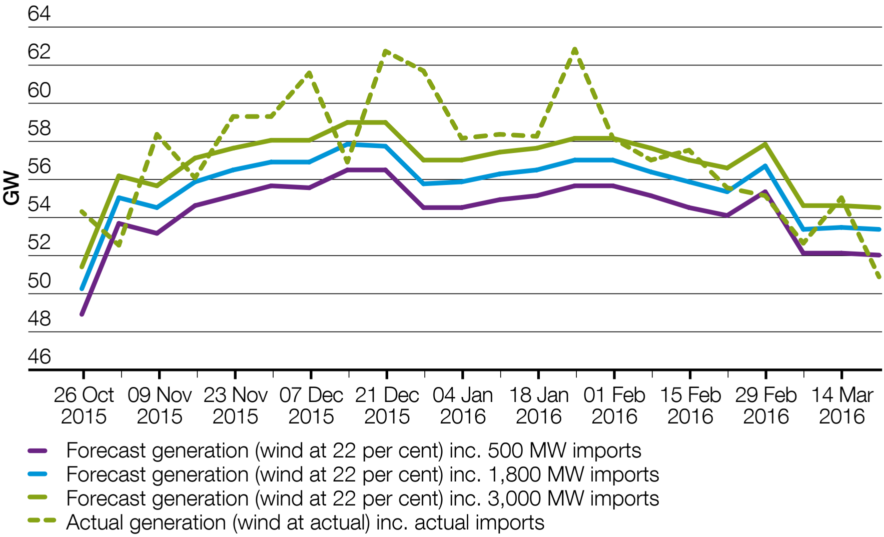


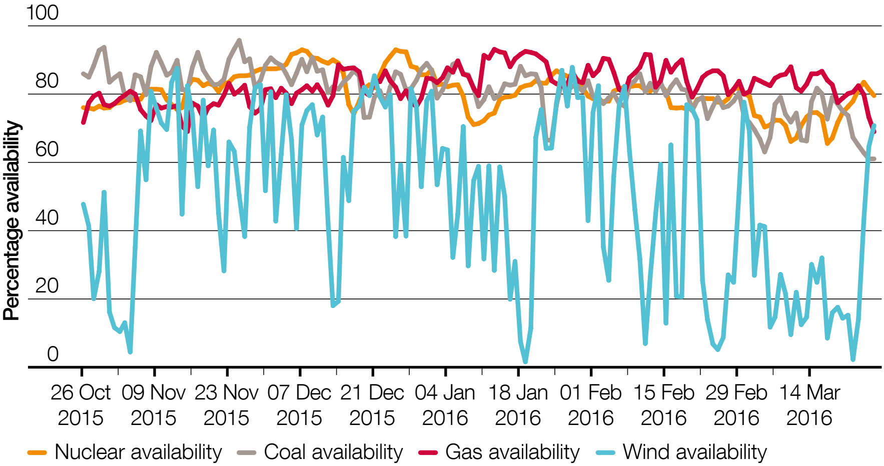
Figure 3 shows that our forecast broadly matched the generation seen at the peak demand period of each week. The differences are caused by a number of factors, in particular the natural variability of wind.

Where actual output was lower than our forecast in some weeks of November and December, this was predominantly caused by reduced availability of coal generation combined with a period of low wind output.

On 4 November, forecasts for the darkness peak indicated that the system margin would be inadequate. As a result, a Notification of Inadequate System Margin (NISM) was issued to market participants to request more capacity to be made available. The market responded and, with sufficient capacity available, the NISM was withdrawn a few hours later. You can read more about this on page 13.

In late February, after the peak winter period, a number of nuclear plants began planned outages. These outages, combined with higher than anticipated coal unavailability and low wind output, meant that available generation was lower than our forecast between 22 February and 7 March. Actual generation was lower than forecast in the last week of March as coal units began to run down fuel stocks ahead of their announced closures.

Figure 4
Winter 2015/16 daily total generation availability by main fuel types at the peak demand period



To understand the availability of different generation types in more detail, figure 4 shows the availability of nuclear, coal and gas for the peak periods of each day across winter 2015/16. As wind has a significant impact on how our forecast compares with actual generation, wind availability has also been included. The total availability includes both planned outages and breakdowns.

The nuclear fleet behaved broadly as expected, with planned maintenance and cell refuelling taking place as scheduled. Nuclear availability decreased at the end of December 2015 following the planned closure of Wylfa power station.

The availability of coal plant was less than expected. Coal availability was less during the weeks commencing 25 January, due to a number of breakdowns, and 29 February, when some generators began to run down fuel stocks ahead of their announced closures.

Gas availability was broadly in line with our expectations. However, during high demand days, its availability was higher than expected. This could be a reflection of the gas fleet responding to market signals, in addition to a more reliable and dynamic gas fleet remaining following the withdrawal of older plant from the market.

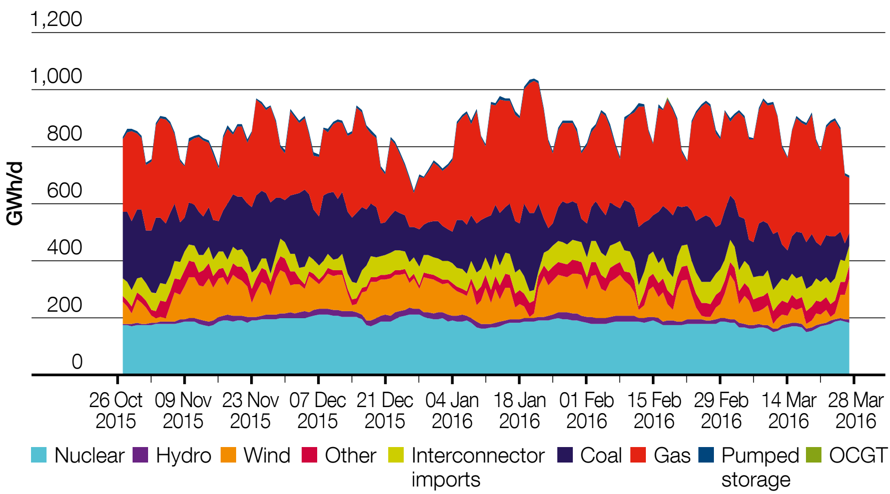
The natural variability of wind is shown in figure 4. Wind availability varies significantly from day to day.

Generator output

In order to understand the generation that ran over winter 2015/16, figure 5 shows the generation output by fuel type. Gas-fired plant provided a greater proportion of the generation output than coal over the winter. Fuel prices meant that gas was more economical to run than coal-fired generation for most of the winter. You can find out more about our analysis of fuel prices on page 49. Gas was also the marginal fuel type, used for supporting the real-time balancing of the electricity system.

There was a marked increase in wind generation volume compared to winter 2014/15. This was due to the expected increase in the installed capacity, and the higher level of wind experienced across winter 2015/16. Average wind output over the weekly demand peaks was 33 per cent. We used an equivalent firm capacity of 22 per cent in the *Winter Outlook Report*. This means that, on average, wind output was higher than we expected for winter 2015/16.

Figure 5
Winter 2015/16 generation output by fuel type



Breakdown rates

Table 2 shows the assumed breakdown rates by fuel type used in our *Winter Outlook Report* forecast, compared to the actuals observed during the peak demand periods over winter 2015/16. Breakdown rates are applied to the operational data provided to us by generators, in order to account for unplanned generator breakdowns or losses close to real time. As we cannot directly see why power stations do not generate, breakdown rates may include commercial decisions to reduce output, as well as plant failure. Rates are based on how the generators performed in peak periods over the last three winters[4].

The actual breakdown rate for nuclear generation was lower than expected in our *Winter Outlook Report*. As our assumed breakdown rate was based on average generator performance over three years, it included the effect of higher nuclear unavailability in 2014.

The actual breakdown rate of combined cycle gas turbine (CCGT) generation was lower than our assumption. We believe this is a reflection of the gas fleet responding to market signals during higher demand periods.

The actual breakdown rate of coal was higher than we anticipated. We believe this is as a result of commercial decisions to reduce output, as well as plant failure.

Table 2
Winter 2015/16 assumed and actual breakdown rates of generation plant

Power station type	Assumed breakdown rate	Actual breakdown rate
Nuclear	12%	6%
Hydro generation	10%	10%
Coal + biomass	12%	15%
Pumped storage	2%	4%
OCGT	2%	3%
CCGT	12%	7%

[4] Peak demand periods of winter are defined as the highest 20 per cent of demand half hours, during November to February between 10am and 8pm Monday to Thursday.

What we said in the *Winter Outlook Report*	What actually happened	Why was there a difference
Demand expected to peak in mid-December at 53.3 GW	Demand was 1 GW lower than expected	Increases in non-weather related embedded generation and CDM reduced demand
Sufficient generation available to meet demand	There was sufficient generation available	There was sufficient generation available, in line with our forecast

Interconnected markets

Interconnector flows were largely as expected in the *Winter Outlook Report*. GB typically imported electricity from France and the Netherlands. However, due to narrowing price spreads, there was some volatility of flows on the French interconnector. As anticipated, there was a net flow of electricity from GB to Ireland over the winter.

Key messages

- **Interconnector capability in winter 2015/16 was broadly as projected in our *Winter Outlook Report*. A maintenance outage reduced capability on the Interconnexion France-Angleterre (IFA) in October 2015, while the Moyle interconnector returned to full capability earlier than anticipated, in February 2016.**
- **As anticipated in the *Winter Outlook Report*, overall there was a net flow of electricity from Continental Europe to GB for winter 2015/16.**
- **As expected, over the winter there was a net flow of electricity from GB to Ireland during peak periods.**

Key terms

- **Import:** interconnectors flowing electricity into GB.
- **Export:** interconnectors flowing electricity out of GB.
- **Net import/export:** the sum of total generation flowing via interconnectors, either into or out of GB.

Overview

Interconnectors link the GB transmission system to the electricity systems of France, the Netherlands and Ireland. The interconnection capacity between GB and other markets is 4,000 MW. Flows on these interconnectors are closely related to electricity prices in each of these energy markets.

In the *Winter Outlook Report*, based on analysis of forward prices, we expected there to be a net flow of electricity from Continental Europe to GB. With prices expected to be higher in Ireland, we anticipated there would be net exports to Ireland from GB. These projections were correct.

European markets review

- **The average prices in the Dutch and French markets were lower than previous winters. This was predominantly caused by an increase in the volumes traded between western European markets, as a result of the new cross-border capacity allocation method in the European market coupling process.**
- **The mild temperatures, adequate availability of nuclear and gas plant, and an increase in the renewable installed capacity, particularly in Germany, resulted in comfortable margins in Continental Europe.**
- **With French and Belgian nuclear units coming to the end of their expected lifespan, there is ongoing uncertainty in their nuclear supply. However, the overall availability of the nuclear fleet in both countries was sufficient across the winter.**
- **Installed capacity of wind generation in Germany continued to increase. In 2015, 33 per cent of electricity was generated from renewables, which was the highest proportion ever recorded. Germany is a net exporter of electricity during days of high solar and wind generation, contributing further to the liquidity of the European coupled market.**

Interconnector performance

Interconnexion France-Angleterre (IFA) is a 2,000 MW capacity interconnector between France and GB. When we published the *Winter Outlook Report*, there were no planned outages scheduled for winter 2015/16. For two weeks in October 2015, maintenance outages reduced capability to 1,500 MW.

Britned is a 1,000 MW capacity interconnector to the Netherlands. As expected, it was at full capability throughout the winter.

The East West Interconnector (EWIC) to the Republic of Ireland remained at its full capability of 500 MW throughout winter 2015/16.

In the *Winter Outlook Report*, we expected the Moyle interconnector to Northern Ireland to remain at a reduced capability of 250 MW, due to cable replacement works, until mid-2016. The cable replacement project was completed earlier than anticipated and full capacity of 500 MW was restored in February this year.

Interconnector flows

Interconnector flows are closely related to price spreads. At the time of our analysis in October, prices in France and the Netherlands were expected to be lower than those of GB, resulting in net imports of electricity to GB on IFA and Britned. With electricity prices projected to remain high in Ireland, we anticipated there would be net exports from GB to Ireland across both interconnectors during the peaks.

Figure 6 shows the total interconnector flows at peak periods for winter 2015/16, compared with the previous three winters. In winter 2015/16, overall there were net imports of approximately 2,000 MW at peak periods, out of a possible 3,000 MW. This reflects the higher energy prices in GB in relation to those in Continental Europe.

Although prices in GB were lower than previous winters, this was also the case in France and the Netherlands. French and Dutch energy prices were lower due to the good availability of plant and the convergence of prices between continental markets. This price convergence is predominantly as a result of a new cross-border capacity allocation method, implemented in 2015.

Figure 6
Combined interconnector flow at weekly GB peak demand

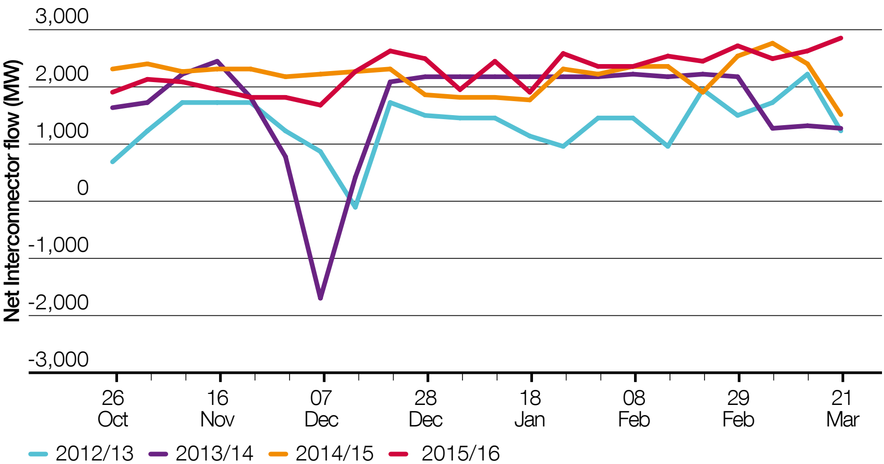


Figure 7 shows the flows on each interconnector at the weekly peaks for winter 2015/16.

As expected in the *Winter Outlook Report*, full imports were seen on Britned during most of the peak periods. However, in contrast to our forecast, IFA was not always fully importing into GB. In addition to the maintenance outage discussed earlier, during some weekday periods, the difference between GB and French prices narrowed, causing volatility in IFA flows. This was particularly the case during cold spells in France and early in the mornings, between 6am and 8am. At peak times, full imports were typically received.

Figure 7
Interconnector flows at weekly GB peak demand

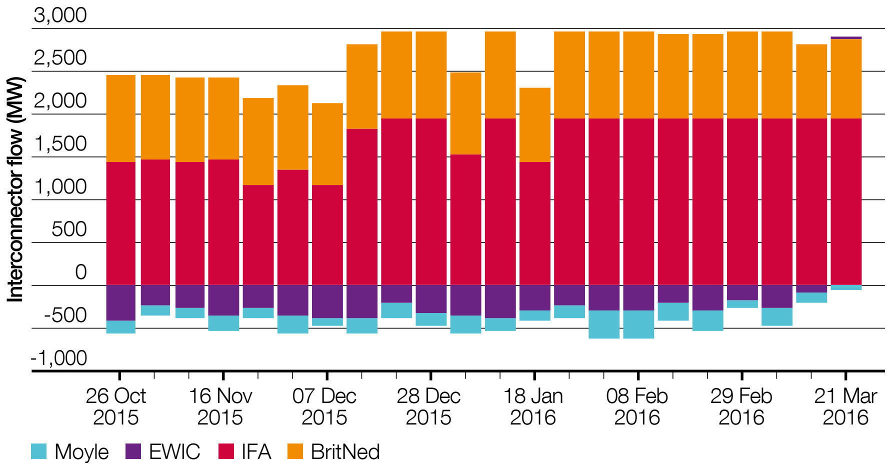
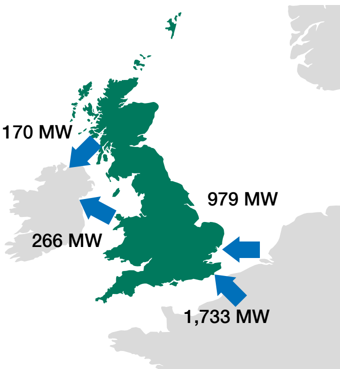


Figure 8 summarises the average flows seen on the four interconnectors during the peak periods in winter 2015/16.

Figure 8
Average flows experienced on the interconnectors during weekly peak demand periods in winter 2015/16



What we said in the *Winter Outlook Report*	What actually happened	Why was there a difference
Forward prices indicated there would be net imports of electricity from Continental Europe to GB	Prices remained higher in GB than Continental Europe, resulting in net imports of electricity to GB	Interconnector flows behaved as expected
With high prices projected in Ireland, we expected a net export of electricity from GB	Prices remained higher in Ireland than GB, resulting in net exports of electricity	

Gas review

This chapter sets out how gas supply and demand in winter 2015/16 compared to our forecasts. It details our analysis of fuel prices and outlines how we are managing the flexibility requirements of our customers.

The chapter contains the following sections:

- Gas demand
- Gas supply
- Fuel prices
- Operational challenges.

Gas demand

The total gas demand for winter 2015/16 was higher than forecast in our *Winter Outlook Report*. This was as a result of falling gas prices increasing gas demand for electricity generation, and higher levels of exports to Europe. This was partly offset by lower than expected demand from other large-scale consumers and the residential sector. There were sufficient gas supplies to meet demand throughout the winter.

Key messages

- **Total gas demand for October 2015 to the end of March 2016 was 49.4 bcm. This was 0.8 bcm higher than forecast in our *Winter Outlook Report*.**
- **Falling gas prices increased demand for electricity generation.**
- **Winter 2015/16 was the second warmest since 1960. This led to lower levels of residential demand.**

Key terms

- **Non-daily metered (NDM):** a classification of customers where gas meters are read monthly or at longer intervals. These are typically residential, commercial or smaller industrial consumers.
- **Daily metered (DM):** a classification of customers where gas meters are read daily. These are typically large-scale consumers.
- **Weather corrected demand:** demand calculated with the impact of the weather removed. This is sometimes known as ‘underlying demand’. Weather is one of the main drivers of the difference in demand from one day to the next. We take out the impact of weather to understand other important underlying trends.
- **Seasonal normal conditions:** a set of conditions representing the average that we could reasonably expect to occur. We use industry agreed seasonal normal weather conditions. These reflect recent changes in climate conditions, rather than being a simple average of historic weather.
- **Composite weather variable (CWV):** temperature explains most of the variation in gas demand but a better fit can be obtained by including other variables. The combination of temperature and other weather variables is called the composite weather variable.

Overview

Total gas demand for winter 2015/16 was higher than forecast in our *Winter Outlook Report*. Falling gas prices caused increased gas demand for electricity generation. Exports to Ireland and Continental Europe were also higher than expected. Non-daily metered (NDM) demand turned out lower than forecast. This was predominantly due to the mild weather, which resulted in decreased gas demand for residential heating.

Review of weather

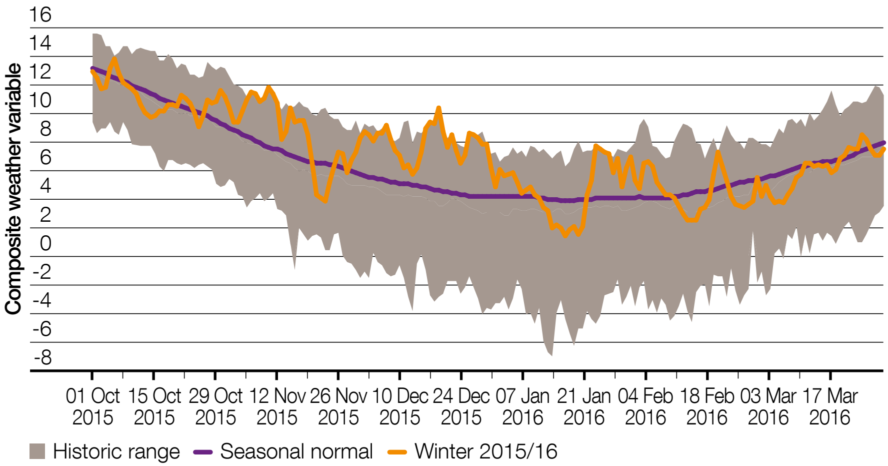
Weather, and in particular temperature, explains much of the variation in gas demand. We review weather conditions to better understand past and future trends.

The six months from October 2015 to March 2016 were warmer than seasonal normal conditions. This period was the second warmest winter since 1960, when the gas industry's weather history began. The coldest day was on 17 January 2016. This was the fifth warmest 'coldest day' since 1960.

For the three month mid-winter period, from December to February, the weather severity was 1 in 42 warm. This means we would expect only 1 in every 42 winters to be as warm or warmer, and 41 in every 42 winters to be colder.

Figure 9 shows the weather for winter 2015/16 in terms of composite weather variable (CWV). This is compared with the daily maximums and minimums since October 1960. The seasonal normal line has been adjusted to account for climate change; it is not the average of the historical values.

Figure 9
Winter composite weather 2015/16



Review of demand

In our *Winter Outlook Report* forecast, we expected gas demand to be similar to the 2014/15 weather corrected demand. Although we expected demand from gas-fired power stations to increase in response to the narrow price differential between coal and gas, we did not anticipate that this increase would be significant. We expected NDM demand to remain broadly similar to 2014/15, while imports to Ireland and Continental Europe were projected to decrease.

Table 3 shows the total actual and weather corrected gas demands for winter 2015/16, compared against our forecast in the *Winter Outlook Report*.

NDM demand was 6 per cent lower than forecast in our *Winter Outlook Report*. This was as a result of the mild weather conditions, which led to lower gas demand for heating. Demands from NDM customers were particularly low during December because of the exceptionally warm weather conditions, shown in figure 9. If NDM demand is adjusted to consider the effect of weather, the demand matched our forecast.

Daily metered (DM) and industrial demand for winter 2015/16 was lower than anticipated. We expected gas demand in these sectors to increase in response to lower gas prices. However, demand continued to decline, falling by 0.3 bcm compared to winter 2014/15.

Gas exports to the Republic of Ireland are expected to decrease when Corrib, a new gas field west of Ireland, increases flows to its full capability. In our *Winter Outlook Report* we anticipated this would occur in mid-March. We now do not expect full capability to be reached until late summer 2016. As a result, exports to Ireland did not decrease over winter as expected.

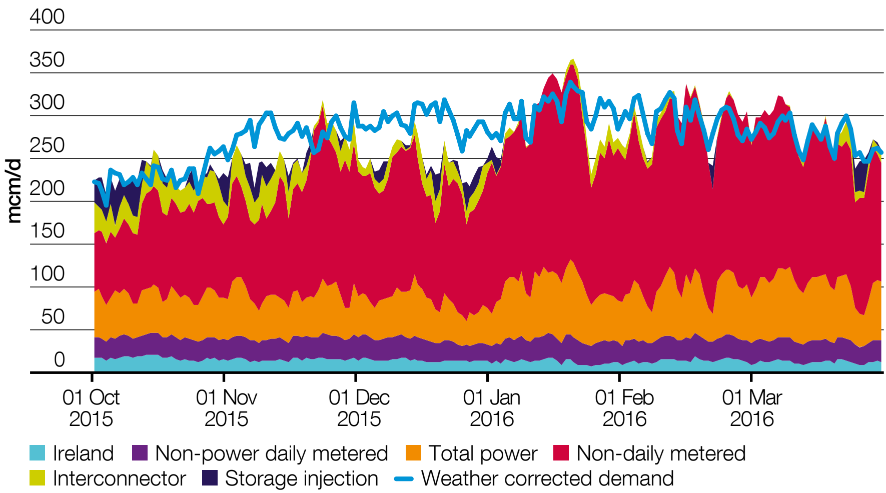
You can find more about the demand associated with IUK exports and storage injection in the gas supply section on page 45.

Table 3
Gas demand 2015/16 versus forecast

October to March Winter (bcm)	Our forecast	Actual	Weather corrected
NDM	29.6	27.7	29.6
DM + industrial	5.4	4.6	4.7
Ireland	2.4	2.6	2.6
Total power	9.5	10.4	10.4
Total demand	**46.8**	**45.5**	**47.4**
IUK export	0.4	2.7	2.7
Storage injection	1.4	1.2	1.2
GB total	**48.6**	**49.4**	**51.3**

Figure 10 shows that the highest demand day in winter 2015/16 was 20 January 2016, with a demand of 369 mcm[5]. While this is 1 per cent higher than the highest demands experienced in winter 2014/15, it remains relatively low when compared with the previous ten years. The winter 2015/16 demand is due to a combination of a relatively warm 'coldest day' and decreasing industrial and NDM demand.

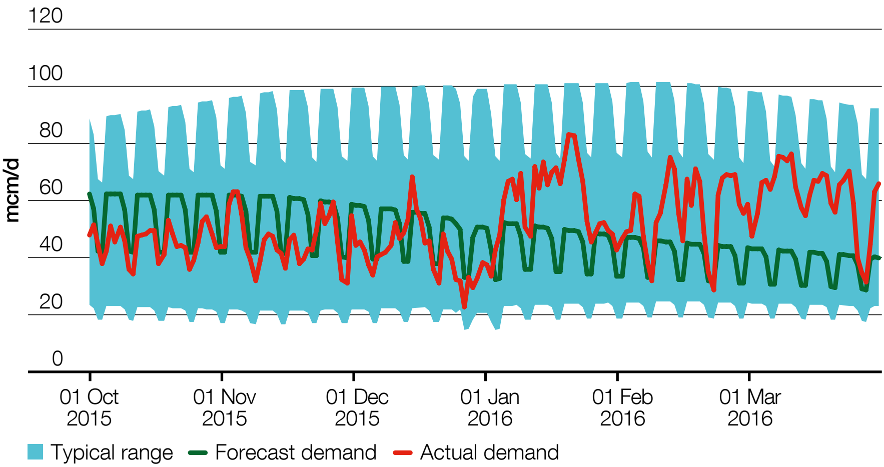
Figure 10
Winter gas demand 2015/16



[5] This measures end user demand. The demand at national transmission system offtake level was 366.5 mcm.

Figure 11 shows the national transmission system (NTS) connected electricity generation gas demand for winter 2015/16, together with the pre-winter base forecast and a typical range. At the low end of the range we assume that fuel prices favour coal-fired generation over gas, while breezy weather conditions drive high levels of wind generation. The upper end of the range reflects lower gas prices, with calm weather conditions reducing the output from wind turbines.

Figure 11
Winter NTS connected electricity generation demand 2015/16



The chart shows that NTS electricity generation gas demand was higher than forecast in our *Winter Outlook Report* from January 2016 onwards. At the time of our forecast in October, forward prices indicated a marginal increase in gas prices, with coal prices continuing to fall. As a result, with coal prices expected to be favourable, we anticipated gas demand for electricity generation would decline in the second half of winter 2015/16.

However, gas prices continued to fall during the winter and so a decrease in gas demand for electricity generation did not occur. In the final weeks of winter, gas demand for electricity generation was on average 20 mcm/d higher than our forecast.

<table>
<tr><th>What we said in the Winter Outlook Report</th><th>What actually happened</th><th>Why was there a difference</th></tr>
<tr><td>Gas demand expected to be similar to 2014/15</td><td>Gas demand was 0.8 bcm higher than forecast</td><td rowspan="2">Falling gas prices caused increased demand from gas-fired power stations</td></tr>
<tr><td>Gas demand for electricity generation anticipated to be slightly higher</td><td>Gas demand for electricity generation increased</td></tr>
</table>

Gas supply

As anticipated in our *Winter Outlook Report*, there was sufficient gas available to meet demand for winter 2015/16. Gas was supplied from a diverse range of sources.

Key messages

- **Sufficient gas was available to meet demand for winter 2015/16, with gas supplied from a wide range of sources.**
- **There was a slight increase in supply from the UK Continental Shelf (UKCS) due to a number of new fields starting production.**
- **The BBL pipeline provided gas within our forecast range in the second half of the winter.**
- **Storage supplies were adequate, even with restrictions at Rough and Hornsea.**
- **Supplies exceeded 350 mcm on only four days of the winter.**

Key terms

- **UK Continental Shelf (UKCS):** made up of the 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.
- **BBL:** this gas pipeline runs between Balgzand in the Netherlands and Bacton in the UK.
- **IUK:** the Interconnector (UK) Limited is a gas pipeline connecting Bacton in the UK and Zeebrugge in Belgium.
- **Liquefied natural gas (LNG):** formed by chilling gas to -161 °C so that it occupies 600 times less space than in its gaseous form.
- **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. The site mainly puts gas into storage (‘injection’) in the summer and takes gas out of storage in the winter.
- **Medium-range storage:** these commercially operated sites have shorter injection/withdrawal times. This means that they can react quickly to demand, injecting when demand or prices are lower and withdrawing when they are higher.
- **Short-range storage:** the only short-range storage site on the national transmission system during the winter was at Avonmouth, near Bristol. This onshore site stored liquefied natural gas that had been condensed from the transmission system, not delivered by ship. When needed, the liquid gas was re-vaporised and delivered to the transmission system. Short-range storage is able to respond quickly to fluctuations in demand but has limited stock. The Avonmouth facility was closed in April 2016.

Overview

There was sufficient gas available from a wide range of sources to meet demand for winter 2015/16, as forecast in our *Winter Outlook Report*. Supplies from the UK Continental Shelf (UKCS) and Norway were within our forecast ranges. With greater global availability of liquefied natural gas (LNG), we anticipated that even with prices remaining higher in East Asia than Europe, more gas would be available for the GB market. Actual LNG flows were slightly higher than in winter 2014/15. Continental flows were slightly lower than expected. BBL flows over the whole winter were lower than last year, although deliveries in the second half of the winter were similar to winter 2014/15. IUK exported to the continent for most of the winter, in response to the low demand and high level of supply.

As expected, the continuing tension between Russia and Ukraine did not lead to any disruption to supplies to GB.

Gas supply by source

In our *Winter Outlook Report* forecast, we expected a similar level of performance from the UKCS and Norway compared to winter 2014/15. We suggested that LNG flows might be higher than the previous winter due to greater global availability. On the other hand we thought that flows from Continental Europe might be lower than in recent winters. Table 4 shows that our predictions were broadly correct, although the UKCS performed slightly better than expected.

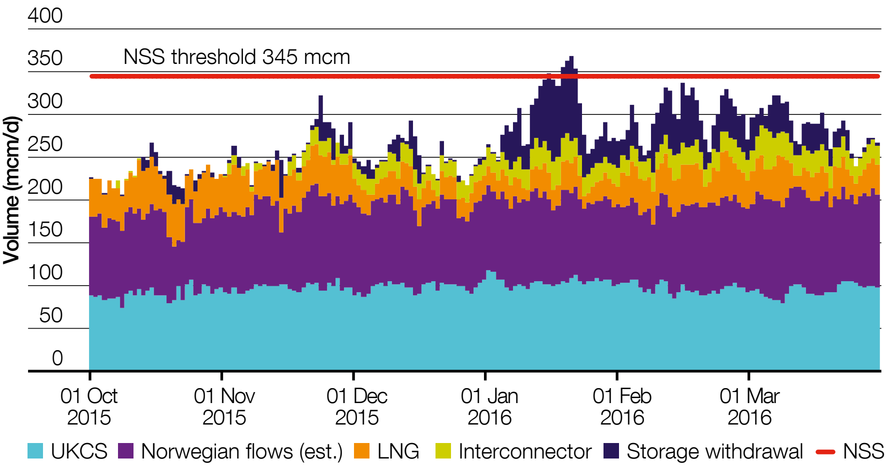
Table 4
Historical gas supply by source

	2013/14		2014/15		2015/16	
	bcm	%	bcm	%	bcm	%
UKCS	17	37%	16	33%	18	36%
Norway	17	37%	18	38%	18	36%
Continent	6	13%	4	8%	3	6%
LNG	3	7%	5	10%	6	13%
Storage	3	7%	5	10%	4	8%
Total	**46**		**48**		**49**	

Daily supplies for the winter are shown in figure 12. The chart also shows the forecast Non-Storage Supply (NSS) level.

The NSS forecast represents an upper expectation of supply associated with cold weather and high demand. It is discussed in more detail on page 43.

Figure 12
Daily gas supply



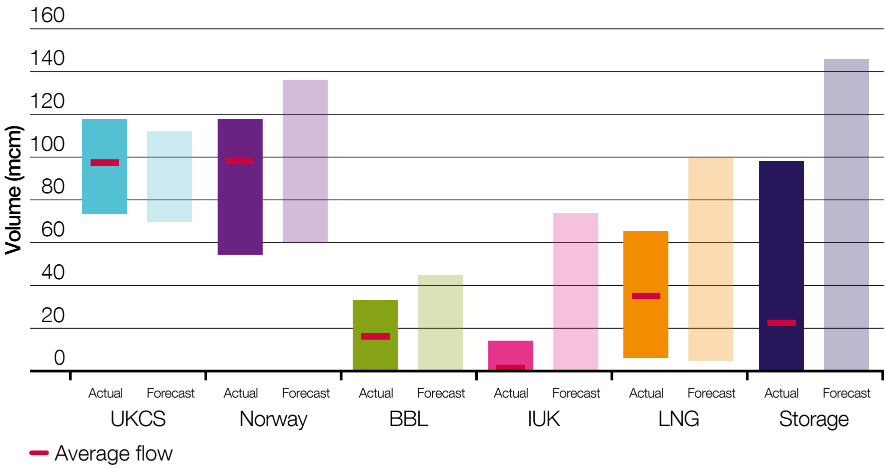
Supplies for winter 2015/16 are compared to our forecasts in figure 13. The darker coloured bars show the range of actual daily flows by source, with the average level shown by the red lines. The paler coloured bars show the forecast range included in our *Winter Outlook Report*.

For the UKCS and Norway, the forecast ranges were based on analysis carried out for our *Future Energy Scenarios* in summer 2015. This analysis was informed by feedback from energy industry stakeholders.

For continental imports through BBL and IUK, and for LNG imports, the forecast ranges were based on actual flows in recent winters. For all three sources, the forecast maximum flow was the maximum capacity of the facility. The wide range in the forecasts reflects the uncertainty in the import market.

Storage supplies in any winter can be expected to show the greatest variability. Supplies can range from no flow to maximum flow from all facilities in times of high gas demand or price. Our forecast in the *Winter Outlook Report* reflected this potential range.

Figure 13
Actual and forecast supplies by source



Gas supply by location

In our *Winter Outlook Report* we included a forecast of peak flows for each terminal. Table 5 shows this forecast, together with the observed maximum flows.

It is important to note that the forecasts are for the highest flow that might be expected at the terminal through the winter. These are not necessarily all on the same day. For instance, Grain LNG terminal might be expected to flow at 59 mcm/d if demand was high and there was a shortage of other supplies.

Conditions through the winter meant that imports of continental gas, Norwegian gas and LNG did not reach their maximum possible flow. As a result, the observed flows at Bacton (which includes flows via BBL and IUK), Grain (LNG), Milford Haven (LNG) and St Fergus (Norwegian flows) did not reach their possible maximum values. Maximum flows at Barrow, Teesside and Theddlethorpe, which are all supplied solely by the UKCS, were close to our forecast.

Table 5
Forecast and actual flows by location

mcm/d	2015/16 forecast maximum flows	Actual maximum flows
Bacton	151	69
Barrow	8	7
Grain	59	7
Easington	74	79
Milford Haven	86	57
St Fergus	102	81
Teesside	24	22
Theddlethorpe	7	9
Storage	146	98

Gas supply in cold weather

In our *Winter Outlook Report* we published a forecast for each component of the NSS at high demand levels. This analysis is used to assess whether a Margins Notice should be issued to the industry. A Margins Notice provides the industry with a day ahead notification of a potential imbalance between supply and demand, highlighting it in sufficient time for market participants to take effective action.

Table 6 shows our forecast range for each NSS supply type, together with the cold day forecast and the actual range for winter 2015/16.

Historically, the cold day has been defined as a day with total demand over 400 mcm/day. However, demand has not reached this level for the last four winters. As a result, we now use a slightly lower threshold. The cold day is taken from the average load duration curve. Load duration curves are published every year in our *Gas Ten Year Statement*.

As demand did not reach the cold day threshold, a comparison of our forecast with actuals is difficult. To show behaviour on the coldest days of the winter, table 6 also includes the range for the four days when demand exceeded 350 mcm.
On these days, supplies from the UKCS and Norway were a reasonable match for our projections. Supplies for BBL, IUK and LNG were lower than our cold day projections. This may be because 350 mcm is still some way below the cold day threshold. The market was well supplied on these days so prices did not rise to the level that would attract further interconnector or LNG flows.

Table 6
Cold day forecast and actual supply

mcm/d	Forecast		Actual	
	Range	Cold day	Range	350 + range
UKCS	70–112	100	73–118	104–112
Norway	60–136	110	55–118	99–109
BBL	1–45	40	0–33	22–31
IUK	0–74	45	0–14	0
LNG imports	5–100	50	6–59	33–35
Total NSS		**345**		
Storage	0–136		0–98	82–98

Supply components in detail

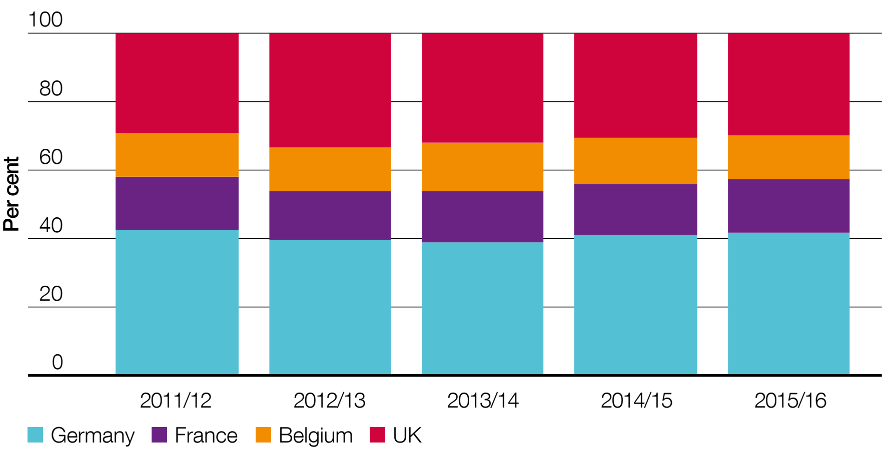
UKCS

The average flow from the UKCS fell comfortably within our forecast range. However, as shown in figure 13 and table 6, both the maximum and minimum flows were slightly higher than we expected.

Norway

Average Norwegian flows were in line with our forecast range, although the maximum and minimum flows were both slightly lower than expected. Flows from Norway depend not only on Norwegian production, but also on the distribution of Norwegian gas between Continental Europe and GB. In the *Winter Outlook Report* our forecast range for Norwegian supplies included the two extreme cases; high flows to Europe and lower flows to GB, and lower flows to Europe and higher flows to GB. Figure 14 shows that the percentage of Norwegian gas exports coming to GB in winter 2015/16 was similar to the previous year.

Figure 14
Destination of Norwegian gas exports



bcm	2011/12	2012/13	2013/14	2014/15	2015/16
UK	16.9	19.1	17.6	18.2	18.3
Belgium	7.1	7.4	7.4	7.6	8.0
France	9.3	8.2	8.4	9.0	9.5
Germany	24.5	22.5	21.1	24.3	25.7

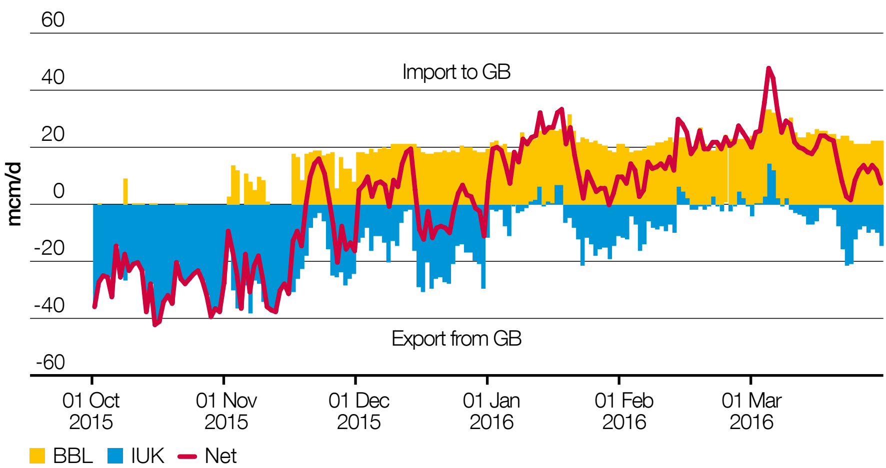
IUK and BBL

IUK is a bi-directional interconnector between the UK and Belgium. BBL is a single direction pipeline flowing from the Netherlands to the UK. Despite the fact that these two interconnectors often flow in opposite directions, it can be useful to consider the net flow across both when trying to understand the imports to the GB market. Flows for the two interconnectors and the net flow are shown in figure 15.

For winter 2015/16, net imports were significantly lower than in winter 2014/15. Imports were 0.4 bcm, compared to 2.8 bcm the previous year. This was partly due to relatively low demand in GB, high availability of other supplies and the ongoing production restrictions due to seismic activity at the Groningen field in the Netherlands.

There was a marked difference in flows during the winter. In late 2015 the net flow, aggregated over the two pipelines, was an export of 1.3 bcm, or 14 mcm/d. For the same period in 2014, the aggregated flow was an import of 1 bcm, or 11 mcm/d. This was a continuation of the trend seen in the summer, with few imports and significant exports. This changed in early 2016, which coincided with colder conditions in GB, with imports of 1.6 bcm, or 18 mcm/d. This was similar to early 2015, which saw imports of 1.7 bcm, or 19 mcm/d.

Figure 15
IUK and BBL flows



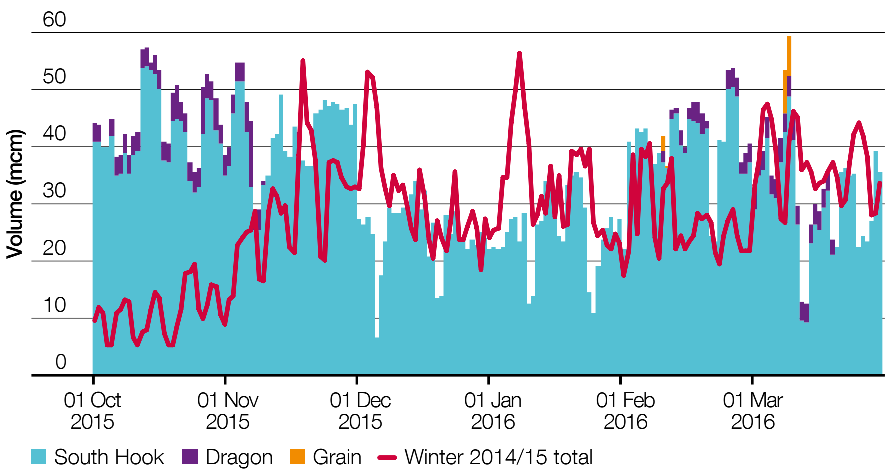
LNG

LNG flows are strongly influenced by the gas price in different markets. At the time of our forecast, we expected that prices in the East Asian market, principally Japan and South Korea, would be slightly higher than the GB price. In that case, East Asia would be the preferred market for most traded and spot LNG.

During the winter, the difference between the relative prices of the East Asian and GB markets widened as the national balancing point (NBP) gas price reduced, reaching a maximum difference in January. Figure 16 shows that the GB LNG flows were higher during October and November, reduced in December and January, before increasing again in late winter 2015/16. This shows reasonable correspondence with the difference in prices. Nearly all LNG imports were through the South Hook terminal; Dragon and Grain provided very little gas.

In the *Winter Outlook Report* we mentioned the new LNG export facility at Sabine Pass in the US. The first cargo was exported from this new facility in February 2016. This was delivered to South America rather than Europe. No cargoes were delivered to Europe from the US during winter 2015/16.

Figure 16
LNG flows by terminal



Storage

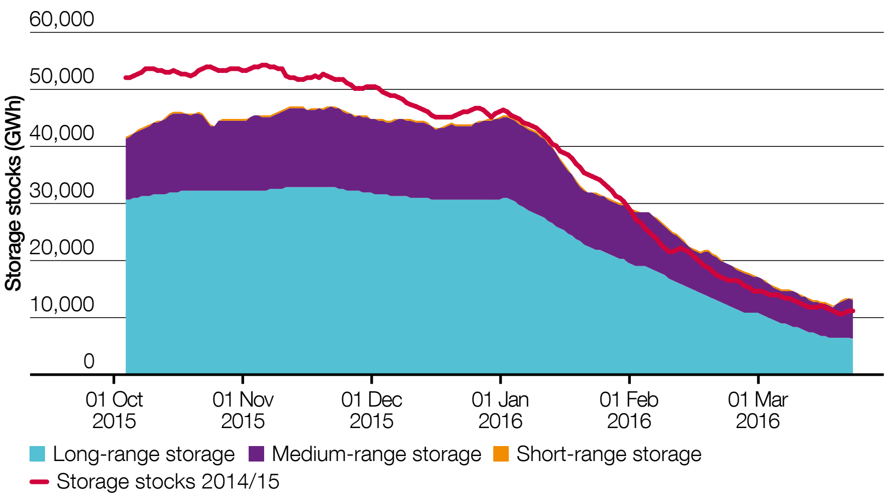
In the *Winter Outlook Report* we highlighted the reduced storage space available for the winter. This was predominantly caused by reductions at the Rough and Hornsea sites. Figure 17 shows that the aggregate stock level at the start of the winter was considerably lower than winter 2014/15.

Over the last few years storage has been a major source of flexibility or swing in gas supplies. This makes it hard to predict storage flows ahead of the winter. Daily flows can be seen in figure 12.

Demand in the first half of the winter was quite low, and there was very little withdrawal from storage. Demand increased in the second half of winter and withdrawals increased to match. Aggregate storage performance for the second half of the winter was very similar to 2014/15.

There is very little short-range storage in figure 17. There was only one short-range storage facility in GB during winter 2015/16, at Avonmouth. Avonmouth closed in April 2016. At the beginning of the winter, Avonmouth had a declared 480 GWh of space and 143 GWh/d of deliverability.

Figure 17
Aggregate stock level



What we said in the *Winter Outlook Report*	What actually happened	Why was there a difference
Supply patterns were likely to be similar to 2014/15	Supply patterns were similar to 2014/15	Little difference between our forecast and winter 2015/16
Slightly higher supplies from the UKCS	Slightly higher supplies from the UKCS	
Uncertain continental flows	Low flows from BBL in the first half of winter. IUK exported for most of the winter	
No disruption to GB flows resulting from Russia–Ukraine conflict. The only exception would be in very cold weather with disruption of Ukrainian transit	There was no disruption to GB supplies	There was no disruption to supplies, in line with our forecast

Fuel prices

The price of gas reduced throughout winter 2015/16. Gas became the favoured fuel for electricity generation for much of the winter.

Key messages

- **Gas was the favoured fuel for electricity generation during the second half of winter 2015/16.**
- **National balancing point (NBP) gas prices reduced by approximately 25 per cent across the winter.**
- **UK carbon prices reduced by approximately £2 per tonne of carbon dioxide. This reflected a decrease in the EU Emissions Trading Scheme carbon prices, which declined by 30 per cent during winter 2015/16.**

Key terms

- **National balancing point (NBP) gas price:** the wholesale gas market in Britain has one price for gas, irrespective of where it has come from. This is called the national balancing point price of gas. It is usually quoted in pence per therm.
- **EU Emissions Trading Scheme (ETS):** a European Union trading scheme that allows participants to buy and sell greenhouse gas emission allowances.
- **Combined cycle gas turbine (CCGT):** a power station that uses the combustion of natural gas or liquid fuel to drive a gas turbine generator to produce electricity. The exhaust gas from this process is used to produce steam in a heat recovery boiler. This steam then drives a turbine generator to produce more electricity.

Overview

Fuel prices can have a significant influence on energy demands and supply patterns. In our outlook reports we concentrate on how short-term uncertainty influences the choice of fuel for electricity generation. This is because fuel prices for electricity generation are largely governed by shorter-term spot markets. As a result, the most profitable fuel for electricity generation can change from day to day. In contrast, prices for end users are generally based on tariffs that respond to longer-term trends in wholesale prices.

Our analysis of fuel prices shows that gas was the favoured fuel for electricity generation for winter 2015/16.

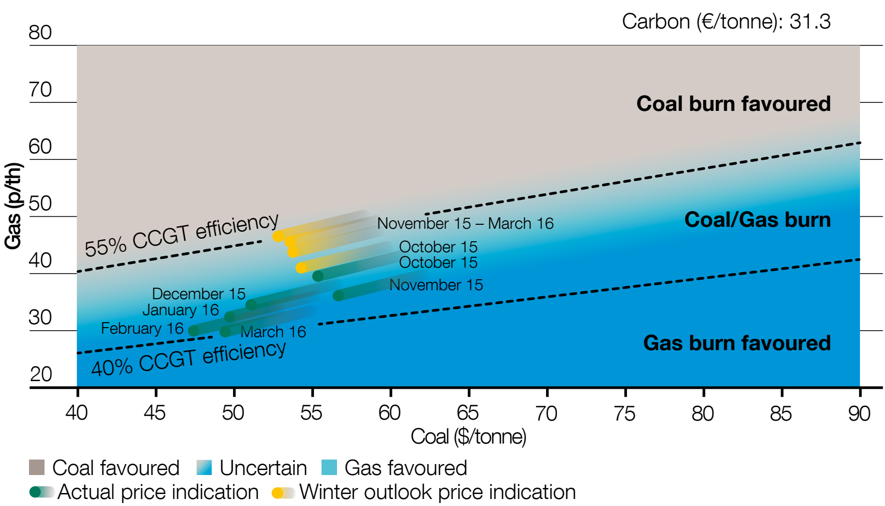
Review of the impact of fuel prices on electricity generation

Figure 18 shows how the prices of coal and gas affect the choice of fuel for electricity generation. The price indication from the *Winter Outlook Report* is compared with the actual price indication for winter 2015/16.

At the time of our analysis in October, the forward prices of gas and coal, plus the cost of carbon, suggested that coal would be the slightly favoured fuel for electricity generation. We anticipated that only higher-efficiency combined cycle gas turbines (CCGTs) would have been able to compete with coal.

Gas, coal and EU Emissions Trading Scheme (ETS) carbon prices all reduced throughout the winter. The national balancing point (NBP) gas price reduced by approximately 25 per cent. Although international coal prices decreased, the impact on GB was limited due to the weakening Sterling to US dollar exchange rate. As a result, the relative prices of the two fuels favoured gas-fired electricity generation throughout the winter.

Figure 18
Relative electricity generation economics for winter 2015/16



What we said in the *Winter Outlook Report*	What actually happened	Why was there a difference
Forward prices were likely to slightly favour coal-fired electricity generation over gas-fired	The price of gas reduced. Gas became the favoured fuel for electricity generation for much of the winter	NBP gas prices reduced by approximately 25 per cent
		International coal prices reduced. However, the impact on GB was limited due to a weakening Sterling to dollar exchange rate
		UK carbon prices reduced as a result of declining EU ETS carbon prices

Operational challenges

The way the network is being used within day continues to change. During winter 2015/16, reduced within day supply and demand profiling resulted in less linepack swing than we anticipated in the *Winter Outlook Report*. However, within day flexibility requirements remain an ongoing issue for system operability.

Key messages

- **The supply and demand flow profiling seen in winter 2015/16 was less than in recent winters. This resulted in a reduction in the level of linepack swing.**
- **The largest linepack swing was 27.9 mcm, compared to 38.6 mcm in 2014/15.**

Key terms

- **Linepack:** the amount of gas within the national transmission system. The more linepack in the system, the higher the gas pressure will be.
- **Linepack swing:** the difference between the amount of gas in the system at the start of the day and at the lowest point during the day.
- **Profiling:** the rate at which gas is put into or taken off the transmission system during the gas day. A flat profile corresponds to a consistent rate across the day.

Overview

Winter 2015/16 was a mild winter, with overall demand in line with winter 2014/15. With increased LNG imports and storage behaviour consistent with winter 2014/15, supplies remained diverse and challenging to forecast.

Users of the transmission system are incentivised to balance supply into, and demand from, the network by the end of the gas day. In recent years we have seen an increasing mismatch in instantaneous supply and demand profiles during the gas day, with a notable trend towards later reconciliations of the daily balance. If the supply profile does not match that of demand during any given day, increasing levels of linepack may need to be utilised to make sure that demand and pressure obligations continue to be met. These changes make it increasingly challenging to cost-effectively and efficiently optimise the configuration of the network and compressor running strategies.

During winter 2015/16, supply and demand profiling was less significant than in recent years, resulting in lower than expected daily linepack swing. However, within day behaviour remains an ongoing issue for system operability.

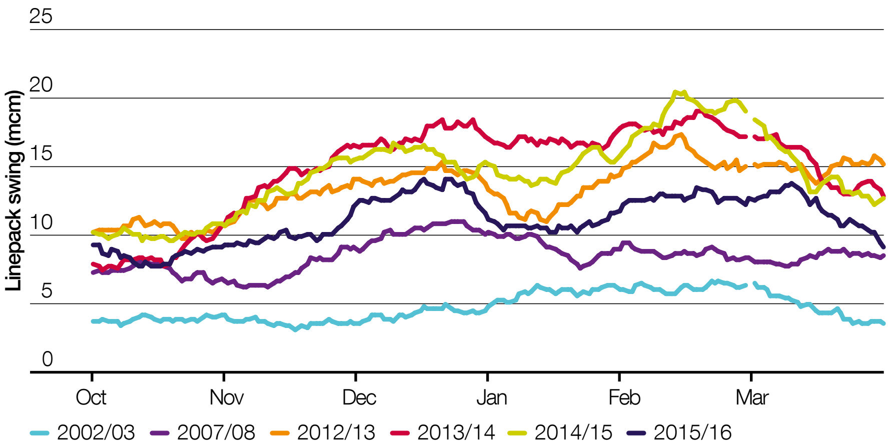
Linepack utilisation

Reductions were seen in both supply and demand flow profiling over winter 2015/16, compared to recent years. In particular, power station demand and both interconnector and storage supplies saw less within day variability, leading to lower average daily linepack swings. We are working with the industry to fully understand the causes of these changes.

Figure 19 shows the level of linepack swing for winter 2015/16, compared with a number of previous winters. The largest linepack swing for winter 2015/16 was 27.9 mcm, in comparison to 38.6 mcm in 2014/15.

Despite the reduction in linepack swing, within day profiling remains an ongoing issue for system operability. The gas transmission network, and associated contractual rules, have historically been built to operate based on flat supply and demand profiles. It can therefore be challenging to meet customer requirements, in particular maintaining pressures, on days of significant linepack swing. As a result, we are continuing to monitor the level of flexibility required and engage with our customers and stakeholders through the system flexibility work stream. You can find out more about system flexibility on our **website**.

Figure 19
Comparison of NTS linepack swing for a 30 day rolling average



What we said in the *Winter Outlook Report*	What actually happened	Why was there a difference
Daily supply and demand uncertainties and within day profiling remain key operational challenges	Day-to-day supply and variability continued. Some decrease in daily linepack swing	Expectations for winter were broadly as expected. We are working with the industry to understand why there was some reduction of within day profiling

Glossary

Word	Acronym	Section	Description
Average cold spell	ACS	Electricity	A particular combination of weather elements that gives rise to a winter peak demand, which has a 50 per cent chance of being exceeded as a result of weather variation alone.
BBL	BBL	Gas	A gas pipeline between Balgzand in the Netherlands and Bacton in the UK. You can find out more at **www.bblcompany.com**
billion cubic metres	bcm	Gas	Unit of volume used in the gas industry. 1 bcm = 1,000,000,000 cubic metres.
BritNed		Electricity	BritNed Development Limited is a joint venture of Dutch TenneT and British National Grid that operates the electricity link between Great Britain and the Netherlands. It is a bi-directional interconnector with a capacity of 1,000 MW. You can find out more at **www.britned.com**
Combined cycle gas turbine	CCGT	Various	A power station that uses the combustion of natural gas or liquid fuel to drive a gas turbine generator to produce electricity. The exhaust gas from this process is used to produce steam in a heat recovery boiler. This steam then drives a turbine generator to produce more electricity.
Composite weather variable	CWV	Gas	A single measure of daily weather. It is the combination of temperature and other weather variables, including wind speed. The purpose of CWV is to define a linear relationship between the weather and non-daily metered gas demand.
Compressor		Gas	Compressors are used to move gas around the transmission network through high pressure pipelines. There are currently 68 compressors at 24 sites across the country. These compressors move the gas from entry points to exit points on the gas network. They are predominately gas-driven turbines that are in the process of being replaced with electric units.
Contingency balancing reserve	CBR	Electricity	Services developed to support system balancing by enabling National Grid to access additional reserve held outside of the market. There are two types: demand side balancing reserve and supplemental balancing reserve.
Daily metered	DM	Gas	A classification of customers where gas meters are read daily. These are typically large scale consumers.

Word	Acronym	Section	Description
Demand side balancing reserve	DSBR	Electricity	Demand side balancing reserve (DSBR) is a service that has been developed to support National Grid in balancing the system. DSBR provides an opportunity for large consumers or owners of small embedded generation to earn money through a combination of upfront payments and utilisation payments by contracting to reduce demand or provide generation when required. The service may be required for short periods between 4pm and 8pm on weekday evenings between November and February.
Demand side response	DSR	Various	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.
East West Interconnector	EWIC	Electricity	A 500 MW interconnector that links the electricity transmission systems of Ireland and Great Britain. You can find out more at **www.eirgridgroup.com/customer-and-industry/interconnection/**
Embedded generation		Electricity	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 transmission system.
Equivalent firm capacity	EFC	Electricity	An assessment of the entire wind fleet's contribution to capacity adequacy. It represents how much of 100 per cent available conventional plant could theoretically replace the entire wind fleet and leave security of supply unchanged. EFC is currently assumed to be 22 per cent.
EU Emissions Trading Scheme	ETS	Gas	An EU-wide system for trading greenhouse gas emission allowances. The scheme covers more than 11,000 power stations and industrial plants in 31 countries.
European Union	EU	Various	A political and economic union of 28 member states that are located primarily in Europe.
Future Energy Scenarios	FES	Various	The FES is a range of credible pathways for the future of energy out to 2050. They form the starting point for all transmission network and investment planning, and are used to identify future operability challenges and potential solutions. You can find out more at **http://fes.nationalgrid.com/**
Gigawatt	GW	Electricity	A measure of power. 1 GW = 1,000,000,000 watts.
Great Britain	GB	Various	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.
Grid supply points	GSP	Electricity	A connection point between the transmission system and the distribution system.
Interconnector		Electricity	Electricity interconnectors are transmission assets that connect the GB market to Continental Europe. They allow suppliers to trade electricity between these markets.

Word	Acronym	Section	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 that 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 (UK) Limited	IUK	Gas	A bi-directional gas pipeline between Bacton in the UK and Zeebrugge in Belgium. You can find out more at **www.interconnector.com**
Interconnexion France-Angleterre	IFA	Electricity	The England-France Interconnector is a 2,000 MW link between the French and British transmission systems. Ownership is shared between National Grid and Réseau de Transport d'Electricité (RTE).
Linepack		Gas	The volume of gas within the national transmission system (NTS) pipelines at any time.
Linepack swing		Gas	The difference between the amount of gas in the system at the start of the day and at the lowest point during the day.
Liquefied natural gas	LNG	Gas	Natural gas that has been converted to liquid form for ease of storage or transport. It is formed by chilling gas to -161 °C so that it occupies 600 times less space than in its gaseous form. You can find out more at **http://grainlng.com/who-are-we/lng-in-the-energy-mix/**
Load		Various	The energy demand experienced on a system.
Long-range storage		Gas	There is one long-range storage site on the national transmission system: Rough, situated off the Yorkshire coast. Rough is owned by Centrica. The site mainly puts gas into storage ('injection') in the summer and takes gas out of storage in the winter.
Medium-range storage		Gas	These commercially operated sites have shorter injection/withdrawal times. This means they can react quickly to demand, injecting when demand or prices are lower and withdrawing when they are higher.
Megawatt	MW	Electricity	A measure of power. 1 MW = 1,000,000 watts.
Million cubic metres	mcm	Gas	Unit of volume used in the gas industry. 1 mcm = 1,000,000 cubic metres.
Moyle		Electricity	A 500 MW bi-directional interconnector between Northern Ireland and Scotland. You can find out more at **www.mutual-energy.com**
National balancing point (NBP) gas price	NBP	Gas	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. The wholesale market in Britain has one price for gas, irrespective of where it has come from. It is usually quoted in pence per therm. You can find out more at **https://www.ofgem.gov.uk/gas/wholesale-market/gb-gas-wholesale-market**

Word	Acronym	Section	Description
National electricity transmission system	NETS	Electricity	High voltage electricity is transported on the transmission system 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).
National transmission system	NTS	Gas	A high pressure gas transportation system consisting of compressor stations, pipelines, multijunction sites and offtakes. Pipelines transport gas from terminals to offtakes and are designed to operate up to pressures of 94 barg.
Non-daily metered	NDM	Gas	A classification of customers where gas meters are read monthly or at longer intervals. These are typically residential, commercial or smaller industrial consumers.
Non-storage supply	NSS	Gas	All gas supplies to the national transmission system excluding short, medium and long-range storage.
Normalised demand		Electricity	Demand assessed for each week of the year based on a 30 year average of each relevant weather variable. This is then applied to linear regression models to calculate what the demand would have been with this standardised weather.
Notification of Inadequate System Margin	NISM	Electricity	A routine notification issued to generators, interconnected system operators and suppliers to advise that there is a likelihood that there will be an inadequate margin of reserve capacity available. The purpose is to make the recipients aware and request that additional reserve capacity is made available.
Operational Code 2 data	OC2	Electricity	Information provided to National Grid by generators. It includes their current generation availability and known maintenance outage plans. You can access the latest OC2 data throughout the year on the BM Reports website at **www.bmreports.com**
Open cycle gas turbine	OCGT	Various	Gas turbines in which air is first compressed in the compressor element before fuel is injected and burned in the combustor.
Peak		Various	The maximum requirement of a system at a given time, or the amount of energy required to supply customers at times when need is greatest. It can refer either to a given moment (e.g. a specific time of day) or to an average over a given period of time (e.g. a specific day or hour of the day).
Profiling		Gas	The rate at which gas is put into or taken off the transmission system during the gas day. A flat profile corresponds to a consistent rate across the day.

Word	Acronym	Section	Description
Residual balancer		Gas	Users of the gas system are incentivised to balance supply into, and demand from, the network. If this balance is not expected to be achieved on any given day, the System Operator (National Grid), as residual balancer, will enter the market and undertake trades (buys or sells) to seek to resolve any imbalance.
Seasonal normal demand		Gas	The level of gas demand that would be expected on each day of the year. It is calculated using historically observed values that have been weighted to account for climate change.
Short-range storage		Gas	The only short-range storage site on the national transmission system during the winter was at Avonmouth, near Bristol. This onshore site stored liquefied natural gas that had been condensed from the transmission system, not delivered by ship. When needed, the liquid gas was re-vaporised and delivered to the transmission system. Short-range storage is able to respond quickly to fluctuations in demand but has limited stock. The Avonmouth facility closed in April 2016.
Station load		Electricity	The onsite power station requirement, for example for systems or start up.
Supplemental balancing reserve	SBR	Electricity	Supplemental balancing reserve (SBR) is a service that has been developed to support National Grid in balancing the system. Contracts are set up between National Grid and generators to make their power stations available in winter, where they would otherwise be closed or mothballed.
System Operator	SO	Various	An entity entrusted with transporting energy in the form of natural gas or electricity on a regional or national level, using fixed infrastructure. 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.
Transmission system demand	TSD	Electricity	Demand that National Grid as System Operator sees at grid supply points (GSPs), which are the connections to the distribution networks. It includes demand from the power stations generating electricity (the station load).
Triad		Electricity	Triads are the three half-hourly settlement periods with the highest system demand. Triads can occur in any half-hour on any day between November and February. They must be separated from each other by at least ten days.
Underlying demand		Electricity	A measure of demand that removes the effect of weather and the day of the week.
UK Continental Shelf	UKCS	Gas	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.

Word	Acronym	Section	Description
United Kingdom of Great Britain and Northern Ireland	UK	Various	A geographical, social and economic grouping of countries that contains England, Scotland, Wales and Northern Ireland.
Weather corrected demand		Electricity	The demand expected or outturned with the impact of the weather removed. A 30 year average of relevant weather variable is constructed for each week of the year. This is then applied to linear regression models to calculate what the demand would have been with this standardised weather.
Weather corrected demand		Gas	The demand expected with the impact of weather removed. Actual demand is converted to demand at seasonally normal weather conditions, by multiplying the difference between actual CWV and expected CWV by a value that represents demand sensitivity to weather.
Winter Outlook Report	WOR	Various	The *Winter Outlook Report* is published each year in October by National Grid to show the expected security of supply position on both the gas and electricity systems for the coming winter. It is the product of the *Winter Consultation* process and is based on data supplied by the industry, market insight and analysis.

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