Winter Review and Consultation 2019

The *Winter Review* and *Consultation* includes:

- our annual report reviewing winter 2018/19 and comparing it with our forecast
- a consultation with our stakeholders which helps to inform our analysis for the 2019/20 *Winter Outlook* Report.

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Welcome

Thank you for reading our *Winter Review and Consultation* report. This report looks back to winter 2018/19 and compares what happened with our *Winter Outlook* forecast. It is an opportunity to look at the factors that influenced any differences and how well challenges were anticipated and met. The consultation included in this report is a vital element of the stakeholder engagement that informs our forthcoming 2019/20 *Winter Outlook* Report and we welcome your views.

Following the positive feedback we received, this report follows a similar concise format as the *Summer Outlook* Report. We have also introduced a new way for you to take part in the consultation by working within the report itself to provide your responses.

As we look back over last winter, we are pleased to report the lowest carbon intensity winter on record for the electricity system, a continuation of the positive long-term trend of reducing carbon intensity. Following records for wind and solar generation and coal-free running hours, it is another milestone which shows the progress that is being made to decarbonise the electricity system. In our role operating the electricity system, we are committed to the continued innovation and transformation necessary to build on this so we are ready and able to operate the electricity system at zero carbon by 2025.

One of our key goals is to facilitate successful whole energy system outcomes to help maximise consumer benefit. For this reason, this report and the *Summer* and *Winter Outlooks* are produced on a dual fuel basis and explore whole energy interactions where relevant. We have included a new section in this report which reflects on the significance of interactions between the gas and electricity systems last winter.

We hope you find this report useful and take the opportunity to feed back to us through the consultation. Alternatively you can email us at **marketoutlook@nationalgridso.com** or join the conversation using social media via LinkedIn, Facebook and Twitter, **#winterreview**.

Fintan Slye
Director UK System Operator

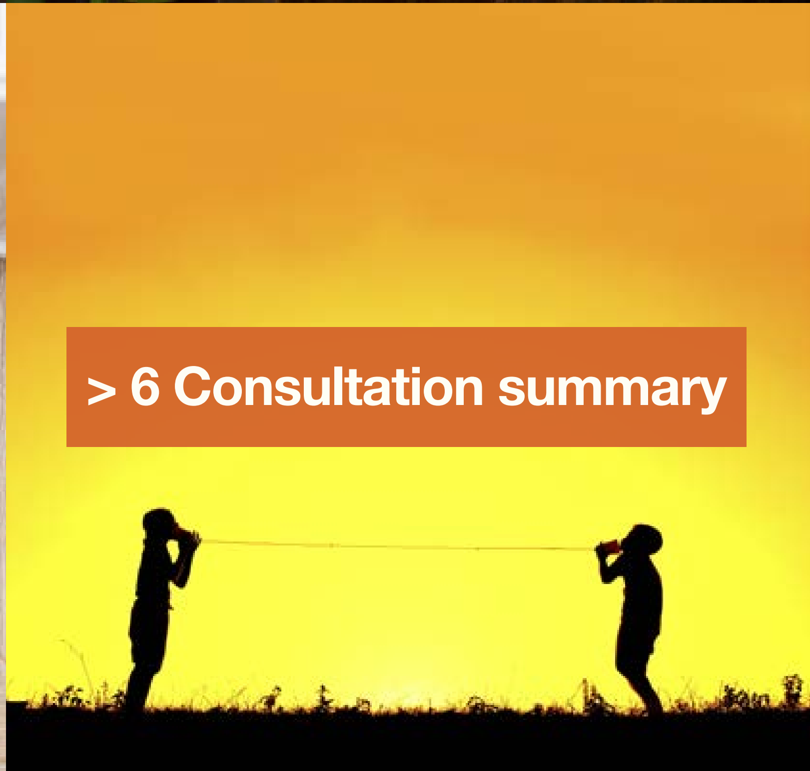

> 1 About the consultation


> 2 Executive summary


> 3 Whole energy system


> 4 Electricity


> 5 Gas


> 6 Consultation summary

1 About the Winter Review and Consultation

Responding to the *Winter Review and Consultation*

The purpose of the consultation is to gather stakeholder insight to inform our analysis for the 2019/20 *Winter Outlook* Report, published in October.

Your views on the market and related issues are important to provide a comprehensive picture of the challenges and opportunities of the forthcoming winter. It also allows us to test how useful the suite of Outlook documents are and to identify potential improvements.

Consultation questions

You will see a ? icon when there is a consultation question specific to that section. In the interactive version when you hover over the icon the question will appear. The questions are also summarised at the end of the section. A full list of consultation questions can be found on pages 44 and 45.

The consultation closes on 19 July 2019.

Response options

You can send your consultation response to us:

As commentary within the report

- Download a copy of the report from the website.
- Complete the questions on the editable pages of the document at the end of each section.
- Email your completed copy to **marketoutlook@nationalgridso.com**

As a separate document

- This can be emailed to **marketoutlook@nationalgridso.com**

Alternatively you can let us know what you think on Twitter, or by joining our LinkedIn **Future of Energy** page.

We look forward to hearing your views.

Consumer benefit

Our Mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable affordable energy for all consumers.

Consumers benefit from our activities in five ways:

Improved safety and reliability

As the energy landscape continues to decarbonise and transform, we operate a system with much more complex flows of energy and invest to make sure it remains safe and secure in the future.

Lower bills than would otherwise be the case

We lower consumers' bills by efficiently and effectively balancing the electricity and gas systems, and facilitating markets worth over £35 billion per year. We make decisions that influence network development, wider wholesale market costs and capacity, all of which form part of the consumer bill.

Reduced environmental damage

As the SO, we are at the centre of the transition to a low-carbon system. We design markets that support new, low-carbon technologies and disruptive solutions to today's environmental challenges.

Improved quality of service

Improved service quality for our customers and stakeholders ultimately benefits the consumer as interactions in the value chains across the industry become more seamless, efficient and effective.

Benefits for society as a whole

We are committed to providing transparent, accurate information and insight. This is essential to the evolving challenge of system operability and the role of markets in delivering secure and efficient system operation. We provide all data and insights free of charge. It facilitates industry discussion, fosters innovation and improves decision-making across the industry, ultimately delivering benefits for consumers and society as a whole.

Consumer benefit

In the *Winter Review and Consultation* we share information on system operability for gas and electricity over the past winter. The goal of this report is to increase understanding of system operations and support decision-making across the industry.

The consultation provides the opportunity to engage with stakeholders on our future work so that we can continuously improve the quality of our service.

Examples of our consumer benefit work over winter 2018/19:

Advancing Energy Forecasting (Electricity)

We are improving the accuracy and accessibility of our forecasting. Our Carbon Intensity Forecasting Platform allows end-consumers to adjust their electricity consumption behaviour based on how 'green' the generation is predicted to be. Over winter 2018/19, this platform received around 4.5 million hits per month. Read more about this work and our future plans in our ESO 2018/19 end of year report[1] and 2019-2021 Forward Plan[2].

Information Provision Enhancements Project (Gas)

The aim of the project is to provide an agile and industry enhancing upgrade to the existing MIPI system with an improved and industry led set of operational data enhancements. It will also provide a platform for the provision of greater industry transparency on National Grid's actions in its role as Gas System Operator (GSO).

Data we provide and insight into our decision making is used across the industry to aid more effective customer-led commercial and operational decisions. This enables progress towards decarbonising energy and drives efficiencies for parties such as shippers or NTS connected customers that ultimately reduce the end consumer bill to an extent greater than reductions to only the direct gas transmission element.

The project and engagement to date has delivered improved demand and trading data sets, and a new industry engagement platform. This is an innovative way of allowing industry players to vote, articulate views and generate meaningful discussion on the needs and value of data and transparency.

To view the data community, visit the website[3].

2 Executive summary

Winter 2018/19 overview

Executive summary

Winter 2018/19 was the fifth warmest winter in the past 59 years and had high levels of wind. Our operations across the electricity and gas networks responded flexibly throughout the winter period to meet the different challenges presented by variable weather conditions.

1

Winter 2018/19 was the lowest carbon intensity winter on record for electricity generation, and levels of carbon intensity have almost halved in the last five years. High wind and low coal generation contributed to a continued reduction in the average carbon intensity of electricity over the winter, setting a new record of 242.8 grams CO_2 equivalent/kWh, in line with long-term trends.

2

Whole energy system interactions were prominent as high levels of renewable electricity generation resulted in variable gas demand for power. The preference for gas generation over coal led to the highest day for gas demand for electricity generation on record at 97.2 mcm.

3

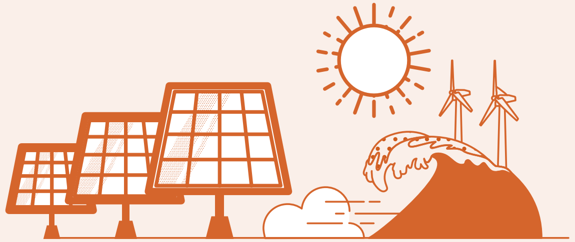
Electricity supply margins were in line with expectations and there were no significant difficult days for meeting gas demand. Electricity and gas demand levels were also close to our forecast, although gas demand for electricity generation was higher than expected.

4

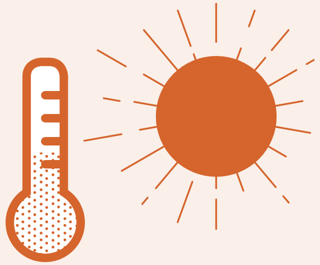
Despite the mild weather, there were operational challenges that were overcome in relation to both gas and electricity. On the electricity system, unexpected outages and system conditions contributed to low system inertia and a higher risk of Rate of Change of Frequency (RoCoF) events. The gas system responded to large day-to-day swings in demand and increased supply diversity including higher than expected levels of liquefied natural gas (LNG).

Winter 2018/19 overview

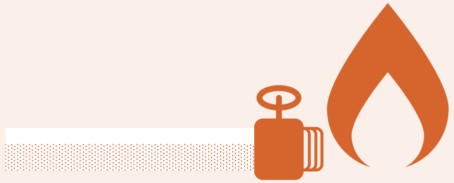
Executive summary



The lowest carbon intensity winter on record, **almost half the CO_2 equivalent** compared to five years ago



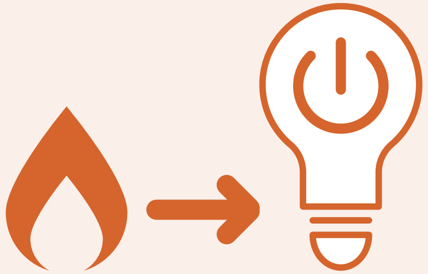
5th warmest winter in nearly 60 years



Gas delivered **over 3 times more energy** than electricity over the winter

Gas and electricity **demand and supply margins close to our forecast**

Flexible system operation was needed to manage the challenges of variable demand



Highest single day gas demand for electricity generation on record at 97.2 mcm

Electricity overview winter 2018/19

Executive summary

Headline messages

- High wind and low coal generation contributed to a continued reduction in the average carbon intensity of electricity over the winter, setting a new record of 242.8 grams CO_2 equivalent/kWh, in line with long-term trends.
- Transmission demand over the winter period was suppressed because of higher output from distribution connected wind.
- Throughout the winter there was a good electricity supply and comfortable margins, despite some extended nuclear outages and the suspension of the GB Capacity Market in November 2018.
- Despite a healthy margin, there were operational challenges over the winter due to high renewable output, lower inertia from conventional plant, lower transmission demand (due to milder weather) and the reduced availability of some plant and the Western High Voltage Direct Current (HVDC) link for some of the winter.
- Triad avoidance was higher than anticipated and, for the first time, the system saw high frequency deviations around Triad periods that we attributed to batteries switching from charging to discharging.
- The relative cost of gas compared to coal for electricity generation meant less fuel switching took place from gas fired electricity generation to coal fired electricity generation.

Electricity winter 2018/19

	2018/19 Forecast (weather corrected)	2018/19 Actual (weather corrected)	2018/19 Actual (not weather corrected)
Peak transmission system demand	48.2 GW	48.5 GW	48.8 GW
Minimum transmission system demand	20.8 GW	21.0 GW	21.6 GW
Triad avoidance	2.0 GW*	N/A	2.4 GW

*Triad avoidance is not weather corrected.

Gas overview winter 2018/19

Executive summary

Headline messages

- There were no significant events during winter 2018/19 that adversely affected gas supply and demand.
- There was an unexpected reduction in gas prices after the time of our forecast. Influencing factors included the mild winter weather, high storage levels and availability of LNG supplies in Europe which led to increased competition in the supply market.
- Overall gas demand in winter 2018/19 was lower than previous years but not as low as our forecast. This was due to a higher demand for gas for electricity generation than anticipated as a result of the low gas prices and hence the relative cost of gas compared to coal.
- Winter 2018/19 included the highest day for gas demand for electricity generation on record at 97.2 mcm.
- The peak gas day demand was 402 mcm as compared to 417.6 mcm in 2017/18 during the severe cold weather.
- A variety of sources met the gas demand including a higher number of LNG deliveries than forecast due to market changes.
- The National Transmission System (NTS) responded flexibly to large day-to-day swings in gas demand, changes in storage and withdrawal patterns and increased diversity of supply.

Gas demand winter 2018/19

	2018/19 Forecast (seasonal normal)	2018/19 Actual (weather corrected)	2018/19 Actual (not weather corrected)
Demand for electricity generation	7 bcm	12.3 bcm	12.3 bcm
Total demand	46.6 bcm	50.9 bcm	49.6 bcm

Consultation questions

Executive summary

Winter Review and Consultation

Q1
What do you use the *Winter Review and Consultation* document for? What information in the report is most useful to you?

Q1... Type your answer here

Q2
Is there anything else that could be included in the *Winter Review and Consultation*?

Q2... Type your answer here

Q3
How do you think the *Winter Review and Consultation* could be improved to increase benefit for consumers?

Q3... Type your answer here

Q4
Do you have any other feedback on the new format of this report and the 2018 *Summer Outlook*[1] Report?

Q4... Type your answer here

Questions continued on the next page

[1] https://www.nationalgrideso.com/insights/summer-outlook

Consultation questions

Executive summary

Winter Outlook Report

Q5
Is there anything different you would like to see in the 2019/20 *Winter Outlook* Report which will be published in October?

Q5... Type your answer here

Q6
Is there anything you would like to share with us on your preparations for changes to the energy trading environment over the forthcoming winter period?

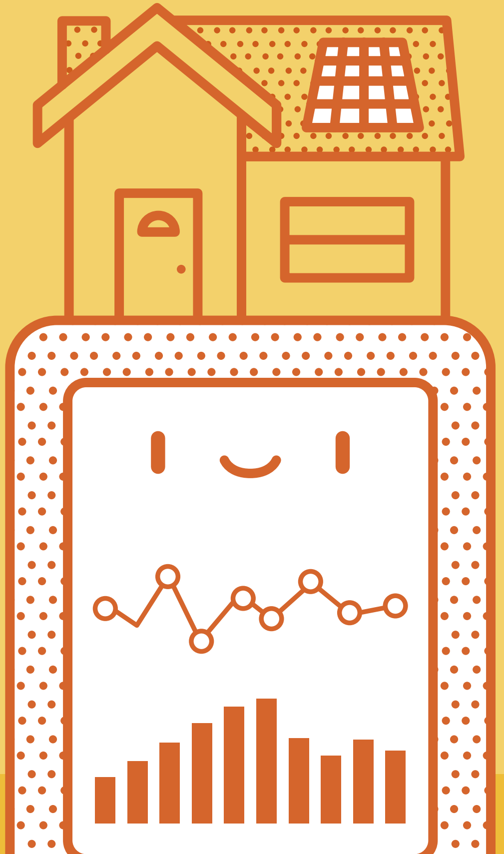
Q6... Type your answer here

General

Q7
Do you have any other feedback on this report or our other Outlook documents?

Q7... Type your answer here

Further consultation questions can be found after each section of the report. See pages 44 and 45 for a full summary of all of the consultation questions.



Send your completed consultation response to:
marketoutlook@nationalgridso.com

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> 2 Executive summary
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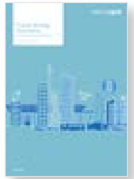
> 5 Gas
> 6 Consultation summary
> 7 Glossary

Our publications

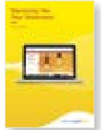
Executive summary



Future Energy Scenarios
July
A range of credible pathways for the future of energy from today to 2050. Scenarios are unconstrained by network issues.

The *ETYS*, *GTYS* take the unconstrained scenarios in *FES* to develop requirements for planning and operating the electricity and gas transmission systems over the next 10 years.

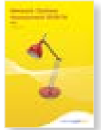
Needs case



Electricity Ten Year Statement
November
The likely future transmission requirements on the electricity system.

Gas Ten Year Statement
November
How we will plan and operate the gas network, with a ten-year view.

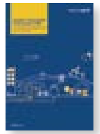
Options



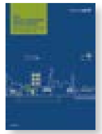
Network Options Assessment
January
The options available to meet reinforcement requirements on the electricity system.

Ten Year Network Development Plan
Overview of the European gas and electricity infrastructure and its future developments.

The operability publications consider the unconstrained scenarios in *FES* to explore operability risks and associated requirements of the transmission networks and services.

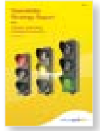


System Operability Framework
How the changing energy landscape will impact the operability of the electricity system.

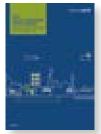


Gas Future Operability Planning
November/ December
How the changing energy landscape will impact the operability of the gas system.

Ad-hoc, insights -led productions and reports

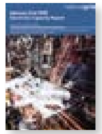


Operability Strategy report
Highlights the challenges we face in maintaining an operable electricity system, and summarises the work we are undertaking to ensure we meet those challenges.

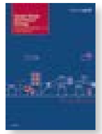


Future gas supply patterns
How variability in supply pattern seasonally and day-to-day has changed, and could change in the future.

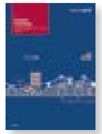
We also produce ad-hoc reports that develop shorter-term plans for more specific elements of operational assets and services, where the need arises.



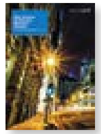
Capacity report
Capacity Market auctions for delivery in 2019/20 and 2022/23.



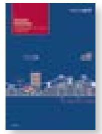
System Needs and Product Strategy
Our view of future electricity system needs and potential improvements to balancing services markets.



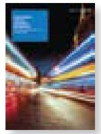
Product Roadmap for Restoration
Our plan to develop restoration products.



Wider Access to the Balancing Mechanism Roadmap
Our plan to widen access to the balancing mechanism.



Product Roadmap for Reactive Power
Our plan to develop reactive power products.



Transmission Thermal Constraints Management
Our plan for the management of thermal constraints.

Each year we provide short-term forecasts that explore any operational challenges anticipated over the summer and winter periods.

Winter Review and Consultation
June
A review of last winter's forecasts versus actuals and an opportunity to share your views on the winter ahead.

Summer Outlook Report
April
Our view of the gas and electricity systems for the summer ahead.

Winter Outlook Report
October
Our view of the gas and electricity systems for the winter ahead.

3
Whole energy system

Electricity and gas interactions

Our energy system is changing. The long-term trends of decarbonisation and decentralisation, and short-term trends such as price changes, are driving increased interaction between the gas and electricity transmission systems. Insight into this interaction today can help to inform future developments in the energy industry.

In this chapter we review the interactions between the electricity and gas transmission systems during winter 2018/19.

Overview

Whole energy system

This section uses common units for gas and electricity to show a direct comparison for both fuels over winter 2018/19.

Why?
The gas and electricity industries normally use the conventions, units and metrics most applicable to the respective fuels. However, as whole system interactions increase there is value in viewing the energy provided by both fuels through a single lens.

Consultation questions

What information could we provide in our 2019/20 *Winter Outlook* Report that would help to increase shared understanding on whole energy system interactions?

For example:-
In this section, we stated gas demand figures in new units (GWh and TWh rather than bcm and mcm) and directly compared gas and electricity demands.

Is this something that would be useful to include in future *Winter* and *Summer Outlook* Reports?

If so, why is this helpful?

Are there any other gas or electricity metrics that you could suggest that should be included? If so, why are these new metrics useful?

Figure 3.1
Total energy flow winter 2018/19 – both fuels (TWh)

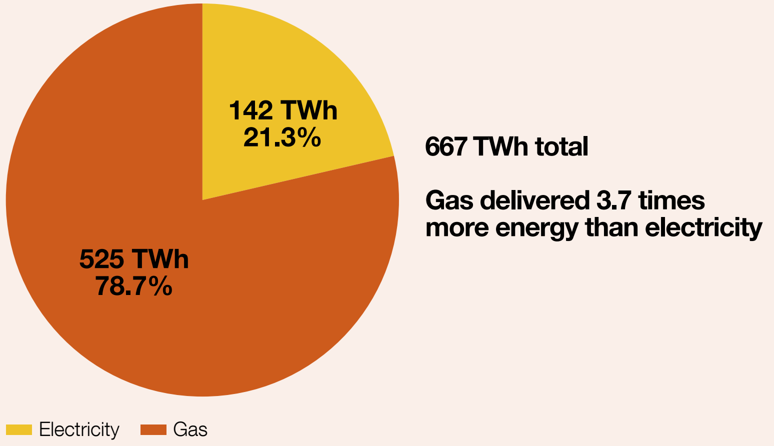
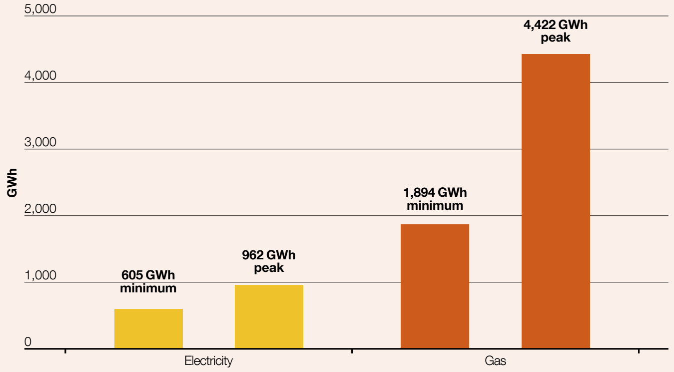


Figure 3.2
Minimum to peak day flows for gas and electricity over winter 2018/19



Gas peak day flow is 2.3 times higher than the minimum day flow.

Electricity peak day flow is 1.5 times higher than the minimum day flow.

Transmission level demand levels only.

Case study: whole energy system interactions across winter 2018/19

Interactions between renewable and gas fired electricity generation

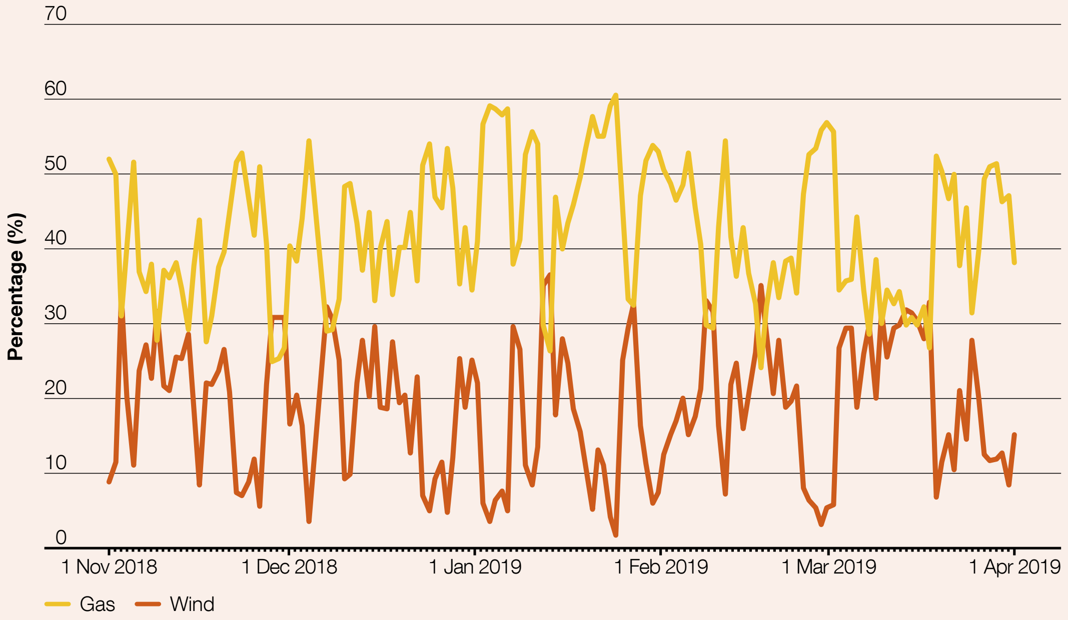
The recent growth in renewable generation has led to more variable patterns for thermal electricity generation throughout the year. This case study looks back at this pattern across winter 2018/19, which had several interesting features from a whole energy system perspective. The running patterns for winter 2018/19 can be seen in Figure 3.3.

Winter 2018/19: the highest day for gas demand for electricity generation on record

Wind levels were high over the winter meaning that wind generation displaced a lot of thermal electricity generation. This would normally lead to less gas demand for power. However, a reduced gas price meant that gas was in merit over coal for generators.

This contributed to winter 2018/19 having the highest single day for gas demand for electricity generation (97.2 mcm) on record. This occurred on a day when wind output was low and electricity demand was met mostly by gas rather than coal plant.

Figure 3.3
Load factors for wind generation for electricity and gas fired generation in winter 2018/19



Managing variable gas demand from electricity generation
The way that output from gas fired electricity generation mirrored renewable generation in winter 2018/19 was similar to summer 2018. This meant the gas demand to these sites was more variable and the NTS compressor portfolio was increasingly relied upon to manage the variability in operating pressures.

Case study: whole energy system interactions across winter 2018/19

The response of the market to the low gas price was seen across the whole energy system.

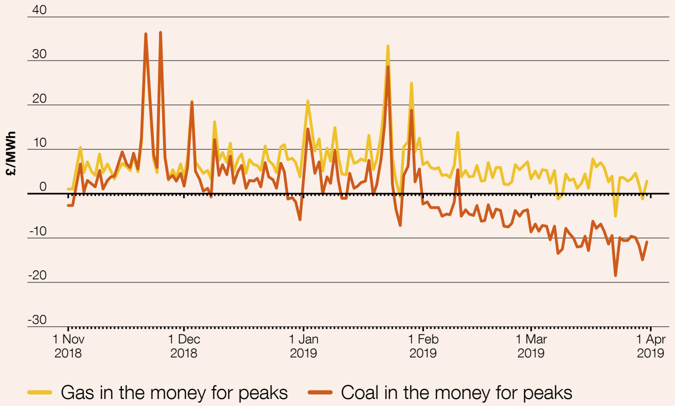
At the time of our *Winter Outlook* Report, forecast gas prices were increasing and we predicted that this trend would continue throughout the winter leading to a preference for coal fired electricity generation. However, the downturn in the gas price and the relative cost of gas compared to coal (including the impact of carbon prices) meant that coal output fell sharply and there was a preference for gas fired generation to fill the gaps when renewable output dropped (see Figure 3.4).

The gas price reduction was driven by a combination of factors that added competition in the supply market, driving prices down.

- Mild winter weather and high existing storage levels in Europe suppressed demand.
- LNG production increasing globally.
- Usual LNG delivery to the Asian market was lower due to high shipping costs.

The impact was that overall gas demand across the winter from electricity generation was only slightly lower than 2017/18, despite the high levels of wind generation.

Figure 3.4
Modelled clean spark spreads and clean dark spreads for winter 2018/19



Case study: whole energy system interaction day-on-day

Managing sudden and unexpected changes in demand on the National Transmission System (NTS) from one day to the next can be challenging. A drop in demand as renewable generation increases can be just as difficult to manage as a rapid rise and requires more flexible and proactive NTS operations.

A significant day-on-day demand change in winter 2018/19

25 January 2019 was the biggest day-on-day demand change last winter. It was much warmer than the previous day and very windy.

Renewable generation from wind was five times higher than the previous day, resulting in a 35% drop in gas demand for electricity generation. Heating was also switched off leading to a 20% reduction in LDZ demand.

Day-to-day operational management is becoming as important as within-day management. We are ensuring our processes and operating strategies are ready to respond to these changing market requirements.

	24 January	25 January
Demand change	384 mcm	306 mcm
This 78 mcm drop is more than twice the highest linepack swing of the winter and significantly higher than the biggest day-on-day demand change in winter 2017/18 (48 mcm).		
Storage	53 mcm withdrawal	11 mcm injection

Figure 3.5
Absolute day-on-day change in NTS demand (mcm/d)

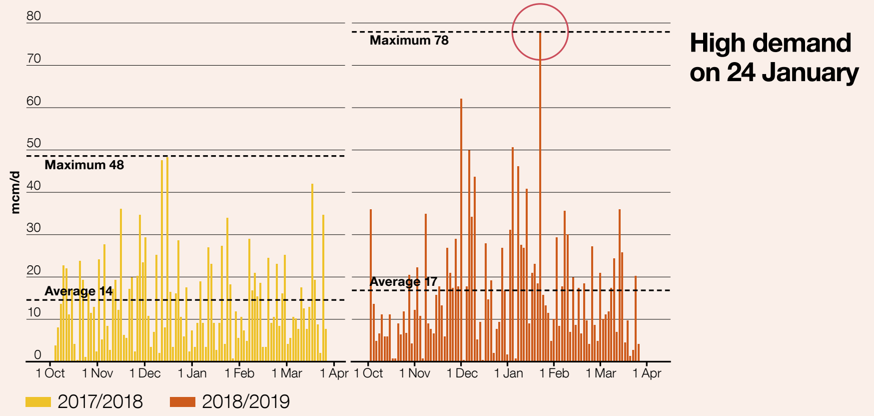
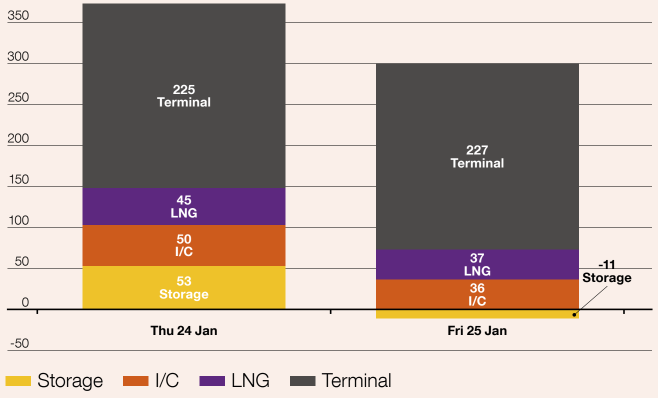


Figure 3.6
Day to day net supply profile on 24 and 25 January 2019 (mcm/d)



Consultation questions

Whole energy system

Now, tell us what you think...

General

Q8

What information could we provide in our 2019/20 *Winter Outlook* Report that would help to increase shared understanding on whole energy system interactions?

Q9

In this section, we stated gas demand figures in new units (GWh and TWh rather than bcm and mcm) and directly compared gas and electricity demands. Is this something that would be useful to include in future *Winter* and *Summer Outlook* Reports?

- If so, why is this helpful?

Q10

Are there any other gas or electricity metrics that you could suggest that should be included?

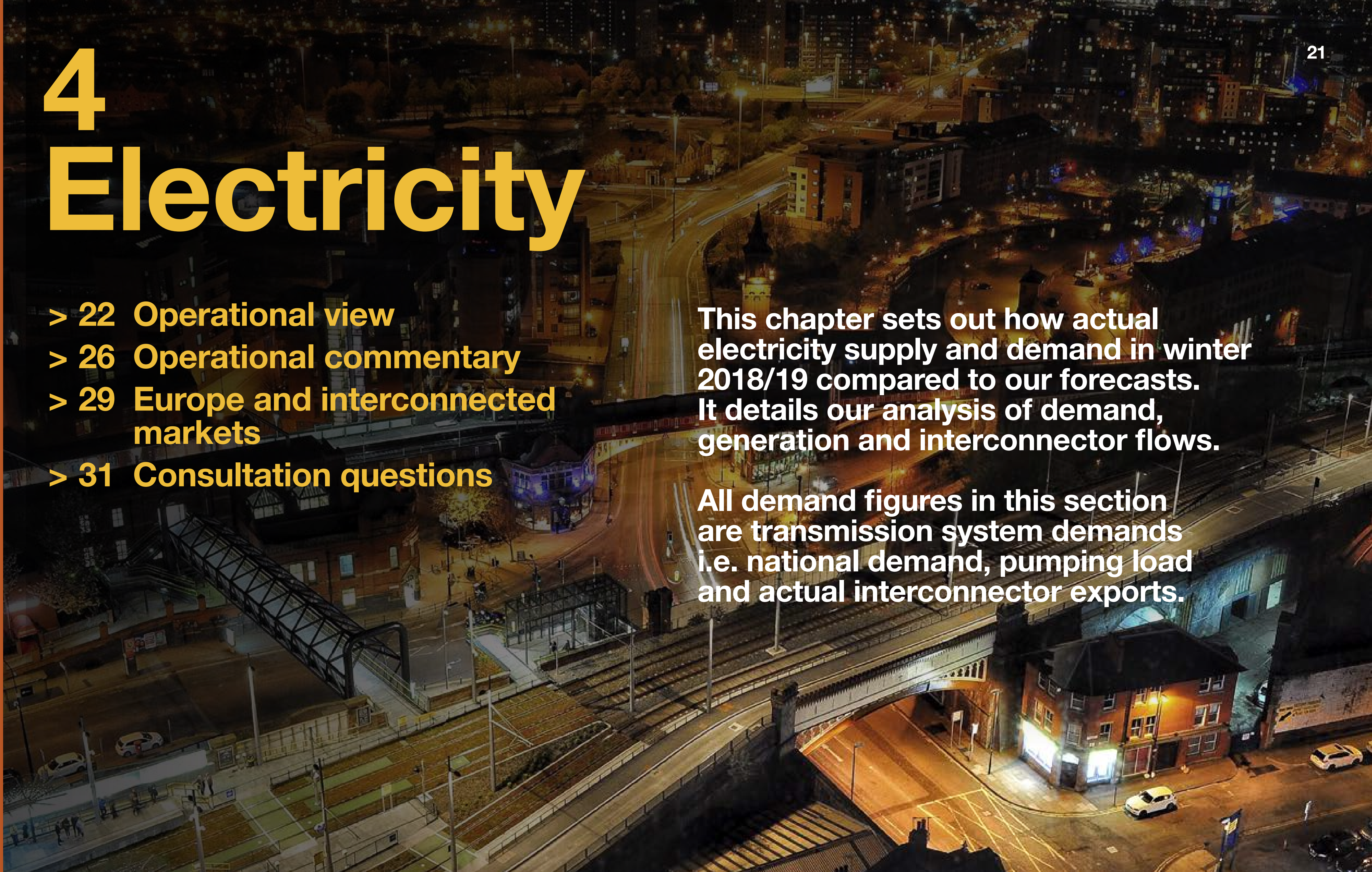
- If so, why are these new metrics useful?

Q8... Type your answer here

Q9... Type your answer here

Q10... Type your answer here

Send your completed consultation response to: marketoutlook@nationalgridso.com



4 Electricity

This chapter sets out how actual electricity supply and demand in winter 2018/19 compared to our forecasts. It details our analysis of demand, generation and interconnector flows.

All demand figures in this section are transmission system demands i.e. national demand, pumping load and actual interconnector exports.

Demand

Electricity

The 2018/19 winter was on average fairly mild in terms of temperature. The windy weather also meant that high output from distribution connected wind generation further suppressed transmission system demand. Both peak and minimum transmission system demands were close to forecasts from our 2018/19 *Winter Outlook* Report.

Figure 4.1 shows daily actual and weather corrected transmission system demand, alongside our estimates of Triad avoidance (see next slide). Unlike winter 2017/18, we did not see any unusual weather spells, or any peak demand periods occurring outside of the usual Triad period (November to February).

Peak transmission demand was slightly higher than anticipated due to high exports to Ireland. Whilst the winter as a whole was mild, at the times of peak and minimum demand the weather was slightly colder than average, hence weather corrected demand is slightly lower than actual demand.

Figure 4.1
Triad avoidance

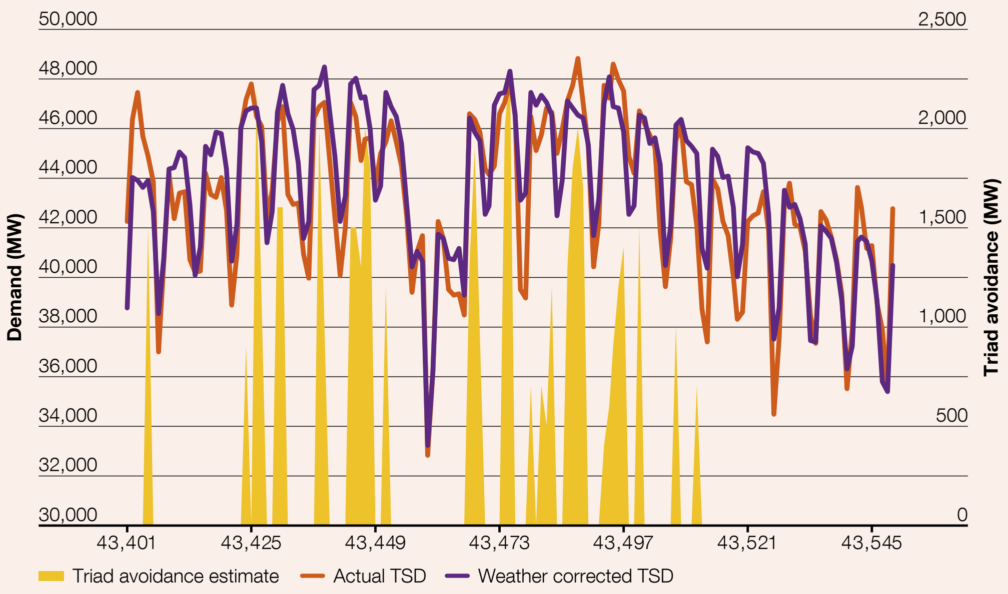


Table 4.1
Peak and minimum transmission system demands for winter 2018/19

GW	*Winter Outlook* forecast	Actual	Winter 2018/19 (Weather corrected)
Peak demand	48.2	48.8	48.5
Minimum demand	20.8	21.6	21.0

Triad avoidance

Electricity

What we said in *Winter Outlook*	What actually happened	Why was there a difference?
Triad avoidance is expected to be 2.0 GW, and the introduction of CMP264/265 could lead to a reduction in Triad avoidance compared to previous years.	Estimated Triad avoidance peaked at 2.4 GW in January 2019. This was higher than winter 2017/18. For the first time, we saw frequency deviations in the settlement period before expected Triad avoidance activity. We assume this is as a result of batteries switching from charging to discharging. We would welcome further insight from industry to help us plan to manage frequency events associated with battery behaviour (see consultation question 12).	The phased implementation of CMP264/265 may mean there is no reduction in Triad avoidance at this time, as reducing energy consumption over Triad remains valuable. We would welcome further insight from industry to help plan for winter 2019/20 (see consultation questions 11 and 12).

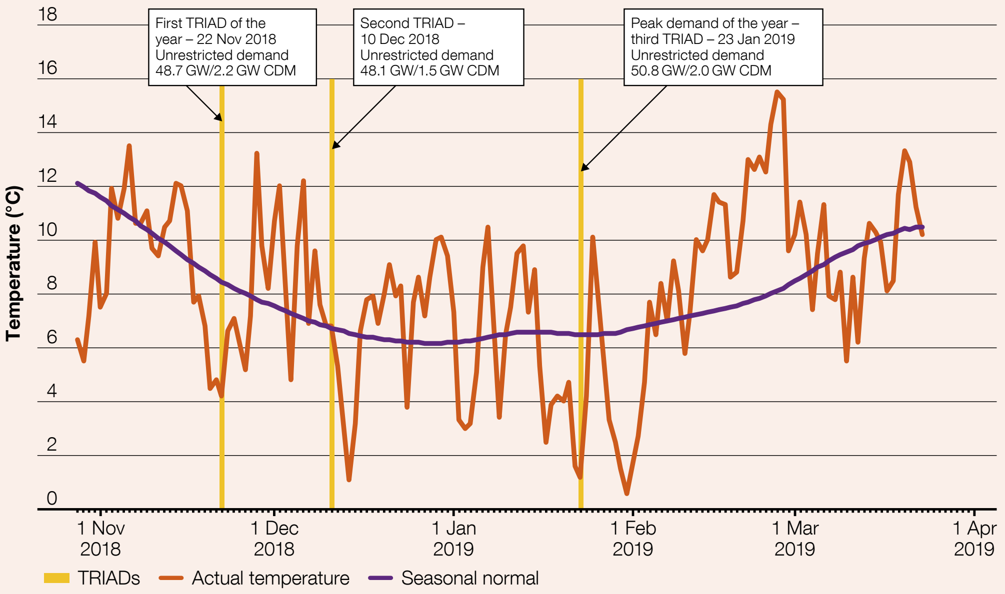
These are the ESO's best estimate of Triad avoidance based on daily post-event analysis of peak demand, incorporating our expertise along with analysis of the drop in underlying peak demand. This estimate is not based on any demand reduction data provided to us by suppliers, customers or aggregators.

Consultation questions

Did you or your customers participate in Triad avoidance over the winter of 2018/19, and what were your primary reasons for doing so? Do you think that the peak level of Triad avoidance will increase or decrease in winter 2019/20 and what do you think will be the reason for this change?

Figure 4.2

Shows the daily actual and seasonal normal temperature for winter 2018/19, alongside the date of each of the 3 Triads, and our estimates of Triad avoidance for each of these.

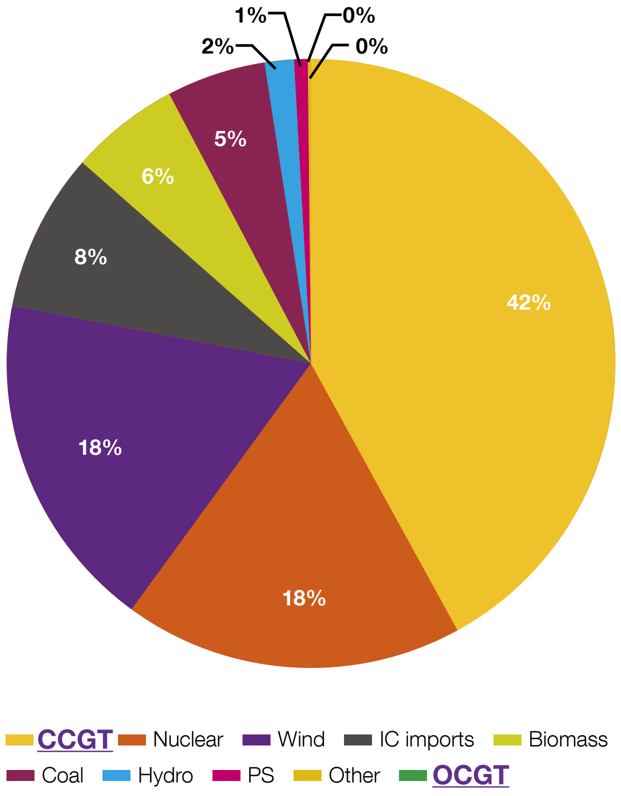


Supply
Electricity

The weather over the winter of 2018/19 was windy, leading to a high contribution of wind generation to overall winter supply. Gas fired plant provided roughly the same level of output (as a percentage of total supply) as last winter, whilst coal output fell sharply. Generation output by fuel type for each day of the winter can be found in the Data Workbook.

What we said in *Winter Outlook*	What actually happened	Why was there a difference?
We anticipate gas prices to be higher than coal, leading to fuel switching from gas fired to coal-fired generation.	Generally clean spark spreads were greater than clean dark spreads for most of the winter, leading to much less coal generation than last winter.	Gas prices fell shortly after the publication of *Winter Outlook* and high EU ETS prices supported the relative cost of gas compared to coal generation.
Assumed forecast breakdown rates as per the Data Workbook.	Breakdown rates were equal to or lower than expected for most fuel types. We have included a separate calculation for biomass this year.	Differences in breakdown rates had minimal impact on the overall supply forecast.
The end of October and first half of December will have the lowest level of operational surplus due to expected demand and planned generator outages.	Minimum operational surplus was during the week beginning 26 November 2018.	This was due to low wind in the week beginning 26 November and low interconnector imports, particularly from France, alongside planned generator outages.
Both normalised and average cold spell demand can be met in all weeks across the winter under all interconnector scenarios.	Despite nuclear outages and a Capacity Market suspension, there were sufficient generation and interconnector imports to comfortably meet demand throughout the winter period.	Two nuclear stations had to extend outages whilst waiting for regulator approval to return to service, and the GB Capacity Market was suspended (see spotlight).

Figure 4.3
Percentage of total winter 2018/19 electricity provided by each fuel type (transmission connected only)



Spotlight

Lowest carbon intensity over winter to date

As different types of electricity generation switch on or off over the winter, we are able to measure the average carbon intensity of electricity being produced at any time in GB.

Fossil fuel technologies such as coal fired generation emit high amounts of carbon dioxide per kilowatt hour of electricity produced, whilst renewable generation such as wind does not.

Winter 2018/19 was mild, meaning that demand for electricity was suppressed due to warmer temperatures and less need for heating. At the same time, there were high levels of wind generation. Coal generation reduced as gas generation became more economic to run, as a consequence of lower gas prices.

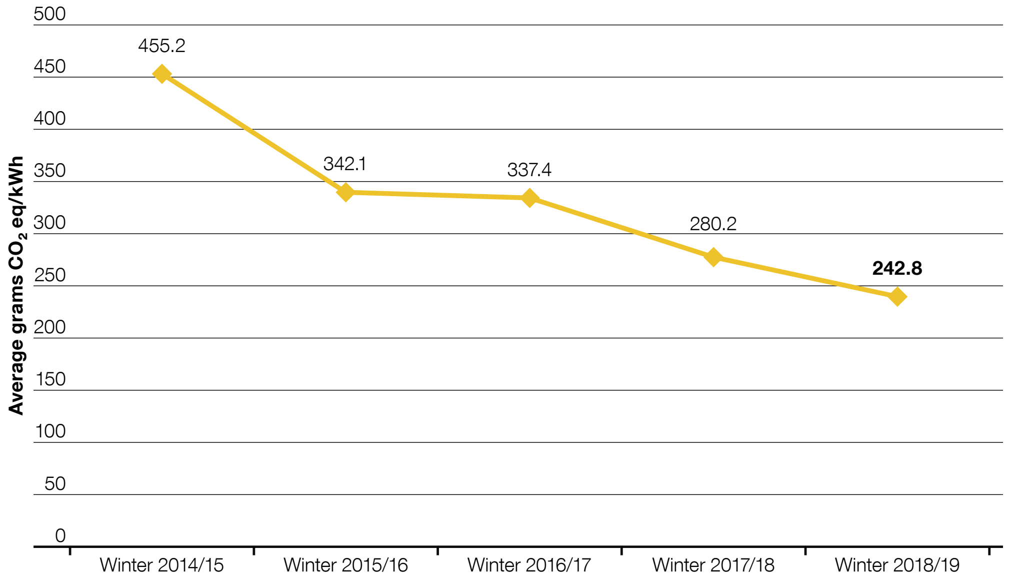
The cumulative effect of all of these factors was that the average carbon intensity of electricity reduced. Following a trend we have seen over the past 10 years, winter 2018/19 was the lowest average carbon intensity winter on record at 242.8 grams CO_2 equivalent/kWh, and almost 50% lower than five years ago (Figure 4.4).

242.8 grams

Lowest carbon intensity winter on record

Figure 4.4

Average carbon intensity of electricity, winter only, 2014/15 to 2018/19



More information, including our methodology for calculating carbon intensity of electricity, can be found at https://carbonintensity.org.uk

Operational commentary

Electricity

The winter of 2018/19 had milder weather and high output from renewables. Alongside this, there was reduced availability of nuclear plant (as units were awaiting regulatory approval) and reduced availability of the Western HVDC link for some of the winter.

The combination of these factors meant there was lower transmission demand, and a lower proportion of conventional plant on the system. Generation had to be constrained at times, particularly in September and October before the Western HVDC link was commissioned.

These factors also meant that there was lower inertia on the system, and a higher risk of a Rate of Change of Frequency (RoCoF) event (see next slide). This led to operational challenges, despite a healthy margin. Action had to be taken to reduce the largest infeed loss to manage RoCoF, and syncrohonous generation was brought onto the system to increase system inertia.

Some of these challenges were anticipated ahead of time when outages were announced and so, to best manage the risk to the system, maintenance work was brought forward so that it could be completed ahead of the winter season.

Consultation question

Increasing amounts of distributed generation, including distribution connected battery units, are having an operational impact on the transmission network. What information could industry provide to help the ESO manage this impact as efficiently as possible?

Operational commentary – RoCoF

Electricity

Figure 4.5
RoCoF limit Saturday 12 January 2019 – 670 MW

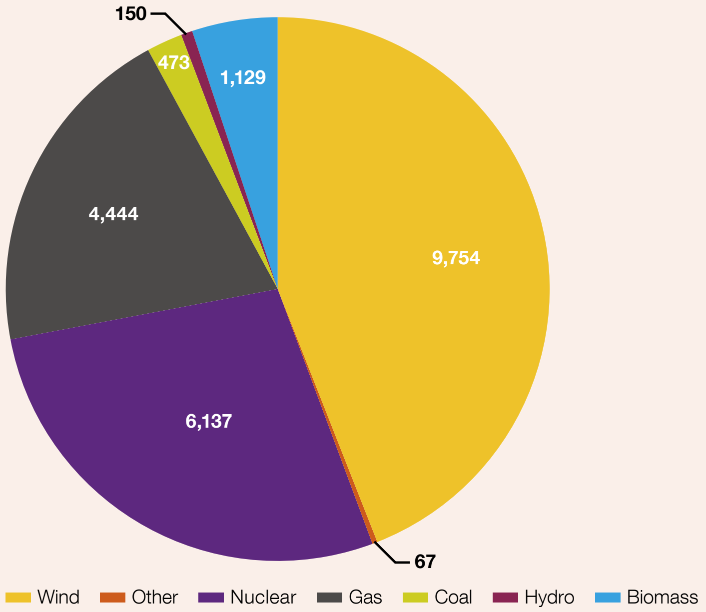
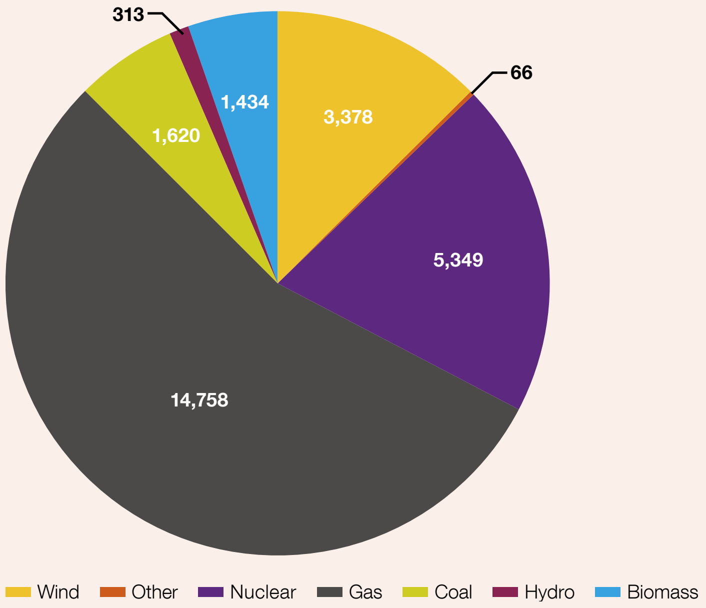


Figure 4.6
RoCoF limit Friday 18 January 2019 – 1,200 MW



- As shown above, RoCoF limit is strongly related to the amount of synchronous generation on the system.
- At 4am on 12 January 2019, there was 11 GW less synchronous generation and 6.3 GW more wind, compared with the 18th. Consequently, there was a very low RoCoF limit of 670 MW.
- To manage this, synchronous units were brought on to increase system inertia, and action was taken to reduce large infeed loss. Synchronising additional machines was required to keep the RoCoF limit above the infeed loss of nuclear generators.
- Six days later, with much less wind on the system and more synchronous generation, mainly gas, the RoCoF limit had almost doubled to 1,200 MW.

Spotlight
Suspension of the GB Capacity Market (CM), November 2018

The GB Capacity Market was suspended on 15 November 2018. Despite the suspension of CM payments, electricity supplies remained secure over the winter.

- Tempus Energy brought forward a legal challenge in December 2014 to contest the decision to grant the GB's Capacity Market (CM) with state aid approval, claiming that the design of the CM unfairly discriminated against demand side response projects.
- On 15 November 2018, the General Court of the European Union annulled the European Commission's approval of state aid for the GB Capacity Market. This decision was based on procedural grounds. It was not against the design of the Capacity Market itself. As a result, capacity payments were not made to GB capacity holders after 15 November 2018.
- However, electricity supplies remained secure over the winter of 2018/19, as plants chose to remain open despite the suspension of CM payments.
- National Grid ESO is working closely with BEIS and Ofgem to ensure that the Capacity Market can operate as fully as possible during the standstill period.
- In a recent BEIS consultation from 19 December 2018 to 10 January 2019, the majority of respondents supported the Government taking action to continue the operation of the Capacity Market during the standstill period to the greatest extent possible.
- Consequently a postponed T-1 auction for delivery year 2019/20, originally scheduled for January 2019, took place on 11-12 June 2019, with payments made upon EU approval. Further information can be found on the EMR website **https://www.emrdeliverybody.com/SitePages/Home.aspx**.

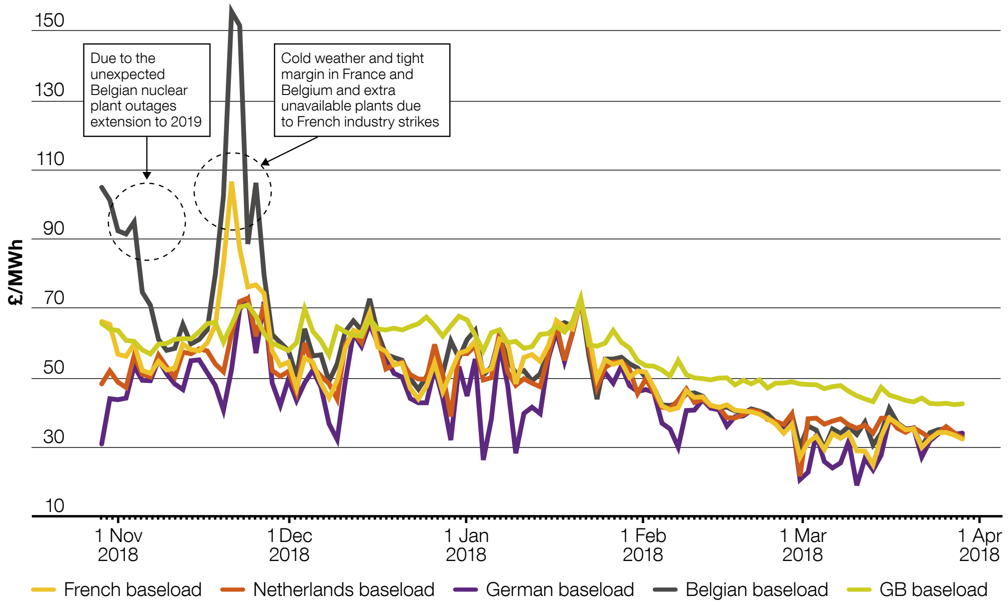
Europe and interconnected markets

Electricity

There are 5 interconnectors connecting the GB electricity market with the Netherlands, Belgium, France and Ireland. Flows on the interconnectors are driven by the electricity price differential between markets on either side of the interconnector.

What we said in *Winter Outlook*	What happened?	Reason for difference
There are no planned interconnector outages for winter 2018/19.	There were a few short outages on interconnectors, but only one outage (on the East West Interconnector (EWIC)) lasted more than 24 hours.	See additional information in the Data Workbook.
Forward prices for winter 2018/19 in Continental European markets are expected to be lower than in GB. However, a planned reduction in Belgian nuclear capacity in November could affect flows.	For most of winter 2018/19, forward prices in Continental Europe were lower than in GB. There were some limited exceptions, particularly in November 2019, in part due to Belgian nuclear outages.	Some price spikes occurred in Belgium due to nuclear plant outage extensions. Further price spikes occurred in France and Belgium during periods of cold weather/tight margin and French industrial action. (See Figure 4.7)
There is more French nuclear capacity available this winter than last winter, which should ease France's demand for imports in cold conditions.	Available French nuclear capacity in winter 18/19 was higher than or close to winter 17/18 for most of the winter, except in January 2019.	There were some prolonged nuclear outages in France – see further information in the Data Workbook.

Figure 4.7
GB and European baseload prices for winter 2018/19



Europe and interconnected markets

Electricity

What we said in *Winter Outlook*	What happened?
We expect a net flow of power from Continental Europe to GB at peak times, occasionally not at full import.	Peak flows were as expected – see Figure 4.8.
We expect GB to export to Ireland during peak times on both the Moyle and EWIC interconnectors. This may be reversed to import with high wind output in Ireland or during periods of system stress.	As expected, both the Moyle and EWIC interconnectors exported electricity to Ireland at peak times, for the majority of the winter.

Figure 4.8
IFA, BritNed and Nemo Link flows at peak

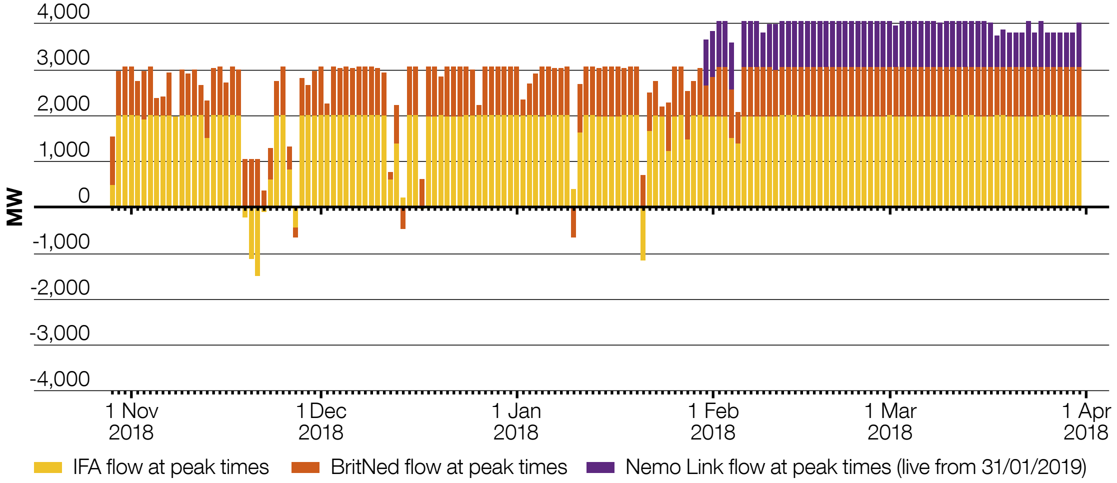
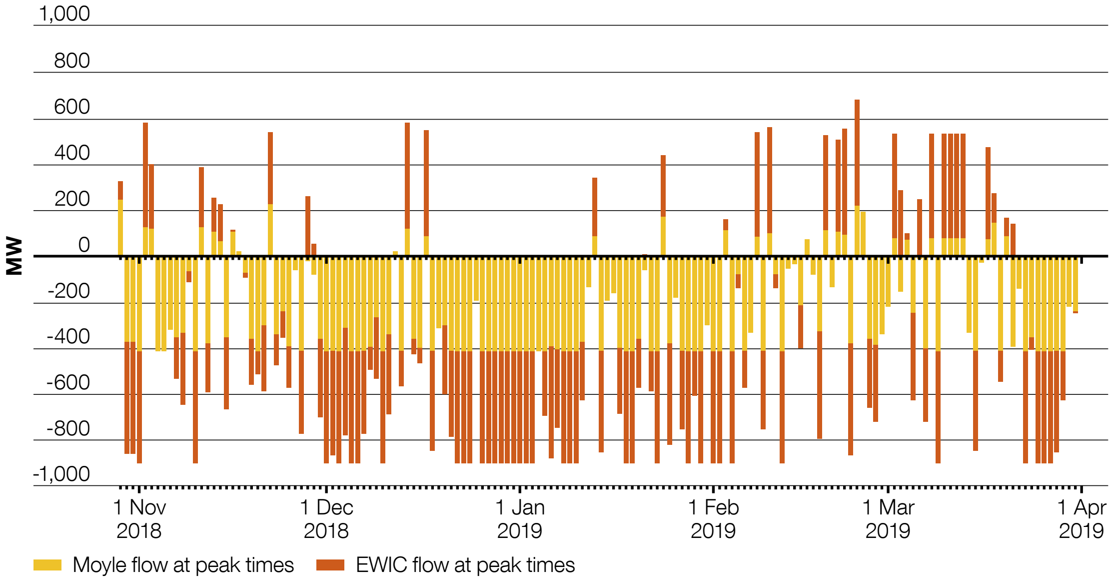


Figure 4.9
GB and Ireland peak flows for winter 2018/19



Electricity consultation questions

Now, tell us what you think...

Triad avoidance

Q11

Did you or your customers participate in Triad avoidance over the winter of 2018/19, and what were your primary reasons for doing so? Do you think that the peak level of Triad avoidance will increase or decrease in winter 2019/20, and what do you think will be the reason for this change?

Q11... Type your answer here

General

Q12

Increasing amounts of distributed generation, including distribution connected battery units, are having operational impact on the transmission network. What information could industry provide to help the ESO manage this impact as efficiently as possible?

Q12... Type your answer here

General

Q13

Do you have any other comments in relation to electricity demand and supply and related issues ahead of winter 2019/20?

Q13... Type your answer here

Send your completed consultation response to: marketoutlook@nationalgridso.com

5 Gas

This chapter sets out how gas supply and demand in winter 2018/19 compared to our forecast.

Demand and supply overview

Gas

Key messages

1

There were no significant events during winter 2018/19 that adversely affected gas supply and demand; largely due to mild winter weather.

2

Gas demand was lower in winter 2018/19 than in winter 2017/18, but not as low as our forecast, due to slightly higher gas demand for electricity generation than anticipated. This was as a result of low gas prices driving a preference for gas over coal for electricity generation.

3

Winter 2018/19 included the highest day for gas demand for electricity generation on record at 97.2 mcm.

4

A variety of sources met gas demand including higher supplies of LNG than forecast due to market changes. EU imports reduced further than forecast due to the LNG increase.

[1] Total demand includes shrinkage (0.3 bcm). Differences in bcm figures for supply and demand are due to boil off from Grain going directly into the South East local distribution network.

Table 5.1
Gas demand for winter 2017/18 and 2018/19

	Winter 2017/18		Winter 2018/19		
Demand in bcm	**2017/18 Actual demand**	**2017/18 Weather corrected demand**	**2018/19 Forecast**	**Actual demand**	**Weather corrected demand**
NDM	32.0	30.6	29.8	28.9	30.2
DM + Industrial	4.8	4.8	4.8	4.3	4.4
Ireland	1.8	1.8	1.8	2.1	2.1
Total for electricity generation	12.8	12.8	7.0	12.4	12.4
IUK export	0.7	0.7	0.6	0.0	0.0
Storage injection	2.3	2.3	2.3	1.5	1.5
Total demand[1]	**54.7**	**53.3**	**46.6**	**49.6**	**50.9**

Table 5.2
Gas supply for winter 2017/18 and 2018/19 (not weather corrected)

	2017/18 bcm	2018/19 bcm
Supply in bcm	**Actual supply**	**Actual supply**
UKCS	19.7	18.6
Norway	21.0	18.6
BBL	3.1	2.0
IUK	4.7	0.3
LNG	1.8	7.8
Storage	3.8	1.9
GB total	**54.1**	**49.2**

Non-daily metered demand (NDM)

Gas

The NDM component of overall demand was below the seasonal normal as shown in Figure 5.1 due to the mild winter weather with 2018/19 being the 5th warmest winter in the past 59 years. The actual demand versus the seasonal normal CWV profile for the winter period is shown in Figure 5.2.

The 31 January and 1 February 2019 were the coldest days of the winter with the highest LDZ demand seen on 31 January, when LDZ demand peaked at 289 mcm/d and total demand reached 400.8 mcm/d.

What we said in *Winter Outlook*	What actually happened
We forecast NDM demand to be 29.8 bcm (i.e. reasonably close to weather corrected demand for winter 2017/18 which was 30.6).	Our forecast was broadly accurate. Weather corrected demand was 30.2 bcm.

Figure 5.1
NDM demand for winter 2018/19 in relation to seasonal normal

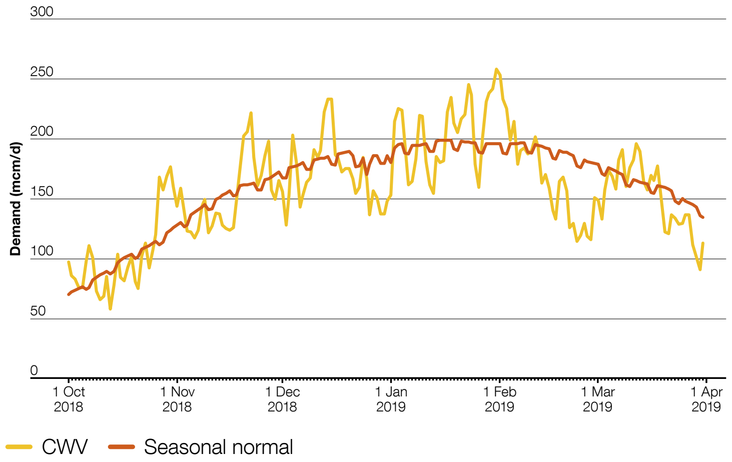
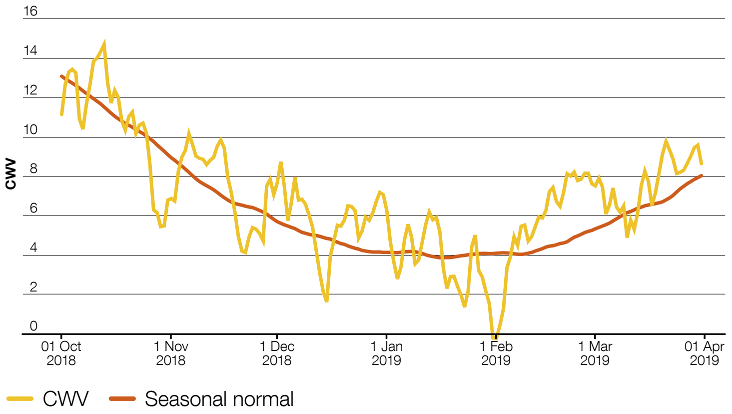


Figure 5.2
CWV for winter 2018/19 in relation to seasonal normal



Demand for electricity generation

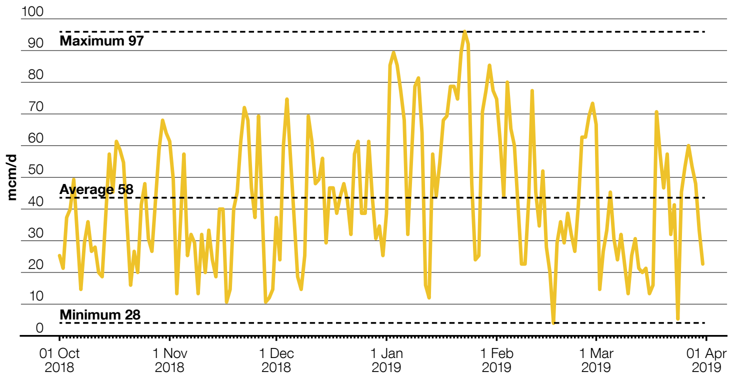
Gas

Gas demand for electricity generation was higher than forecast and included the highest day for gas demand for electricity generation on record at 97.2 mcm.

Although a growth in renewables reduced overall demand for gas for electricity generation, gas prices were lower than expected and resulted in a significant increase in gas fired generation instead of our forecast for higher use of coal (Figure 5.3). Our whole energy system case study explores this interaction in more detail.

What we said in *Winter Outlook*	What actually happened	Why was there a difference?
We forecast that gas used for electricity generation would fall considerably to 7 bcm based on an increase in renewable generation and an expectation that coal fired generation would be cheaper to run.	Actual gas used for electricity generation was 12.8 bcm.	Our forecast analysis was done in September 2018 when the gas prices trend was increasing (see Figure 5.3). The reduction in gas prices was linked to the changing global market for LNG as well as supply, demand and storage interaction in Europe.

Figure 5.3
NTS connected power station demand



Liquefied natural gas (LNG)

Gas

LNG flow far exceeded expectations flowing at all three UK terminals due to market changes (Figure 5.4). This was different to winter 2017/19 when most of the LNG flow was from South Hook (Figure 5.5).

The high flow of LNG into the UK also impacted interconnector gas demand with flows through Interconnector (UK) Limited (IUK) and BBL reduced compared to winter 2017/18.

What we said in *Winter Outlook*	What actually happened	Why was there a difference?
We are not expecting LNG flow to be high on many days this winter.	LNG supply for 2018/19 was 7.8 bcm, in comparison with 1.8 bcm in 2017/18.	LNG deliveries are highly sensitive to the world market. Production capacity is also growing rapidly. In early winter, gas prices in Asia began to fall and shipping costs increased. This resulted in more LNG being brought into Europe, driving competition in the market and making LNG an attractive option for supply in GB.

Figure 5.4
LNG flow 2018/19

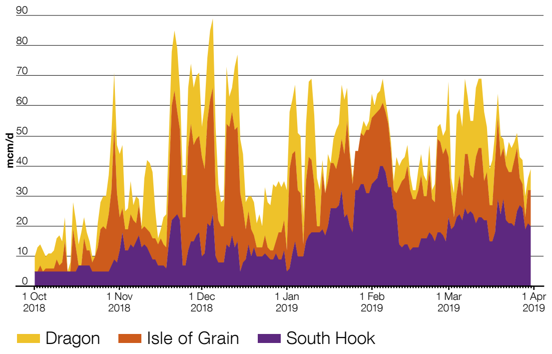
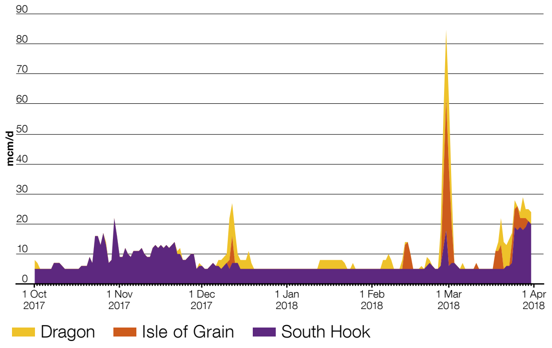


Figure 5.5
LNG flow 2017/18



Consultation questions

Are there any factors that may impact trends in LNG production, supply or prices that may specifically affect winter 2019/20?

Did you expect to see such high flows of LNG last winter?

Why was it so challenging to forecast LNG supply last winter?

Do you expect the high flows of LNG to continue in winter 2019/20?

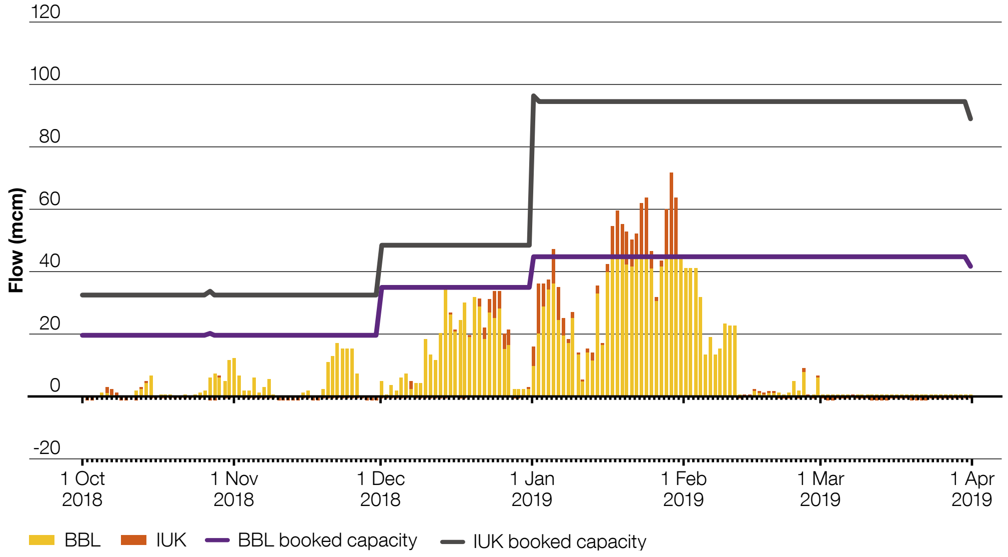
EU interconnectors
Gas

Overall gas interconnector import was much lower than the previous winter as a result of increased availability of LNG. Flows through the winter were predominantly through BBL, IUK flows were lower as forecast.

What we said in *Winter Outlook*	What actually happened	Why was there a difference?
Average flows from IUK are expected to be lower due to the expiry of long-term contracts. As a result, deliveries from BBL may be higher.	Total EU interconnector import was 2.3bcm, much lower than the previous winter (7.8bcm).	Increased LNG deliveries reduced the need for gas delivered through both IUK and BBL. The end of the long-term contracts at IUK and a revised charging structure at IUK meant that flows through BBL were cheaper, and consequently higher than through IUK.

Capacity bookings
By January 2019, capacity bookings had reached the maximum physical capacity (45mcm/d). At times during January and February, BBL flowed up to the maximum booked capacity. IUK capacity bookings were high for the first quarter of 2019, but flows into GB were lower than previous years, mostly only picking up when BBL flows reached booked capacity.

Figure 5.6
Interconnector flows and booked capacity for winter 2018/19



Consultation questions

Is there anything that could impact European supply or demand that may affect interconnector flows to and from GB over winter 2019/20?

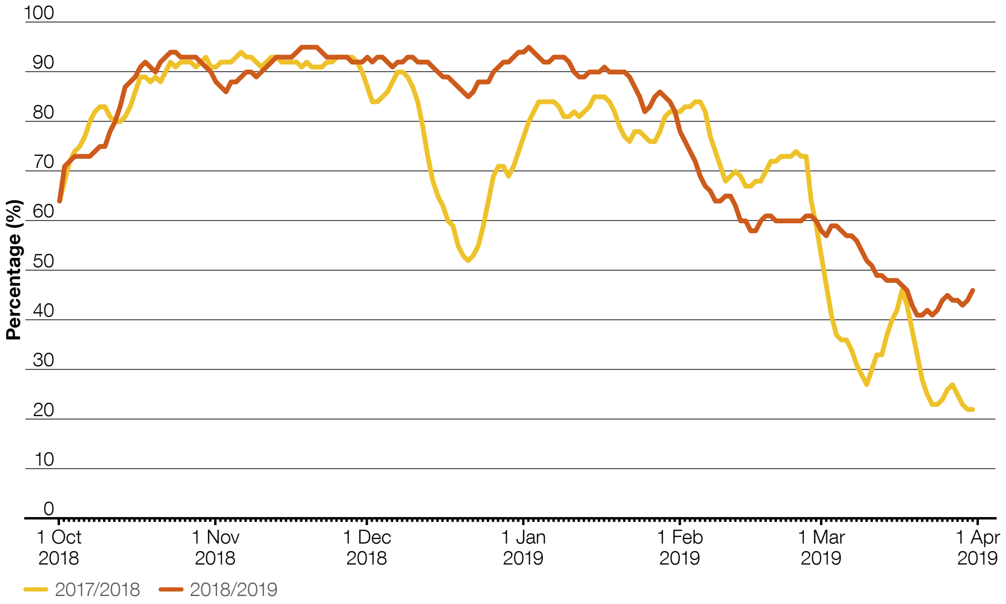
How do you think IUK and BBL flows will change as a result of bi-directional capability at BBL?

Storage
Gas

Cycling of gas in and out of medium-range storage (MRS) was much lower than last winter. This was different to our forecast due to milder weather and high availability of LNG supply which provided much of the flexibility of supply required. Overall storage levels were much higher and steadier throughout the winter than in 2017/18 (Figure 3.7).

What we said in *Winter Outlook*	What actually happened	Why was there a difference?
We expect the trend of increased medium-range storage (MRS) injection and withdrawal to continue.	In winter 2018/19, 1.9 bcm of gas was withdrawn from storage, far less than winter 2017/18 (3.8 bcm). Injection levels were also lower at 1.5 bcm as opposed to 2.3 bcm in 2017/18.	The high availability of LNG supply and mild winter weather reduced the reliance on MRS.

Figure 5.7
Gas in medium-range storage 2018/19 (percentage full)



Storage is an important component of gas supply and, like LNG and interconnectors, provides flexibility to the market.

System operability
Gas

This section looks at the day-to-day supply and demand variability over winter 2018/19 and the impact on the operational management of the system, including linepack and compressor running hours.

Key messages

- There were no significant events during winter 2018/19 that caused major operability challenges.
- The increased interaction of the gas and electricity systems seen in the high demand for gas fired generation required more proactive measures and operational flexibility to set the NTS up for day-to-day variability.
- The diversity of the supply mix, for instance the increase in LNG, also meant different operating strategies were required which ultimately resulted in lower compressor hours.

Figure 5.8
Variability of gas demand components 2018/19

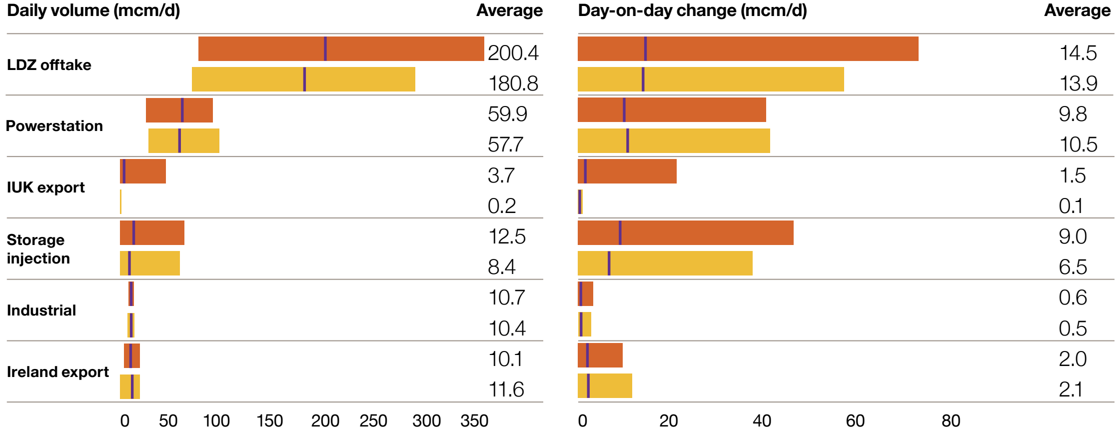
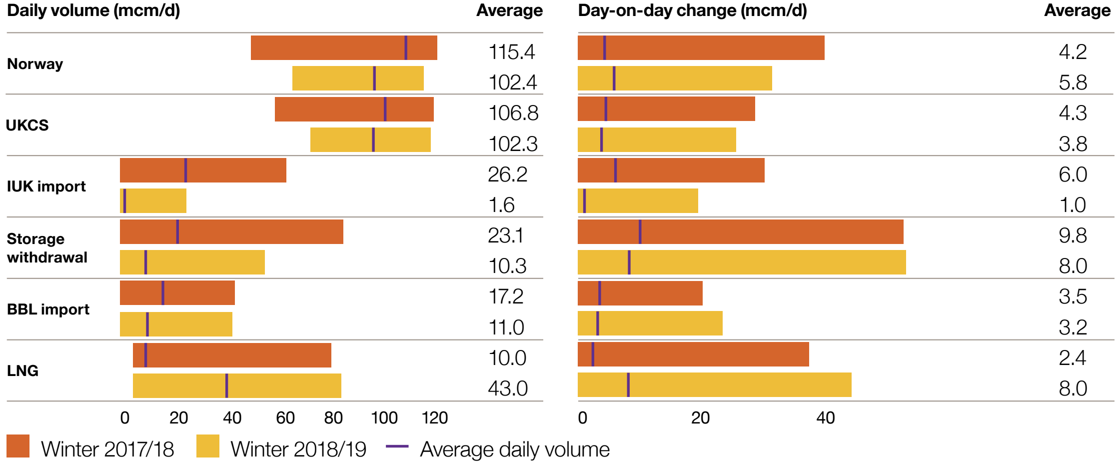


Figure 5.9
Variability of gas supply components 2018/19



NTS linepack and compressor running hours

Gas

Linepack swing

The highest linepack swing in 2018/19 was 33 mcm, lower than 2017/18, largely due to milder winter weather. This was the third highest on record.

Compressor running hours

In winter 2018/19, compressor running hours were lower than the previous five years (Figure 5.11).

Figure 5.10
Linepack swing trend from 2001/02 to 2018/19

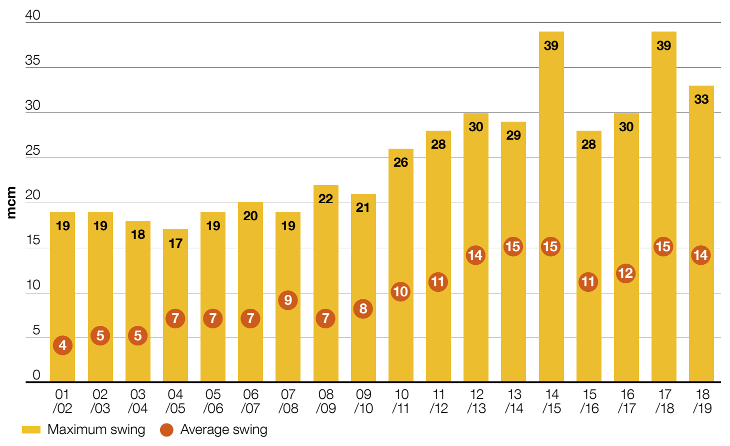
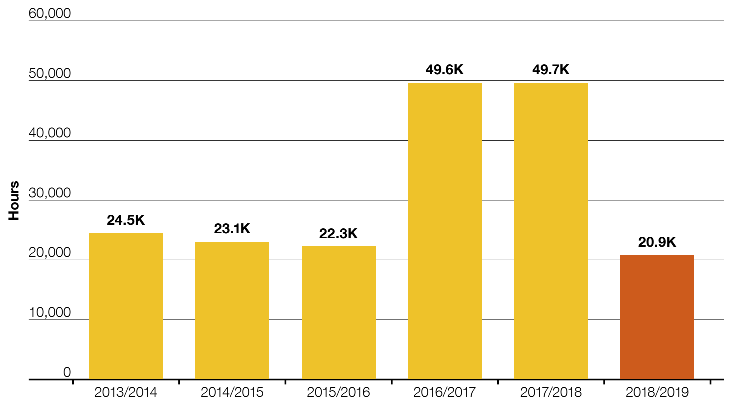


Figure 5.11
Compressor running hours trend from 2013/14 to 2018/19



Margins Notice and Gas Deficit Warning (GDW) Review – Gas

Currently, we have two main tools to provide notice to GB gas market participants of a possible imbalance between gas demand and supply:

- Margins Notice
- Gas Deficit Warning

On 1 March 2018, we issued our first ever Gas Deficit Warning in response to coincident events involving cold weather, high gas demand, and supply failures. The notification had its desired effect on this day as the risk of an end-of-day system imbalance was addressed.

However, as this was the first time we had issued a Gas Deficit Warning, we considered that the time was right to review these notification arrangements with the industry, share learnings from operational experience on 1 March 2018 and improve the arrangements for the future.

We are currently considering how future Margins Notice arrangements could be more transparent, to help the industry better understand how the Margins Notice trigger level is calculated, as well as improved presentation and publication on the Gas System Operator website. Our intention is to implement the changes for this winter.

An additional Active Notification System (ANS) update to inform the market when we are within a specified percentage of the Margins Notice trigger level could also highlight when closer monitoring of margins and balancing would be beneficial.

Further information on the ongoing development of the Margins Notice can be found at **http://gasgovernance.co.uk/index.php/0669**

We have also raised a modification to change the name of the Gas Deficit Warning to the Gas Balancing Notification[2]. **Why?** We believe the proposed new name is more representative of the purpose of the notification, which is to provide a message to GB market participants to supply more gas or reduce demand and does not necessarily mean that there is a gas shortage.

Further information on the change of name from Gas Deficit Warning to Gas Balancing Notification, this can be found at: **http://gasgovernance.co.uk/index.php/0685**

? Consultation questions

Since implementation in 2012, we have not issued a Margins Notice. With the development of a new methodology, what is your view on the optimum number of Margins Notices per winter?

Alternatively, would you find it more helpful for us to show a changing percentage or graph of the Margins Notice on the Gas System Operator website?

Is there anything else we could do that would help you prepare for a change to the notification arrangements for the forthcoming winter?

[2] http://gasgovernance.co.uk/index.php/0685

Gas consultation questions

Now, tell us what you think...

LNG

Q14
Are there any factors that may impact trends in LNG production, supply or prices that may specifically affect winter 2019/20?

Did you expect to see such high flows of LNG last winter?

Why was it so challenging to forecast LNG supply last winter?

Do you expect the high flows of LNG to continue in winter 2019/20?

Q14... Type your answer here

EU gas interconnectors

Q15
Is there anything that could impact European supply or demand that may affect interconnector flows to and from GB over winter 2019/20?

How do you think IUK and BBL flows will change as a result of bi-directional capability at BBL?

Q15... Type your answer here

Margins Notice

Q16
Since implementation in 2012, we have not issued a Margins Notice. With the development of a new methodology, what is your view on the optimum number of Margins Notices per winter?

Alternatively, would you find it more helpful for us to show a changing percentage or graph of the Margins Notice on the Gas System Operator website?

Is there anything else we could do that would help you prepare for a change to the notification arrangements for the forthcoming winter?

Q16... Type your answer here

General

Q17
Do you have any other comments in relation to gas demand and supply ahead of winter 2019/20?

Q14... Type your answer here

Send your completed consultation response to: marketoutlook@nationalgridso.com

6 Consultation summary

This section is an overview of all consultation questions and ways to respond to us. Editable sections can be found throughout the document.

All consultation questions

Editable sections through the document

Winter Review and Consultation

Q1
What do you use the *Winter Review and Consultation* document for? What information in the report is the most useful to you for this?

Q2
Is there anything else that could be included in the *Winter Review and Consultation*?

Q3
How do you think the *Winter Review and Consultation* could be improved to increase benefit for consumers?

Q4
Do you have any other feedback on the new format of this report and the 2018/19 *Summer Outlook*[1] Report?

Winter Outlook Report

Q5
Is there anything different you would like to see in the 2019/20 *Winter Outlook* Report which will be published in October?

General

Q6
Is there anything you would like to share with us on your preparations for changes to the energy trading environment over the forthcoming winter period?

Q7
Do you have any other feedback on this report or our other Outlook documents?

Whole energy system

Q8
What information could we provide in our 2019/20 *Winter Outlook* Report that would help to increase shared understanding on whole energy system interactions?

Q9
In this section, we stated gas demand figures in new units (GWh and TWh rather than bcm and mcm) and directly compared gas and electricity demands. Is this something that would be useful to include in future *Winter* and *Summer Outlook* Reports?

- If so, why is this helpful?

Q10
Are there any other gas or electricity metrics that you could suggest that should be included?

- If so, why are these new metrics useful?

Triad avoidance (Electricity)

Q11
Did you or your customers participate in Triad avoidance over the winter of 2018/19, and what were your primary reasons for doing so? Do you think that the peak level of Triad avoidance will increase or decrease in winter 2019/20, and what do you think will be the reason for this change?

[1] https://www.nationalgrideso.com/insights/summer-outlook

All consultation questions
Editable sections through the document

Now, tell us what you think...

General (Electricity)

Q12
Increasing amounts of distributed generation, including distribution connected battery units, are having operational impact on the transmission network. What information could industry provide to help the ESO manage this impact as efficiently as possible?

Q13
Do you have any other comments in relation to electricity demand and supply and related issues ahead of winter 2019/20?

LNG (Gas)

Q14
Are there any factors that may impact trends in LNG production, supply or prices that may specifically affect winter 2019/20?

Did you expect to see such high flows of LNG last winter?

Why was it so challenging to forecast LNG supply last winter?

Do you expect the high flows of LNG to continue in winter 2019/20?

EU gas interconnectors (Gas)

Q15
Is there anything that could impact European supply or demand that may affect interconnector flows to and from GB over winter 2019/20?

How do you think IUK and BBL flows will change as a result of bi-directional capability at BBL?

Margins Notice (Gas)

Q16
Since implementation in 2012, we have not issued a Margins Notice. With the development of a new methodology, what is your view on the optimum number of Margins Notices per winter?

Alternatively, would you find it more helpful for us to show a changing percentage or graph of the Margins Notice on the Gas System Operator website? Is there anything else we could do that would help you prepare for a change to the notification arrangements for the forthcoming winter?

General (Gas)

Q17
Do you have any other comments in relation to gas demand and supply ahead of winter 2019/20?

Send your completed consultation response to: marketoutlook@nationalgridso.com

Glossary

Throughout this document, there are terms highlighted in purple that are explained in more detail here.

Active Notification System (ANS)
A system for sharing short notifications with the industry via text message or email.

BBL
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)
Unit of volume used in the gas industry. 1 bcm = 1,000,000,000 cubic metres.

Breakdown rates
A calculated value to account for unexpected generator unit breakdowns, restrictions or losses. Forecast breakdown rates are applied to the operational data provided to the ESO by generators. They account for restrictions and unplanned generator breakdowns or losses close to real time. Rates are based on how generators performed on average by fuel type during peak demand periods (7am to 7pm) over the last 3 winters.

BritNed
BritNed Development Limited is a joint venture between 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**

Capacity Market (CM)
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.

Carbon intensity
A way of examining how much carbon dioxide is emitted in different processes. It is usually expressed as the amount of carbon dioxide emitted per kilometre travelled, per unit of heat created or per kilowatt hour of electricity produced.

Clean dark spread
The revenue that a coal fired generation plant receives from selling electricity once fuel and carbon costs have been accounted for.

Clean spark spread
The revenue that a gas fired generation plant receives from selling electricity once fuel and carbon costs have been accounted for.

CMP264/265
Changes to the Charging and Use of System Code (CUSC). These changes were phased in from 1 April 2018, and reduce the value of avoided network charges over Triad periods.

CO_2 equivalent/kWh
The units ‘gCO_2eq/kWh’ are grams of carbon dioxide equivalent per kilowatt-hour of electricity generated. Carbon dioxide is the most significant greenhouse gas (GHG).

GHGs other than carbon dioxide, such as methane, are quantified as equivalent amounts of carbon dioxide. This is done by calculating their global warming potential relative to carbon dioxide over a specified timescale, usually 100 years.

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.

Composite Weather Variable (CWV)
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
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.

Distribution connected
Any generation or storage 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, wind generation and battery units. Generation that is connected to the distribution system is not usually directly visible to National Grid as the system operator and acts to reduce demand on the transmission system.

Glossary

East West Interconnector (EWIC)
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/**

European Union Emissions Trading System (EU ETS)
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.

Gas Deficit Warning
Issued if there is a more serious supply and demand imbalance leading to a material risk to the end of day balance on the National Transmission System.

Gas interconnectors
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.

GW
Gigawatt (GW) is a measure of power. 1 GW = 1,000,000,000 watts.

Interconnexion France–Angleterre (IFA)
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).

Interconnector (elec)
Electricity interconnectors are transmission assets that connect the GB market to Continental Europe. They allow suppliers to trade electricity between these markets.

Interconnector (UK) Limited (IUK)
A bi-directional gas pipeline between Bacton in the UK and Zeebrugge in Belgium. You can find out more at **www.interconnector.com**

Linepack
The volume of gas within the National Transmission System (NTS) pipelines at any time.

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.

Liquefied natural gas (LNG)
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/**

Load factors
Load factors are an indication of how much a generation plant or technology type has output across the year, expressed as a percentage of maximum possible generation. These are calculated by dividing the total electricity output across the year by the maximum possible generation for each plant or technology type.

Local distribution zone (LDZ) demand
Refers to the total amount of gas used by gas consumers connected to the distribution networks.

Margins Notice
Issued if forecast demand for the day ahead exceeds a pre-defined forecast of supply.

Million cubic metres (mcm)
Unit of volume used in the gas industry. 1 mcm = 1,000,000 cubic metres.

Moyle
A 500 MW bi-directional interconnector between Northern Ireland and Scotland. You can find out more at **www.mutual-energy.com**

Medium-range storage (MRS)
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.

National balancing point (NBP)
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**

National Transmission System (NTS)
A high-pressure gas transportation system consisting of compressor stations, pipelines, multi-junction sites and offtakes. Pipelines transport gas from terminals to offtakes and are designed to operate up to pressures of 94 barg.

Glossary

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.

Nemo Link
The Nemo Link is an HVDC sub-sea link between GB and Belgium.

Open cycle gas turbine (OCGT)
Gas turbines in which air is first compressed in the compressor element before fuel is injected and burned in the combustor.

Price trends
Gas demand for electricity generation is highly sensitive to price trends. The carbon tax (Carbon Price Floor) means it is expensive to burn coal. Permits for fuel burning are managed under the EU ETS. When gas prices are particularly high, the power generation merit order may swap to coal due the relative costs of burning the fuels.

Rate of Change of Frequency (RoCoF)
How quickly system frequency changes on the electricity network. Usually measured in Hertz per second. Some generators have a protection system that will disconnect them from the network if the Rate of Change of Frequency goes above a certain threshold.

RoCoF limit
The maximum loss we can allow on the system. A loss of generation larger than this limit has a high risk of resulting in a RoCoF of 0.125Hz/s.

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.

Seasonal normal demand
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.

Transmission system demand (TSD)
Demand that National Grid, as the system operator, sees at grid supply points, which are the connections to the distribution networks.

Triad avoidance
When demand side customers reduce the amount of energy they draw from the transmission network, either by switching to distribution generation sources, using on-site generation or reducing their energy consumption. We observe this behaviour as a reduction in transmission demand. This is sometimes referred to as customer demand management, but in this section we are considering customer behaviour that occurs close to anticipated Triad periods, usually to reduce exposure to peak time charges.

Triads
The three half-hourly settlement periods with the highest electricity transmission 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. Typically they take place on weekdays around 4.30 to 6pm.

Underlying peak demand
Demand varies from day-to-day, depending on the weather and the day of week. Underlying demand is a measure of how much demand there is once the effects of the weather and the day of the week have been removed.

Weather corrected demand (elec)
Weather corrected demand (electricity) The demand expected or out turned with the impact of the weather removed. A 30-year average of each 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 period
The winter period is defined as 1 October to 31 March.

Within-day
Defined as any operation that takes place during the ‘gas day’ (5am to 4:59am).

Figure glossary

Figure 3.3
While gas demand from power generation is a smaller relative component of gas demand in winter than in summer, the wind output in winter is much higher than in summer and so the flexibility requirement in absolute terms is higher. Output from gas fired generation mirrors the output from renewable generation, increasing when renewable output decreases and vice versa. This means the gas demand to these sites is more variable as they respond to different output requirements.

Figure 3.6
To balance the system, there was a 28% reduction in supply from interconnectors; from 50 mcm on 24 January to 36 mcm on 25 January.

Figure 4.1
Total electricity demand, 1 Oct to 31 Mar 2018/19. National demand actual 141.5 TWh/National demand weather corrected 142.0 TWh. Transmission system demand (inc net imports and exports).

Figure 4.2
Triad dates are not perfectly aligned with colder spells. This is because electricity demand is less sensitive to temperature (less electricity used for heating), and also the effect of distributed wind ‘netting off’ transmission demand on windy days (which may or may not be cold days). Similarly to gas, if cold weather falls on a weekend, total demand is less.

Figure 5.1
NDM demand is mainly used for heating and so is very sensitive to the effects of weather. To analyse the effect of weather on gas demand we combine temperature, wind speed and other factors into a single value called the Composite Weather Variable (CWV).

Figure 5.3
Actual gas demand for electricity generation may be higher once demand from embedded generators in the LDZ is taken into account.

Figure 5.10
Third highest swing in the last 18 years, reflecting the long-term trend for a widening spread with peaks increasing, showing that system pressure variability is not just a feature of challenging weather.

Figure 5.11
Prior to winter 18/19, we had begun to see an increase in compressor usage. This winter’s decrease was driven predominantly by the high levels of LNG supply at geographically separated locations resulting in less reliance on compression, rather than a reduction in variability of overall gas demand.

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