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Electricity security of supply

A commentary on National Grid's Future Energy Scenarios for the next three winters

Report

Publication date: 17 July 2015

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Overview

This document is Ofgem's commentary on the first three winters of National Grid's Future Energy Scenarios for electricity security of supply. Our assessment is based on data from National Grid accompanied by our own analysis.

For winter 2015/16, National Grid has procured additional balancing services that it can use to help it balance the system if margins tighten. These services will effectively ensure that the risks to the electricity security of supply reduce to meet the government's reliability standard.

Uncertainty around the outlook for winter 2016/17 has increased. Margins could tighten if further power stations close or mothball. However, we have identified a significant potential for the market to respond positively and reduce the risks to security of supply. The outlook is then expected to improve in the final winter of our analysis due to plant returning to the market.

Context

Ofgem's principal objective is to protect the interests of existing and future energy consumers. This includes their interests in reducing greenhouse gases and in secure supplies of electricity and gas. In this document the Gas and Electricity Markets Authority is referred to as "the Authority" or as "Ofgem".

In each of the past three years we have produced, and published, a Capacity Assessment (CA) report. This fulfilled the Authority's obligation to provide the Secretary of State with an annual report assessing the risks to the security of Great Britain's (GB) electricity supply. The report was intended to inform government and Ofgem decisions on electricity security of supply.

The Department of Energy and Climate Change (DECC) has removed this obligation from 2015 onwards following its decision to introduce a Capacity Market (CM), which obligates National Grid to produce an Electricity Capacity Report each year. As part of our monitoring role of the market and to inform policy decisions, we have continued to undertake the analysis for the short- to medium-term outlook.

We have therefore chosen to publish our commentary of National Grid's Future Energy Scenarios (FES) for the next three winters, highlighting the analysis we have carried out in this area. Its main purpose is to provide the market with an independent assessment of the risks to security of supply.

Associated documents

Past Electricity Capacity Assessment documents can be found on:
www.ofgem.gov.uk//electricity/wholesale-market/electricity-security-supply

The most recent reports on electricity security of supply can be found below:

Electricity Capacity Assessment Report 2014:
www.ofgem.gov.uk/sites/default/files/docs/2014/06/electricity_capacity_assessment_2014_-_full_report_final_for_publication.pdf

Electricity Capacity Assessment Report 2013:
www.ofgem.gov.uk/ofgem-publications/75232/electricity-capacity-assessment-report-2013.pdf

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Executive Summary

This report sets out Ofgem's commentary on the first three winters of National Grid's Future Energy Scenarios (FES) for electricity security of supply.[1] It assesses Britain's supply outlook from 2015/16 to 2017/18. We agree with National Grid's assessment that margins this winter could be tighter than seen in previous years and that there is wide range of uncertainty over the outlook, particularly for 2016/17. While National Grid has tools in place to manage the system this winter and it is prudent for them to consider what they might need for 2016/17, our assessment is that there is potential for the risks to be managed by either a strong market response or a continued reduction in demand.

Since our first Capacity Assessment in 2012, we have projected increasing security of supply risks for the middle of this decade. To mitigate the risks, in 2013 Ofgem approved the Supplemental Balancing Reserve (SBR) and Demand Side Balancing Reserve (DSBR) as extra tools that National Grid could use to help balance the system if the margins tighten. Following the procurement of these services by National Grid,[2] the risks to security of supply for 2015/16 have been effectively brought within the level implied by the government's reliability standard.[3]

There is a wider range of uncertainty over the outlook for 2016/17. Margins could tighten relative to our Capacity Assessment 2014 if there are further plant closures. However, our analysis highlights that there is also significant potential for the market to respond positively, bringing the risks to security of supply within the government's reliability standard. National Grid is consulting with industry on the option of extending the SBR and DSBR services so they could be used beyond winter 2015/16 when they are due to expire.[4] We expect a reduction of the risks for 2017/18, mainly due to plant returning to the market - our outlook for 2017/18 is broadly consistent with the risks presented in our Capacity Assessment 2014.

How we measure the security of supply outlook

This report is based on National Grid's FES and provides a comprehensive assessment of the outlook to security of supply over the next three winters. Further analysis of the near-term outlook is particularly important given that the FES are not aimed at assessing security of supply alone, but are designed primarily to provide a range of scenarios for National Grid to use in planning for the long-term.

We use sensitivity analysis[5] to assess additional uncertainties to those already considered within National Grid's FES. Our results form our view of the credible range of risks, which includes the range of risks associated with National Grid's FES and additional outcomes resulting from our sensitivity analysis.

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[1] National Grid has developed four scenarios for their FES 2015; we describe these briefly in Chapter 2 of this report. The FES 2015 document is available here: fes.nationalgrid.com.

[2] National Grid has procured 2.56 GW of SBR and DSBR services following the approval of the volume methodology and sensitivities to be used for their assessment by Ofgem. For more information, see: www.ofgem.gov.uk/ofgem-publications/95092/authoritydecisiononnbssensitivities-pdf.

[3] The reliability standard is set at 3 hours loss of load expectation per year.

[4] National Grid's consultation is available here: www2.nationalgrid.com/UK/Services/Balancing-services/System-security/Contingency-balancing-reserve/.

[5] These include the level of demand, commercial decisions of generators, conventional generator availabilities and interconnector flows among others.

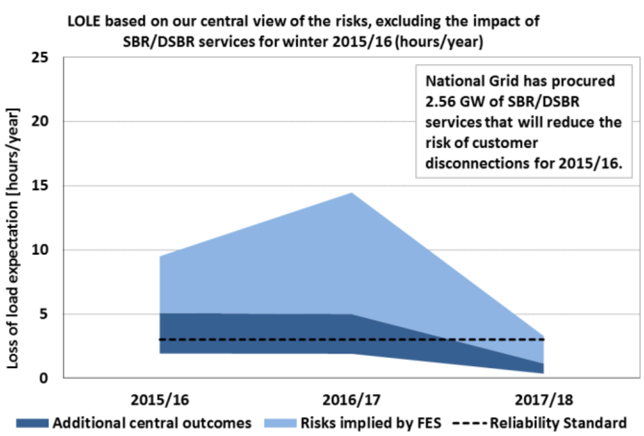
As in previous years, we use several metrics for assessing the risks to security of supply. These are: loss of load expectation (LOLE); de-rated margins; and the risk of customer disconnections.[6] The first two metrics do not directly represent the risk of customers being disconnected.

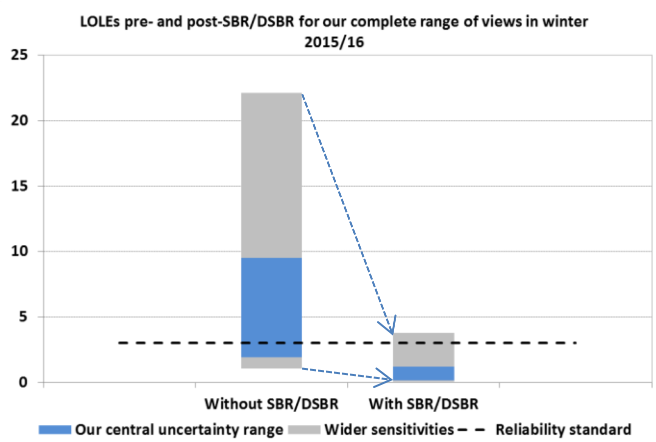
We use the measure of LOLE as the key metric when assessing security of electricity supply. This is the average number of hours in a year when we expect that there will be insufficient supply available in the market, and National Grid may need to take action that goes beyond the normal market operations to balance the system. As the electricity system operator, National Grid has a number of tools it can use to balance supply and demand including, this coming winter, the SBR and DSBR services.[7] Controlled disconnections of customers would only take place if a large supply deficit were to occur and only after these tools had been exhausted.

Our results

In our Capacity Assessment 2014, we identified that the risks to security of supply were increasing up to 2015/16 as a result of plant closures. Since we published our 2014 report, more plant have exited or announced their intention to exit the market permanently or temporarily. This has been partly offset by a reduction in peak demand at the national transmission network level since last year: National Grid believes this is mainly due to increased contribution from embedded generation (seen as negative demand by National Grid at the transmission level).

The graphs below present our views of the risks to security of supply over the next three winters. The left hand graph (total blue range) shows our central view (ie the outcomes we consider most likely) of the expected level of security to be delivered by the normal market alone. The light blue range indicates the risks implied by the FES (which fall within our central view of risks), and the dark blue range indicates our view of the risks associated with other central outcomes. The right hand graph shows how the SBR and DSBR National Grid has procured for this winter have brought the risks to security of supply within the government's reliability standard (3 hours LOLE) for a wide range of credible outcomes.[8]





[6] We do not present the de-rated margins and risk of customer disconnections in the Executive Summary. We present the results for both metrics in Chapter 2.

[7] These would only be used after all normal market options had been utilised. For more information on the tools available to National Grid to balance the system see our infographic: www.ofgem.gov.uk/electricity/wholesale-market/electricity-security-supply.

[8] The SBR and DSBR services are held in reserve outside the electricity wholesale market and would only be used after all actions within the normal operations of the market had been exhausted. Theoretically they do not impact either the LOLE or the de-rated margins calculations, however effectively they reduce the risks as measured by the two metrics.

Winter 2015/16

Our central view of the risks is not exhaustive, so we model wider sensitivities, such as what the risks would be in a colder than average winter.[9] The risks associated with our central view and wider sensitivities helped us to assess and support National Grid's views on procuring the SBR and DSBR services for winter 2015/16.

National Grid has procured 2.56 GW of SBR and DSBR for winter 2015/16. As shown by the right hand graph above, with these services in place the LOLE range has reduced to between around 0 and 4 hours (ie within the government's reliability standard) for the majority of the credible scenarios and sensitivities we have considered in our analysis, including our central view of risks. The de-rated margins, ie the average excess of available generation over peak demand, have also effectively increased to between around 3% and 10% with the SBR and DSBR in place. This range includes National Grid's Base Case margin of 5.1% for this coming winter.[10, 11]

Winter 2016/17

Uncertainty around the outlook for winter 2016/17 has increased. Our central view of the risks shows that the LOLE could range between 2 and 15 hours (compared with between 0 and 3 hours per year projected in our Capacity Assessment 2014). While demand uncertainty plays a role in this range, the projected LOLE depends largely on whether there are further plant closures, or the market responds for example by making further capacity available or increasing imports.

Given the uncertainty in the outlook for 2016/17, National Grid is consulting on whether to extend the SBR and DSBR services beyond this winter when they expire. Ofgem will take a decision on any related recommendation by National Grid later this year.

However, the market could also play a large part in managing the risks. Our analysis has identified significant potential for the market to respond and reduce the risks to security of supply. For example, the LOLE could fall to as low as 2 hours per year if the most optimistic of the four FES occurs (as measured by the risk metrics) and the market responds. This response could take the form of either:

- interconnectors with mainland Europe importing at maximum capacity, as they did in winter 2014/15;[12] or
- generators achieving availability towards the top of the range achieved in recent winters (this sensitivity assumes that CCGT and nuclear plant availability increases to 89% compared to 87% and 82% respectively in the FES); or
- an additional 1 GW of plant is returned to, or retained in the market.

Winter 2017/18

For winter 2017/18, our current view suggests the LOLE will broadly fall to within the government's reliability standard, as plant is expected to return to the market and demand to continue falling. We consider the standard is likely to be met across the full range of our central view of the risks.

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[9] These are briefly presented towards the end of chapter 2 and in more detail in the appendices.

[10] For more information on National Grid's Base Case see its Winter Review and Consultation 2015/16 report: www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/FES/Winter-Outlook

[11] We present the detailed de-rated margins results in Chapter 2.

[12] For more information see for example National Grid's Winter Review and Consultation 2015/16 report.

1. Roles and responsibilities to secure Great Britain's electricity supplies

1.1. In the past three years we have produced, and published, a Capacity Assessment (CA) report. The CA historically fulfilled the Authority's obligation to provide the Secretary of State with an annual report assessing the risks to the security of Great Britain's (GB) electricity supply.[13]

1.2. The Department of Energy and Climate Change (DECC) has removed this obligation from 2015 onwards following its decision to introduce a Capacity Market (CM),[14] which obligates National Grid to produce an Electricity Capacity Report (ECR) each year.[15] As part of our monitoring role of the market and to inform policy decision we have continued to undertake the analysis for the short- to medium-term security of supply outlook. We have therefore chosen to publish our commentary of National Grid's Future Energy Scenarios (FES) for this period, highlighting the analysis we have done. The main purpose of our commentary is to provide the market with an independent assessment of the risks to security of supply.

Broad roles of Ofgem, National Grid and government in electricity security of supply[16]

1.3. In broad terms, the government's role is to set overall policy objectives for security of supply. In the short- to medium-term the market is designed to deliver that security of supply. From 2018/19, the government has set the target level of capacity adequacy and introduced policies to achieve this. The market works within a framework that Ofgem as a regulator sets to ensure value for money for consumers and quality of service in the overall operation of the system. National Grid has obligations to balance the system in an economic, efficient and co-ordinated manner. The broad areas of responsibility of the three organisations are:

- **Ofgem**: We ensure that market arrangements are sufficiently designed to encourage security of supply. We also approve the introduction of balancing services and regulate these indirectly through the cost recovery mechanisms to ensure that any service procured is in the interest of consumers.
- **National Grid**: As the electricity system operator (SO) for Great Britain, National Grid is responsible for balancing the electricity system by ensuring that generation on the national electricity grid matches demand on a second-by-second basis. To do this, the SO buys and sells energy and procures associated balancing services. It also provides valuable information to market participants, and can propose changes to market arrangements through industry codes.

[13] As set out in section 47ZA of the Electricity Act 1989.

[14] For more information see: www.legislation.gov.uk/uksi/2014/2043/pdfs/uksi_20142043_en.pdf.

[15] The primary objective of the ECR is to set out National Grid's analysis and recommendation for the volume to procure for the T-4 CM auction. The first report was published in summer 2014. The ECR 2015 is available here: www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/Electricity%20Capacity%20Report%202015.pdf.

[16] The analysis of this report focuses primarily on the balance between supply and demand that could be delivered by the market alone. In addition to this, security of supply in this section refers to system balancing, which encompasses the SO's actions as residual balancer. However, we note that topics such as system flexibility fall outside the scope of the present analysis.

- **Government**: The government sets overall policy objectives, including on security of supply, for example through primary legislation. The government can also act reactively using emergency powers in certain circumstances. It has also set the target level of generation adequacy for GB's electricity supplies in the context of the CM, the reliability standard.

Key tools

1.4. Since 2013 National Grid has introduced two new tools to better balance the system given the risks to security of electricity supply. Ofgem has approved the Supplemental Balancing Reserve (SBR) and Demand Side Balancing Reserve (DSBR) for winters 2014/15 and 2015/16 that National Grid can use to help it balance the system if the margins tighten.[17]

1.5. The government has also introduced the CM, as part of the Electricity Market Reform (EMR), to reduce the risks to security of supply in the medium term and beyond; the CM's first year of delivery is winter 2018/19. This aims at providing financial incentives to ensure GB has enough reliable electricity capacity to meet demand.[18]

[17] For more information on the roles and responsibilities in relation to the SBR and DSBR services refer to: www.ofgem.gov.uk/ofgem-publications/85278/decisiontoacceptngetapplicationtointroducetwonewbalancingservicesandsubsequentconsultationonfundingarrangements.pdf

[18] For more information on the roles and responsibilities in relation to the EMR refer to: www.ofgem.gov.uk/sites/default/files/docs/2015/06/annual_report_on_the_operation_of_the_cm_final_0.pdf

2. Key results

2.1. This report sets out Ofgem's commentary on the first three winters (ie from winter 2015/16 to 2017/18) of National Grid's FES for electricity security of supply. We expect the balance between supply and demand to be delivered **by the market alone** to tighten for winter 2015/16, due to plant closures and mothballs. However, National Grid's procurement of SBR and DSBR has reduced the risks to security of supply to meet the level implied by the government's reliability standard for a wide range of credible scenarios and sensitivities.[19] Uncertainty around the outlook for winter 2016/17 has increased; the risks could increase if further plant closures occur, however our analysis shows there is significant potential for the market to respond positively and reduce the risks. We project that the risks will drop for winter 2017/18 as some mothballed plant is projected to return to the market, and demand to continue falling.

2.2. As in previous years, we use several metrics for assessing the risks to security of supply which are listed below:

- *Loss of load expectation (LOLE)*: is the average number of hours per year in which supply is expected to be lower than demand under normal operation of the system. Importantly, the LOLE is not a measure of the expected number of hours in which customers may be disconnected as National Grid is expected to use other mitigation actions ahead of any controlled customer disconnections. The LOLE captures the impact of intermittent generation on security of supply, which is important as GB's generation mix changes, particularly with higher penetration of wind in the system.

- *De-rated margins*: is the average excess of available generation over peak demand. De-rated margins are a simple and intuitive way of measuring the risks to security of supply, however they have limitations; specifically they do not reflect the amount of variability associated with them. Like the LOLE, the de-rated margins do not directly represent the risk of customers being disconnected.

- *Likelihood of controlled disconnections*: shows the probability of a large shortfall occurring that would require controlled disconnections of customers. We estimate the likelihood of controlled disconnections with a 1 in n years metric, including the potential impact of the SBR and DSBR.[20]

2.3. Below we present the key results for our view of the risks for each year of the analysis period:

- *Winter 2015/16:* National Grid has secured 2.56 GW of SBR and DSBR for next winter. With these services in place the range of risks to security of supply has effectively been reduced to meet the government's reliability standard for the majority of credible outcomes we have considered in our analysis.

[19] National Grid has procured 2.56 GW of the SBR and DSBR services following the approval of the volume methodology and sensitivities to be used for its assessment by Ofgem. For more information, see: www.ofgem.gov.uk/ofgem-publications/95092/authoritydecisiononnbssensitivities-pdf.

[20] We only present the 1 in n results for 2015/16. Beyond 2015/16, there is currently too much uncertainty to calculate these values.

- *Winter 2016/17:* The range of uncertainty is wider for 2016/17; the risks could increase relative to our projections last year if there are further plant closures. On the upside, there is a significant opportunity for the risks to remain below the reliability standard if the market responds for example by making further capacity available or increasing imports. Our analysis shows that the LOLE could range between 2 and 15 hours per year for our central view of the risks (corresponding to margins between 0% and 4%).

- *Winter 2017/18:* Risks are expected to decrease as plant is assumed to return to the market, in preparation for participation in the CM, and demand continues falling. The LOLE range is largely within the reliability standard for our central view of the risks. Margins are projected to be between 3% and 7%.

2.4. We have also considered broader sensitivities, such as a colder than average winter, outside our central view. These are less likely but still possible and appropriate to consider when assessing the security of supply outlook. It is prudent to consider a wider range of credible outcomes when making procurement decisions about security of supply.

Methodology

2.5. Our assessment is based on National Grid's FES over the next three winters (2015/16 to 2017/18). This provides a range of credible and plausible outcomes for the short- to long-term.

2.6. There is a lot of uncertainty around the future outlook for security of supply that is not fully captured by the FES. We have undertaken sensitivity analysis to assess the risks associated with these uncertainties. The results here show our commentary on the FES and a comprehensive assessment of the outlook to security of supply in the next three winters.

2.7. We have retained the same methodology with our CA 2014 report for estimating the metrics to security of supply.[21]

National Grid's FES results and our sensitivity analysis

Background to National Grid's FES [22]

2.8. The four FES scenarios have been updated since last year based on market developments and stakeholder feedback. The scenarios reflect the energy trilemma of sustainability, affordability and security of supply. National Grid varies two components of the trilemma, the level of green ambition (sustainability) and prosperity (affordability).[23] The four scenarios are: Gone Green (GG), Slow Progression (SP), Consumer Power (CP)[24] and No Progression (NP).

Sensitivities around the FES

[21] For more information on the methodology used to estimate the security of supply metrics, see our CA 2014 report.
[22] For a detailed description of National Grid's FES and the assumptions underpinning these, see: fes.nationalgrid.com.
[23] The FES assume that the EMR programme delivers to the reliability standard of 3 hours LOLE per year from 2018/19, as set by the government.
[24] The Consumer Power scenario has replaced the Low Carbon Life scenario in the FES 2015.

2.9. While the FES provide a credible range of plausible outcomes, we have identified a number of additional uncertainties in the underlying assumptions. These include the level of demand, commercial decisions of generators, conventional generator availabilities and interconnector flows. We capture the impact of these uncertainties with sensitivities. For our central view, these only cover upside uncertainty (where the outlook could be better than National Grid's projections) as we believe the downside is adequately covered by the FES for the three winter period under consideration. Our wider sensitivity analysis covers both more pessimistic and optimistic outcomes.

2.10. We run our optimistic and pessimistic sensitivities around the most optimistic and pessimistic FES respectively, as measured by the risks metrics.[25] In this way we capture the full range of risks around the FES associated with our sensitivity analysis.[26] Our sensitivities illustrate only changes in one variable at a time and do not capture potential mitigating effects, for example the supply side reacting to a cold winter. We do this to assess the impact on the risk measures of the uncertainty related to each variable in isolation.

Our central view of the risks

2.11. Figure 1 and Figure 2 show our central view of the risks to security of supply. The light blue range indicates the risks implied by the FES, which our own analysis supports. The darker blue range indicates the risks based on our sensitivity analysis.

Figure 1: LOLE for our central view of the risks, excluding the SBR/DSBR for winter 2015/16 (total blue area)

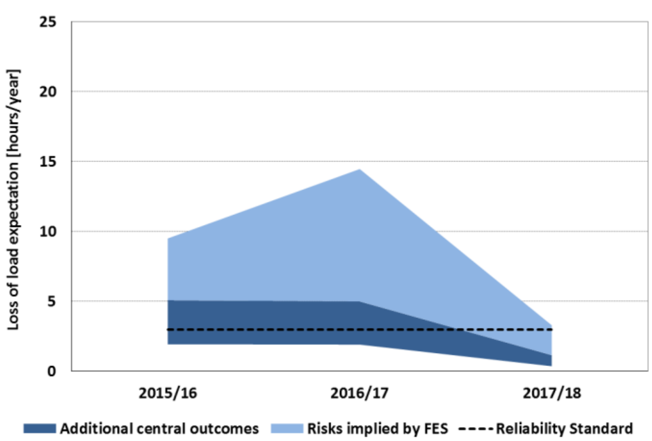
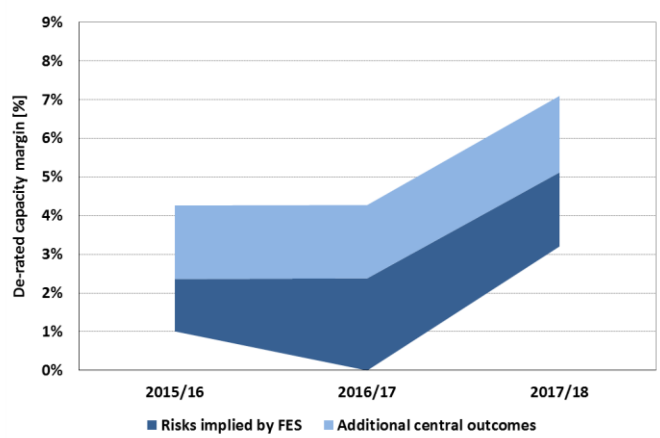


Figure 2: De-rated margins for our central view of the risks, excluding the SBR/DSBR for winter 2015/16 (total blue area)



[25] For winter 2015/16 we run the optimistic and pessimistic sensitivities around the No Progression and Gone Green scenarios respectively. We then apply our optimistic sensitivities around the Consumer Power scenario and the pessimistic sensitivities around the No Progression scenario for winters 2016/17 and 2017/18. Slow progression represents the most pessimistic FES in 2017/18, in terms of the risk metrics, however the difference with No Progression is small.

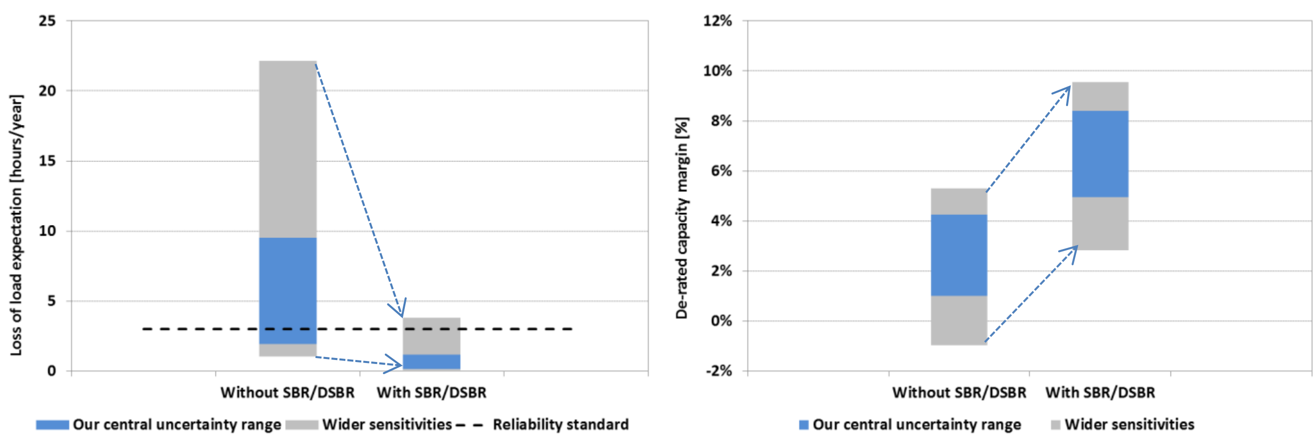
[26] Note that the methodology used in this report is different to the volume methodology for the SBR and DSBR, regarding the scenario around which the sensitivities are run. For defining the volume of SBR and DSBR to procure, National Grid runs the sensitivities around the scenario that lies in the middle of the four FES, as measured by the risks metrics, so that the resulting volume is determined in a neutral way.

Winter 2015/16

2.12. National Grid has procured 2.56 GW of SBR and DSBR services for 2015/16. The volume procured is sufficient to reduce the risks to security of supply to meet the government's reliability standard for a range of credible scenarios and sensitivities. These include our central view of the risks and the majority of wider sensitivities that we have considered for this analysis.

2.13. SBR and DSBR are additional tools that National Grid can use in the event that supply provided by the market alone is insufficient to meet demand. The impact of the SBR and DSBR services on the LOLE and de-rated margins can be seen in Figure 3. This shows that the risk of National Grid having to use additional measures beyond the SBR and DSBR (ie the LOLE) has dropped to between 0 and 4 hours per year. The de-rated margins have also effectively increased to between 3% and 10%. The risks associated with our central view and wider sensitivities helped us to assess and support National Grid's views in relation to procuring the SBR and DSBR services.

Figure 3: LOLEs and de-rated margins pre- and post-SBR/DSBR for our complete range of views in winter 2015/16



Winter 2016/17

2.14. The risks for winter 2016/17 are wider due to significant uncertainty in the outlook. We project that these could increase, as shown on Figure 1 and Figure 2, and exceed the reliability standard as a result of power plant closures and mothballs. Importantly, we have identified upside risks and a significant potential for the market to respond positively (eg through generators increasing their availability in the market) and reduce the risks to security of supply. The LOLE varies to between 2 and 15 hours in our central view of the risks.[27] There is also uncertainty around the future level of demand that drives the wider range of risks. Interpreting the risks to the security of supply outlook through the de-rated margins presents a similar picture. Margins are projected to vary to between 0% and 4% for 2016/17.

[27] Our central view of the risks presented in the CA 2014 for winter 2016/17 was between 0 and 3 hours per year.

Winter 2017/18

2.15. The outlook shows risks decreasing for winter 2017/18, driven by an improvement on the supply side, as mothballed plant is projected to return to the market, and a drop in demand. The LOLE is projected to broadly fall within the government's reliability standard and margins to be between 3% and 7%.[28]

FES Outlook

2.16. Below we present the key assumptions of National Grid's FES on the demand and supply sides and the interconnector flows.

Demand

2.17. Peak demand adjusted for average weather conditions – called average cold spell (ACS) peak demand[29] - has dropped significantly between winter 2005/06 and winter 2014/15 by about 6 GW, as shown in Figure 4. This is the demand as seen by National Grid on the transmission network. Supply from embedded generation[30, 31] and demand-side response[32] is seen as a reduction of demand on the transmission network. National Grid assesses that ACS peak demand dropped by around 0.7 GW between winter 2013/14 and 2014/15, primarily driven by higher contribution from embedded generation, and to a lesser extent by falling industrial demand.

2.18. National Grid's outlook has peak demand increasing in winter 2015/16, against the longer-term downward trend. It projects that peak demand will increase by a net of up to 0.2 GW across the FES due to growth in residential and commercial demand and lower levels of demand side response. Peak demand is then assumed to fall year-on-year for the remainder of the analysis period, mainly due to reductions in industrial demand and increased contribution from embedded generation.[33] Figure 4 shows National Grid's ACS peak demand projections for the FES, excluding the contribution of embedded wind, alongside historical peak demand.

[28] Our central view of the risks, presented in the CA 2014 for winter 2017/18 was between 0 and 3 hours per year.

[29] Average Cold Spell (ACS) peak demand is the demand level resulting from a particular combination of weather elements that give rise to a level of peak demand within a financial year (1 April to 31 March) that has a 50% chance of being exceeded as a result of weather variations alone. The Annual ACS Conditions are defined in the Grid Code.

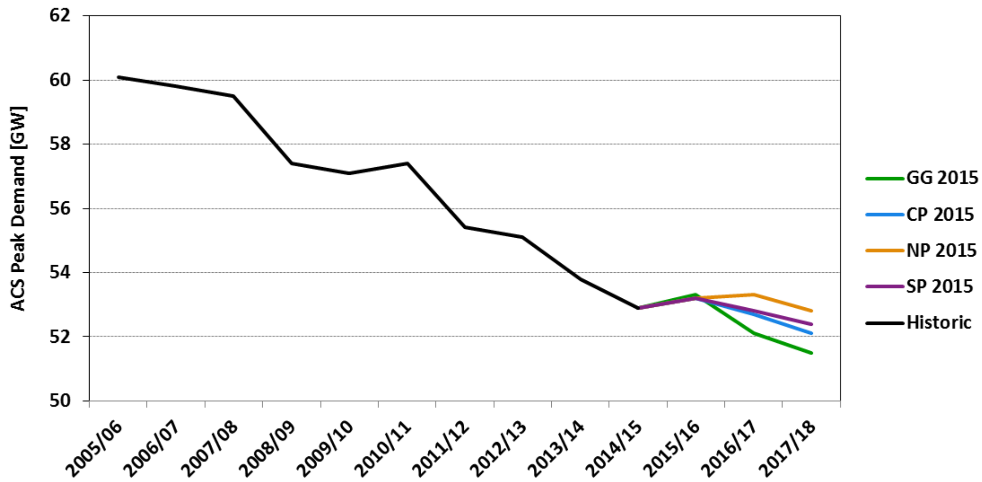
[30] Embedded generation is generation connected to the distribution network. This consists of a range of technologies including small scale Combined Heat and Power, generation from landfill gas, and biomass. The electricity generated by such schemes is typically used in the local system rather than being transported across the UK, so manifests as a reduction in demand seen by National Grid.

[31] The contribution of embedded wind at peak is added back to the ACS demand level, as we are modelling all wind generation explicitly.

[32] An active, short-term reduction in electricity consumption, as seen by National Grid, created either by shifting it to another period, replacing transmission-connected generation with embedded generation, or simply not using electricity at that time.

[33] Uncertainty over demand increases significantly from 2016/17 and peak demand varies by 1.3 GW between the four FES in 2017/18.

Figure 4: National Grid's ACS peak demand projections in the FES (excluding the contribution of embedded wind to ACS peak)[34]



Largest infeed loss reserve

2.19. National Grid reserves power to maintain system frequency within statutory limits in the event of the loss of the largest generator (the largest infeed loss). Like last year, National Grid estimates that the reserve requirement is 0.9 GW and remains constant throughout our analysis.[35]

Supply – Installed Capacity

2.20. Capacity in the market has continued to drop since last year's assessment. National Grid now expects a net reduction of around 4 GW of installed capacity between winter 2014/15 and 2015/16. This is a 2 GW net reduction compared to the expectations in FES 2014.[36] National Grid projects this reduction is mainly caused by gas-fired plants leaving the market either permanently or through mothballing, due to poor plant economics.

2.21. This reduction in capacity continues but slows for 2016/17. Uncertainty in the outlook widens the range in installed capacity between the FES. Reductions in conventional generation and some increases in intermittent renewables broadly characterise the changes. National Grid then projects that the supply outlook will improve in 2017/18 as some mothballed plant is assumed to return to the market, in preparation for participation in the CM.

Supply - Conventional generation availabilities

2.22. The de-rating factors (or availabilities) for the conventional generation technologies is an important assumption for this analysis. We de-rate the installed capacity of generators to reflect

[34] National Grid assesses the contribution of embedded wind to ACS peak demand at around 1 GW in 2015/16, increasing to 1.1 GW in 2017/18. The ACS peak demand projections for the FES and all sensitivities are presented in Appendix A2.
[35] We include this as additional demand in our analysis. For more information see our CA 2014 report.
[36] Some plants were already scheduled to close for winter 2015/16 as they have come to the end of the operating life, or as a result of environmental legislation.

the fact that generator capacity is not available 100% of the time, for example because of unforeseen outages (or breakdowns) or scheduled maintenance.[37] National Grid's de-rating factors are derived from analysis of the historical availability performance of the different generating technologies during the winter peak period in the past seven winters. These have remained broadly consistent with last year's estimates.[38]

Interconnector flows

2.23. National Grid makes assumptions about the level and direction of flows between GB and its interconnected markets during the winter peak demand periods. In last year's report, it assumed zero net flow into GB via the interconnectors. More specifically the FES 2014 assumed that imports from Continental Europe (+0.75 GW) would be cancelled out by exports to Ireland (-0.75 GW).

2.24. National Grid has updated its assumptions for this year and now assumes that GB will see significant net imports of around 1.1 GW. Total imports from Continental Europe (+1.8 GW) are expected to exceed exports to Ireland (-0.75 GW). This assumption is based on analysis of historical flows, feedback from industry and the outlook for our interconnected markets.

2.25. Interconnection capacity between GB and its neighbouring markets is currently 3.8 GW; this breaks down to 3 GW between GB and Continental Europe (2 GW with France and 1 GW with the Netherlands), and 0.8 GW with Ireland. The FES assumes no changes to interconnector capacity with Continental Europe during the analysis period.[39]

Our sensitivities

2.26. This section describes the sensitivity analysis we have undertaken around National Grid's FES. We discuss the assumptions underpinning each sensitivity.

Demand

2.27. Projecting future demand is inherently difficult. Especially against a backdrop of rapid installation of embedded generation, on-going energy efficiency and the changing nature of the relationship between power demand and economic growth. This is a key area of uncertainty in the outlook, because understanding demand evolution is challenging.

2.28. We have developed demand sensitivities in order to account for these uncertainties. We have only developed a low demand, or optimistic, sensitivity in our central view of the risks. We believe the FES range covers uncertainty around higher demand scenarios. For example, demand increases by up to 0.2 GW in all FES in winter 2015/16. Our low demand sensitivity assumes ACS peak demand could be up to around 1 GW lower than in National Grid's most optimistic scenario (as measured by the LOLE), in all three winters of the analysis. This represents approximately the

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[37] This is because some capacity would normally be unavailable due to planned and unplanned outages.

[38] There have been small changes for some technologies. All represent increases to availability. OCGT availability has increased from 94% to 95%; nuclear from 81% to 82%; and hydro from 84% to 85%.

[39] National Gris assumes that the capacity with Ireland will increase to 1 GW (through Moyle increasing its capacity to 0.5 GW) in the final year of the analysis period. Net flows to Ireland are assumed to remain at 0.75 GW of exports.

average drop in demand in the past two winters. We believe this is also a plausible outcome, in addition to the demand assumptions of the FES, given that year-on-year peak demand has mostly dropped since 2005/06.[40]

Supply – Installed Capacity

2.29. Decisions on whether power stations are built, mothballed, returned to service or closed depend on companies' commercial and financial positions. These can be difficult to anticipate in a changing environment, with significant uncertainties around the future outlook for commodity and power prices, and plant profitability as a result.

2.30. Our sensitivities on the supply-side cover upside risks to the FES. We have developed a high supply sensitivity, which assumes that 1 GW of additional capacity is available in each of the next three years. For example, plant could de-mothball as generators respond to the risk of tightening margins which could result in higher prices. This effect may be assisted by the Electricity Balancing Significant Code Review (EBSCR), which is designed to sharpen imbalance prices and is expected to increase profitability of reliable and flexible peak plant.

Supply – Conventional generation availabilities

2.31. We have also developed a high availability sensitivity to account for uncertainty in the future availability of generators. While the methodology used to derive the FES assumptions is sensible, the de-rating factors for conventional generation are based on the historical performance of plant during the past seven years which were characterised by healthy margins. As we are projecting a tighter situation in the future, it is likely that market signals will change and this gives generators a significant potential to respond.

2.32. For similar reasons as described in the high supply sensitivity, there could be opportunities for generators to increase their availability to profit from higher prices, as a result of tighter margins and policy developments. Our high availability sensitivity assumes increased availability for both CCGT and nuclear plants.[41] This is estimated by statistical analysis of plant availability over the past seven winters and is 89% for both CCGT and nuclear plants.[42, 43]

Interconnector flows

2.33. We also analyse sensitivities of the direction and size of interconnector flows to assess the impact these could have on the risk measures. As with the demand and supply, we believe there is a significant upside risk (ie things could be more optimistic than assumed in the FES) for interconnectors to respond to the projected tighter situation in GB.

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[40] Peak demand has mostly decreased since 2005/06 year-on-year. It has increased by a maximum of up to 0.2 GW in one occasion only, during this period as shown in Figure 4.

[41] These represent the greatest uncertainty in terms of the effect of a change in availability.

[42] Specifically it is estimated as the mean availability + one standard deviation, based on the annual availabilities for plant over the past seven winters.

[43] CCGT and nuclear availabilities are 87% and 82% in the FES, respectively.

2.34. Our upside sensitivity assumes there will be full imports to GB from Continental Europe (equal to 3 GW), as margins are expected to tighten in GB. This will increase net imports to around 2.3 GW (or by 1.2 GW from the FES). Our full imports sensitivity still assumes that we export 0.75 GW to Ireland.

2.35. In recent years GB has typically imported power from Continental Europe. Our sensitivity assumes that conditions in interconnected continental markets, the potential increased supply scarcity in GB and market reforms will help maintain imports. Prices in GB have historically been higher than in the Netherlands and France, incentivising imports to GB. The price differential has broadly increased in recent years. The Netherlands has a domestic generation surplus and is connected to other well-supplied markets (ie Norway and Germany).[44] The outlook for France is more uncertain as margins are expected to tighten; exports to GB are still likely unless cold temperatures - the primary reason for potential tightness in France - coincide with tight margins in GB. Higher risks to security of supply and sharper imbalance prices could further incentivise continental imports and reinforce this trend. Since last year's report, we have seen evidence that GB's interconnectors with Continental Europe flow towards the efficient direction more frequently (ie towards the market with higher prices) after GB joining the day-ahead market coupling zone of north-western Europe.[45] While we have not estimated the price differential between GB and the Continental European markets, and the resulting interconnector flows as part of this assessment, we would expect high imports from the continent as the most likely outcome given the factors above.

2.36. GB currently exports to Ireland during winter peak demand periods. Given current levels of price differentials between GB and Ireland and the similarities in the market outlooks, we have assumed that this trend is maintained in the next three winters.[46]

Wider range of sensitivities

2.37. So far in this chapter we presented our central view of the risks for the coming three winters. The range provides a balanced and reasonable assessment of the risks based on our view of the most likely outcomes.

2.38. In addition to our central range of sensitivities, it is sensible to model outcomes that are less likely but still plausible and credible for assessing the security of supply outlook. We have constructed a wider range of sensitivities. The fuller range of sensitivities covers a wider set of possible outcomes for demand, plant closure and mothballing decisions by generators, and the level of interconnector flows. We also present sensitivities on the availability of variable generation and winter weather conditions.[47] These cover more optimistic or pessimistic outcomes than considered in our central view of risks. Some of these sensitivities are statistically less likely,

[44] The Netherlands is also interconnected to Belgium, which is expected to face tight margins in the short- to medium-term. However we generally expect the Netherlands to have a supply surplus even after exports to Belgium are considered.

[45] The continued development of the single European electricity market is expected to further enhance the efficient use of the interconnectors (ie more likely to flow in line with price signals going forward).

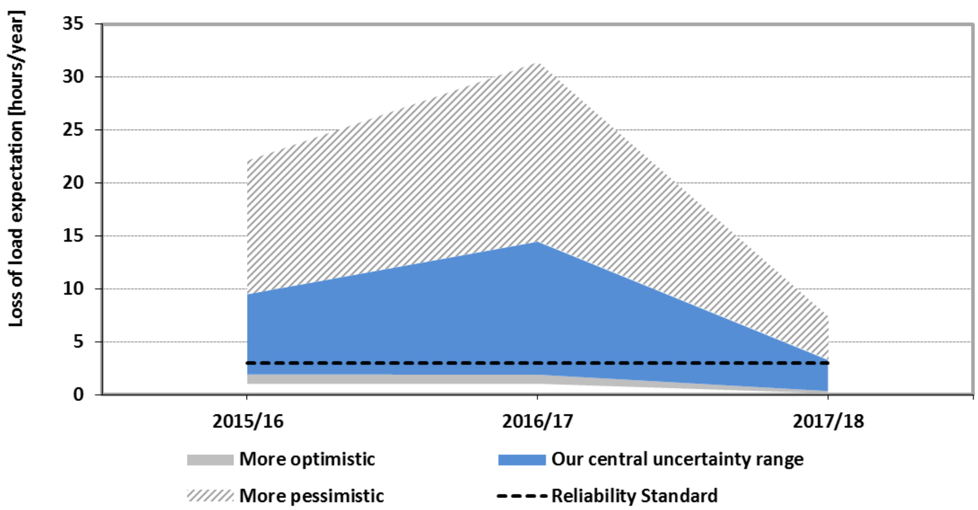
[46] The ongoing redesign of the Single Energy Market in Ireland and expected market coupling with GB could affect the price dynamics between the two markets; however these changes are not expected to reverse the price differentials before winter 2017/18.

[47] More specifically these include: a higher and lower demand sensitivity; a higher and lower supply sensitivity; a low imports sensitivity; a cold and warm winter sensitivity; and a low wind availability sensitivity. Further details can be found in Appendix 1.

such as a colder than average winter. Others we consider less likely situations, such as low imports from interconnectors. Each sensitivity represents a change in a single variable from a scenario, with all other assumptions being held constant.

2.39. Figure 5 presents the LOLE for the wider sensitivity range, including our central range of views. This figure shows that the risks could increase further from our central range, for example, if GB faces a colder than average winter. On the upside, the risks could be lower if more capacity becomes available to the market (eg via plant returning to the market).

Figure 5: LOLE for our central view of the risks and wider sensitivities



Potential impact on customers

2.40. If demand is higher than supply under normal operation of the system, National Grid as the SO has mitigation tools to manage supply shortfalls, with little or no impact on customers in most cases. These include the SBR and DSBR, for this coming winter, voltage control, requesting maximum generation from plant or requesting emergency services from the interconnectors.

2.41. National Grid will hold these tools, including the SBR and DSBR, outside the market and would only use them after all normal market options have been exhausted. It is expected that National Grid would use the SBR and DSBR to balance the system before any other mitigation actions.[48] Figure 6 depicts the expected sequence of their use by National Grid.

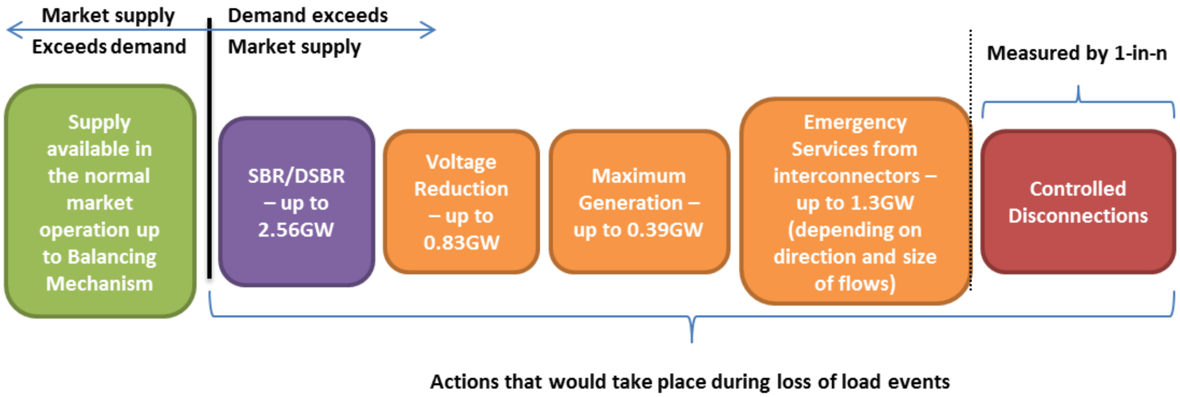
2.42. The use of SBR and DSBR results in a significant reduction of the likelihood of controlled disconnections. For 2015/16, National Grid has procured 2.56 GW of de-rated capacity of the SBR and DSBR. Using an 1 in n metric,[49] these additional measures would reduce the risk of disconnections by up to 1 in 14 to 1 in 77 years. Without SBR and DSBR, the likelihood of controlled disconnections would vary between about 1 in 1 to 1 in 4 years in 2015/16 for our

[48] SBR and DSBR are held outside the market, and theoretically they do not impact either the LOLE or the de-rated margins calculations. However effectively they reduce the risks as measured by the two metrics.

[49] Please see the introduction to this chapter for a definition.

central view of the risks. Beyond 2015/16, there is currently too much uncertainty to calculate 1 in n values.

Figure 6: Electricity market, mitigation actions and the LOLE and 1 in n metrics



Appendix A1 – Wider sensitivity analysis

A1.1. At the end of Chapter 2 we described a wider range of sensitivities alongside our central range, which includes National Grid's FES. Here we describe the assumptions underpinning these sensitivities.

A1.2. Full results of our wider sensitivity analysis, alongside the results for our central view of the risks, can be found in Appendix A2.

Demand

A1.3. For the reasons described in Chapter 2, projecting future levels of demand contains significant levels of uncertainty. Here we look to capture outcomes that are less likely than the range discussed in Chapter 2. We do not consider higher demand sensitivities as we consider these to be adequately captured within the FES range.

A1.4. For the lower demand sensitivity we assume that demand is 1.8 GW lower than National Grid's most optimistic scenario, as measured by the risk metrics for each of the next three winters. The 1.8 GW reduction is obtained using a combination of average errors and the spread of National Grid's last seven winter-ahead demand projections. A combination of factors could drive demand lower than projected by National Grid. For example, higher levels of energy efficiency, higher contribution from embedded generation, or a higher demand-side response could lead to lower demand levels.

Supply

A1.5. In Chapter 2 we presented a high supply sensitivity around the FES, which considered the possibility of more plant being available. Here we consider sensitivities around higher and lower supply which correspond to more or less plant being available in the market as a response to plant economics.

A1.6. For the lower supply sensitivity we assume that a further 0.4 GW and 0.7 GW of installed plant capacity is unavailable for 2015/16 and 2017/18, respectively. We do not assume any further closures or mothballs for 2016/17 as we believe that close-to-zero margins make it unlikely that any additional plant will exit the market permanently or temporarily.

A1.7. For winter 2015/16 we believe that our high supply sensitivity sufficiently captures the possibility of additional generation being available. We believe there is more uncertainty and potential for more plant to be available in 2016/17 and 2017/18; our higher supply sensitivity allows for 2 GW of additional plant being available in these two winters.

Interconnector flows

A1.8. In addition to the full imports sensitivity considered in Chapter 2, we have developed a low imports sensitivity, which assumes 0.5 GW of imports from the continent (we have maintained the assumption of full exports to Ireland); this sensitivity corresponds to net exports of 0.25 GW.

A1.9. Over recent winters GB has been a net importer of capacity from continental Europe. Our analysis of the outlook for our relevant markets has identified that margins in France and Belgium are projected to tighten in the short- to medium term. It is therefore plausible that GB may not receive any imports from France, if both markets were to face simultaneously tight margins (eg due to a cold weather front over north-western Europe).

A1.10. The Netherlands currently has a healthy outlook for the short- to medium-term. We expect it is more likely that the Netherlands will export power to GB. However, there is uncertainty about the actual flows going forward (eg the size of flows from the Netherland if France and Belgium face tight margins due to cold weather across north-western Europe). To capture the uncertainty, this sensitivity assumes 0.5 GW of imports from the Netherlands (equivalent to 50% of the interconnection capacity between the two markets).

Winter weather conditions

A1.11. As in the CA 2014, we have developed two sensitivities to explore the impact of cold and warm winter conditions on the risks to security of supply. Our modelling is underpinned by average winter weather. Here we vary the assumed weather conditions to explore the level of risks if a warmer or colder than average winter occurred.[50]

Wind availability

A1.12. Like in past CA reports, we have also developed a sensitivity around wind availability at times of winter peak demand. National Grid's FES scenarios assume that there is no relationship between wind availability and demand at periods of high demand. However, there is a widespread belief that the wind stops blowing when there is a severe cold spell, resulting in lower wind availability at times of high demand for electricity. We have considered the possibility that a relationship does exist, and have assessed its impact via a low wind availability sensitivity; this assumes that wind availability decreases at time of high demand.[51]

[50] For more information on the detailed assumptions see our CA 2014.
[51] For more information on the detailed assumptions see our CA 2013.

Appendix A2 – Detailed results tables

Table A1: Adjusted ACS peak demand* (estimated as the sum of ACS peak demand, including the contribution of embedded wind at ACS peak, and the reserve for the largest infeed loss***) by scenario and sensitivity**

Adjusted ACS peak demand [MW]	2015/16	2016/17	2017/18
Gone Green 2015	55,200	54,100	53,500
Slow Progression 2015	55,100	54,800	54,400
Consumer Power 2015	55,200	54,700	54,100
No Progression 2015	55,100	55,200	54,800
Higher supply	55,100	54,700	54,100
High supply	55,100	54,700	54,100
Lower supply	55,200	55,200	54,800
Lower demand	53,300	52,900	52,300
Low demand	54,100	53,700	53,100
Full imports	55,100	54,700	54,100
Low imports	55,200	55,200	54,800
Warm winter	55,100	54,700	54,100
Cold winter	55,200	55,200	54,800
High plant availability	55,100	54,700	54,100
Low wind availability	55,200	55,200	54,800

Notes
* Interconnector flows are not included in either the demand or conventional generation figures. All scenarios and sensitivities assume net interconnector imports of 1.1 GW, apart from the Full and Low import sensitivities, which assume net interconnector imports of 2.2 GW and -0.3 GW, respectively. Positive net imports are equivalent to an increase in the margin (or reduction of the risks).
** Demand figures presented in this table include a contribution from embedded wind generation (also modelled explicitly on the supply side), which increases from 1.0 GW in 2015/16 to 1.1 GW in 2017/18 across all scenarios and sensitivities.
*** The reserve for the largest infeed loss is 0.9 GW and is constant across all scenarios and sensitivities over the analysis period.

Table A2: Total installed capacity by scenario and sensitivity in MW

Installed capacity [MW]	2015/16	2016/17	2017/18
Gone Green 2015	71,853	72,319	75,141
Slow Progression 2015	71,853	72,010	74,645
Consumer Power 2015	71,972	73,291	76,807
No Progression 2015	72,626	71,630	75,053
Higher supply	74,601	75,266	78,849
High supply	73,701	74,366	77,949
Lower supply	71,433	71,630	74,343
Lower demand	72,626	73,291	76,807
Low demand	72,626	73,291	76,807
Full imports	72,626	73,291	76,807
Low imports	71,853	71,630	75,053
Warm winter	72,626	73,291	76,807
Cold winter	71,853	71,630	75,053
High plant availability	72,626	73,291	76,807
Low wind availability	71,853	71,630	75,053

Table A3: Total conventional installed capacity by scenario and sensitivity in MW

Installed Conventional capacity [MW]	2015/16	2016/17	2017/18
Gone Green 2015	58,939	58,433	58,749
Slow Progression 2015	58,939	58,173	59,233
Consumer Power 2015	58,939	59,199	60,132
No Progression 2015	59,849	58,057	60,017
Higher supply	61,824	61,174	62,174
High supply	60,924	60,274	61,274
Lower supply	58,519	58,057	59,307
Lower demand	59,849	59,199	60,132
Low demand	59,849	59,199	60,132
Full imports	59,849	59,199	60,132
Low imports	58,939	58,057	60,017
Warm winter	59,849	59,199	60,132
Cold winter	58,939	58,057	60,017
High plant availability	59,849	59,199	60,132
Low wind availability	58,939	58,057	60,017

Table A4: Loss of load expectation by scenario and sensitivity

LOLE [hours/year]	2015/16		2016/17	2017/18
	Exc. SBR/DSBR	Inc. SBR/DSBR		
Gone Green 2015	9.5	1.2	5.4	2.0
Slow Progression 2015	8.9	1.2	10.3	3.3
Consumer Power 2015	9.4	1.1	5.0	1.1
No Progression 2015	5.1	0.5	14.5	2.6
Higher supply	1.2	0.1	1.2	0.2
High supply	2.4	0.2	2.4	0.4
Lower supply	12.1	1.7	14.5	4.3
Lower demand	1.1	0.1	1.1	0.2
Low demand	2.3	0.2	2.3	0.4
Full imports	1.9	0.1	1.9	0.4
Low imports	22.1	3.8	31.4	7.4
Warm winter	1.0	0.0	1.0	0.2
Cold winter	15.4	2.7	21.7	5.2
High plant availability	1.8	0.1	1.7	0.3
Low wind availability	15.1	2.2	22.4	4.9

Table A5: De-rated capacity margin by scenario and sensitivity in %

De-rated capacity margin [%]	2015/16		2016/17	2017/18
	Exc. SBR/DSBR	Inc. SBR/DSBR		
Gone Green 2015	1.0%	4.9%	2.2%	4.1%
Slow Progression 2015	1.2%	5.1%	0.8%	3.2%
Consumer Power 2015	1.0%	5.0%	2.4%	5.1%
No Progression 2015	2.4%	6.4%	0.0%	3.6%
Higher supply	5.1%	9.1%	5.1%	8.0%
High supply	3.8%	7.9%	3.8%	6.7%
Lower supply	0.4%	4.4%	0.0%	2.6%
Lower demand	5.3%	9.5%	5.3%	8.2%
Low demand	4.0%	8.1%	4.0%	6.8%
Full imports	4.3%	8.4%	4.3%	7.1%
Low imports	-1.0%	2.8%	-1.9%	1.5%
High plant availability	4.0%	8.0%	4.0%	6.8%
Low wind availability	-0.1%	3.9%	-1.1%	2.4%