

## **Future Balancing Services Requirements: Response**

National Grid wishes to highlight to participants its current and future requirement for response services. This document illustrates the diurnal and seasonal shape of the requirement and how requirements are anticipated to change over the coming years.

If you would like to know more about providing services of this kind please contact Andy Walden (+44 (0)1926 655087, [andy.walden@uk.ngrid.com](mailto:andy.walden@uk.ngrid.com)) or look here: <http://www.nationalgrid.com/uk/Electricity/Balancing/services/frequencyresponse/>

### ***Gone Green Scenario***

The analysis presented in this document is based on an updated version of the 'Gone Green' scenario used in the 2020 initial consultation<sup>1</sup>. The background to this scenario is as follows:

The UK Government is required to reduce greenhouse gas emissions by 80% by 2050 under the Climate Change Act. The draft UK Renewable Energy Strategy is aimed at supplying 15% of energy from renewable sources by 2020.

Prior to these dates, implementation of the Large Combustion Plant Directive will mean that 12GW of generation capacity in use today will need to stop generating before 2016. We may see further early generation closures driven by the proposed Industrial Emissions Directive.

Additionally, to facilitate the connection of larger generating units, the System Security and Quality of Supply Standards is likely<sup>2</sup> to be modified to increase the normal infeed loss risk from 1000MW to 1320MW and the infrequent infeed loss risk from 1320MW to 1800MW. This change is expected to effect National Grid from 2019/20, but it may be accelerated to allow for earlier connections.

We believe that the 'Gone Green' scenario illustrates a set of plausible outcomes for 2020 and beyond which are useful in illustrating the challenges we face, even though other scenarios are equally plausible and consistent with relevant policy objectives.

### ***Frequency Response***

System frequency is a continuously changing variable that is determined and controlled by the second-by-second (real time) balance between system demand and total generation. If demand is greater than generation, the frequency falls – if generation is greater than demand, the frequency rises.

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<sup>1</sup> <http://www.nationalgrid.com/uk/Electricity/Operating+in+2020/>

<sup>2</sup> Subject to Authority approval of SQSS review GSR007

After a demand or generation fault there is a significant difference between generation and demand, and therefore system frequency changes. National Grid runs the system in such a way that:

- The maximum deviation of frequency after a normal loss is no greater than 0.5Hz.
- The maximum deviation of frequency after an infrequent loss is no greater than 0.8Hz.
- Any deviations outside 49.5Hz and 50.5Hz do not exceed 60 seconds.

National Grid achieves this by using one of three response services, which are defined below. The requirement for these frequency response services is set to the lowest amount that is required in order to meet the obligations outlined above.

Primary and secondary response is an automatic increase in generation (or reduction of demand) when the frequency is below 50Hz. Primary response is delivered within 10 seconds, while secondary response is delivered within 30 seconds.

High response is an automatic reduction in generation (or increase in demand) when frequency is above 50Hz. High response, like primary, is delivered within 10 seconds.

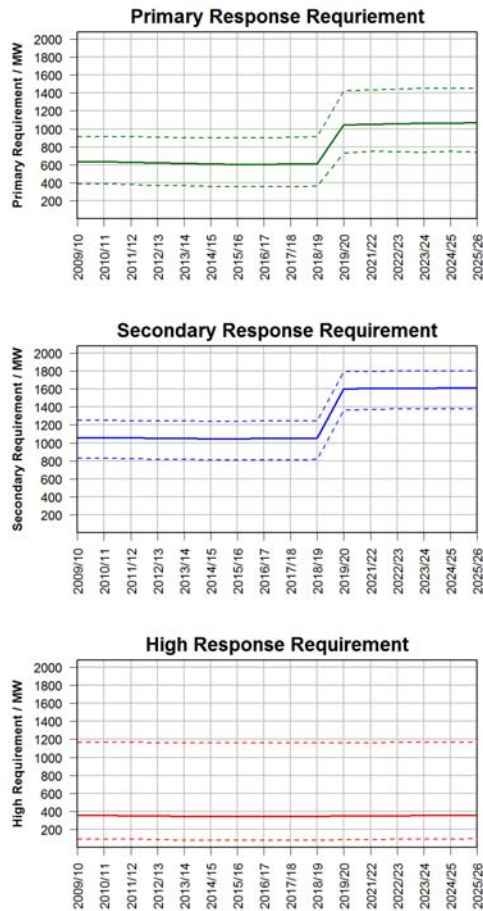
**Response Requirements Per Year – Gone Green Scenario**

The table and graphs below details the average<sup>3</sup> values of the various Frequency Response requirements under our ‘Gone Green’ scenario:

Year	Installed Capacity / MW					Demand / MW	Response Requirement / MW		
	Wind	Nuclear	Coal	Gas	Other		Primary	Secondary	High
2009/10	2,228	10,894	28,166	27,181	10,539	58,400	636	1,060	354
2010/11	3,802	9,679	28,166	28,074	9,383	56,700	634	1,060	354
2011/12	5,795	9,444	28,166	29,364	9,383	55,900	628	1,058	352
2012/13	7,677	9,444	28,166	29,799	9,431	56,100	619	1,052	347
2013/14	9,086	9,444	22,428	31,034	9,946	55,900	614	1,051	346
2014/15	10,681	9,444	22,060	32,234	10,176	56,700	608	1,048	344
2015/16	12,198	9,444	20,120	35,231	7,796	56,800	604	1,048	344
2016/17	14,888	9,444	20,970	34,331	8,346	57,000	606	1,049	345
2017/18	17,378	9,444	21,720	33,437	8,746	57,200	608	1,050	346
2018/19	19,928	8,363	21,720	33,912	9,196	57,700	609	1,051	346
2019/20	22,258	10,033	21,679	32,706	9,645	57,900	1,045	1,604	347
2020/21	24,599	11,233	17,745	31,918	9,939	57,600	1,051	1,606	349
2021/22	26,799	10,548	17,745	31,918	9,999	57,200	1,054	1,608	351
2022/23	28,130	11,748	17,745	31,918	10,264	57,100	1,058	1,609	352
2023/24	28,955	13,418	14,461	33,158	10,280	57,100	1,063	1,611	353
2024/25	29,530	11,008	14,461	32,366	10,380	57,000	1,065	1,612	354
2025/26	30,605	12,658	14,461	32,999	10,770	57,000	1,070	1,613	355

<sup>3</sup> A time-weighted mean

In addition to the average requirement over the year, one can also calculate the minimum and maximum requirement. These figures are included on the graphs as dotted lines.



Circuit outages can raise the credible level of instantaneous demand loss and therefore increase the requirement. When calculating the requirements (both average and range) an intact system has been assumed.

With the currently planned arrival of larger generation units in 2019, the largest credible generation loss increases from 1320MW to 1800MW. This increases the primary and secondary response requirements significantly<sup>4</sup> at that time, from 630MW to 1080MW and from 1020MW to 1570MW respectively.

As the largest demand loss is unchanged into the future, the High requirement is largely unchanged.

<sup>4</sup> SQSS review GSR007 contains a detailed study of this effect. Broadly, one would expect an increase in the requirements by almost the increase in largest loss. The full document can be found here: <http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/reviews/index.htm>

Each year more wind connects, and therefore generates and displaces conventional power stations. This reduces system inertia slightly, and therefore increases the primary and high frequency response requirements. As one can see from the graphs this effect is minor compared with the largest loss effect.

As the range of wind output increases, so does the range of inertia. This causes the range of possible values for the primary requirements to increase<sup>5</sup>.

The maximum response requirement is caused by a combination of low demand and high wind. That is a low inertia system, with little demand side response. Conversely, the minimum requirement is caused by high demand and low wind.

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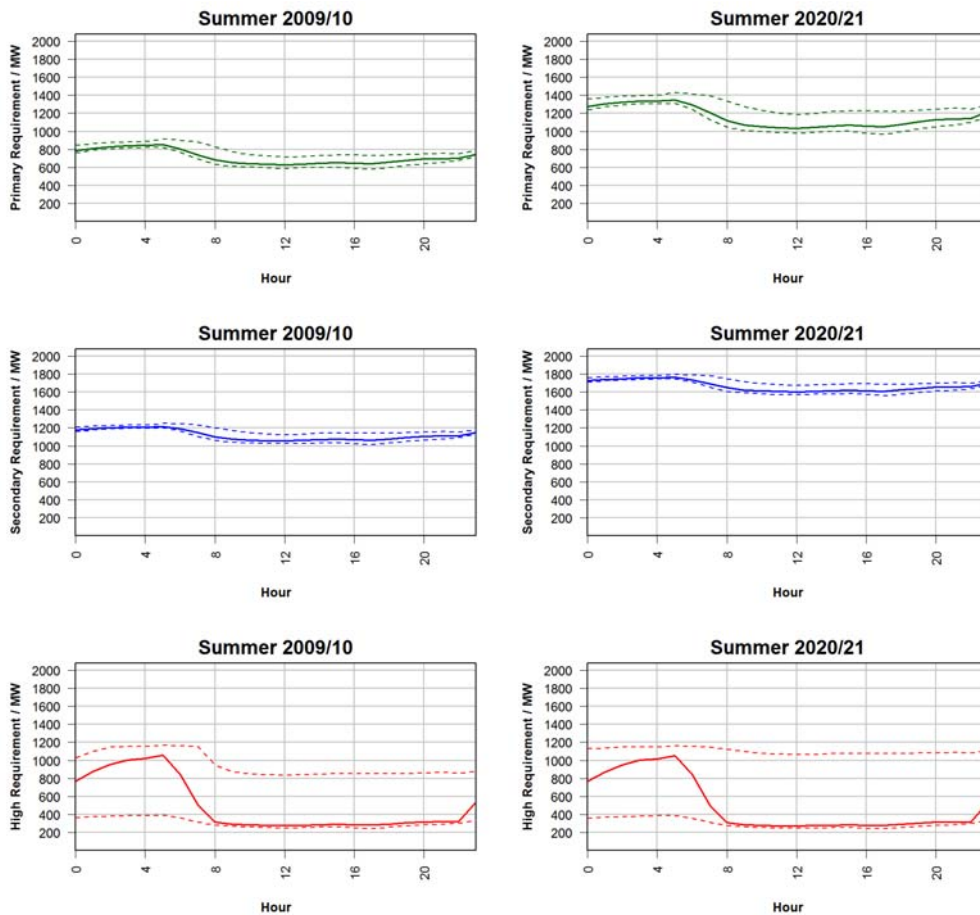
<sup>5</sup> For the primary requirement the range increases from 524MW in 2009/10 to 685MW in 2020/21.

### ***Diurnal and Seasonal Shape of Frequency Requirements***

The requirement for frequency response changes as the demand curve and plant mix changes. Therefore, it makes sense to look at the diurnal and seasonal shape of the requirement.

The graphs below show the diurnal shape of the requirements during the winter<sup>6</sup> and the summer<sup>7</sup>. As before: the minimum, average and maximum values are all plotted.

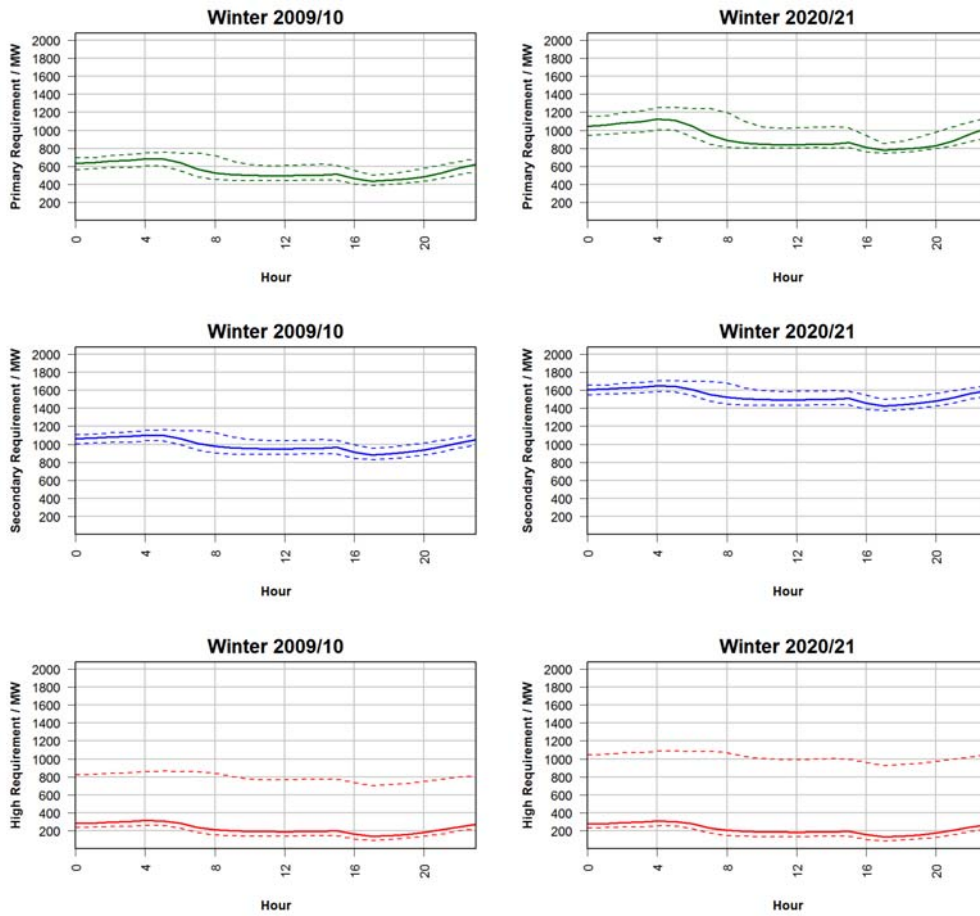
#### **Summer**



<sup>6</sup> Average requirement over engineering weeks 47- 50 (i.e. last two weeks in November, first two weeks in December)

<sup>7</sup> Average requirement over engineering weeks 27-31 (i.e. July)

**Winter**



As system demand provides some frequency response, there is a basic shape in the frequency response requirements.

In addition to the demand effect, overnight the largest credible demand loss increases (while pump storage power stations pump). Consequently, the high requirement increases much more than the primary requirement overnight.

**Changes from 2009/10 to 2020/21**

The basic diurnal and seasonal shape of the requirements are unchanged.

As the yearly summary suggested, the main change is an increase of the primary and secondary requirements caused by the introduction of 1800MW power stations.

By 2020/21 the installed wind capacity is significant, and as a result the slight increase in the range of primary and high requirements is just noticeable.

### ***Minimum Dynamic Requirement***

Most of the response requirements can be met either by static providers (that deliver a certain quantity of response at a single trigger frequency) or by dynamic providers (that smoothly deliver differing amounts of response with frequency changes). The part of the response requirement that cannot be met by static providers is referred to as the minimum dynamic response requirement.

This minimum dynamic response is used to keep the frequency close to 50Hz when small (< 300MW) events occur – such as units failing to synchronise, BOA profiling error / following error and very short term perturbations in demand.

The minimum dynamic requirement and system inertia are complementary. Should the system inertia decrease below a critical value the minimum dynamic response requirement will need to be increased, this point occurs when the lack of inertia moves the system from over damped to under damped<sup>8</sup>.

In order to avoid this problem, National Grid is proposing a change to the grid code, specifying a 'synthetic inertia' requirement for plant that would not otherwise contribute to system inertia.

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<sup>8</sup> Assuming that the system is over damped then the minimum dynamic response requirement can be calculated from the steady state of frequency, rather than the path to that frequency.