Future Balancing Services Requirements: Reserve

National Grid wishes to highlight to participants its current and future requirement for (positive and negative) reserve. 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 Craig Dyke (+44 (0)1926 653397, craig.dyke@uk.ngrid.com) or look here: http://www.nationalgrid.com/uk/Electricity/Balancing/services/reserveservices/

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[1]. 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[2] 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.

Positive Reserve

National Grid needs access to sources of extra power in the form of either generation or demand reduction, to be able to deal with unforeseen demand increase and/or generation unavailability. These additional sources, which are available to National Grid, are referred to as positive reserve and comprise synchronised and non-synchronised sources.

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[1] http://www.nationalgrid.com/uk/Electricity/Operating+in+2020/

[2] Subject to Authority approval of SQSS review GSR007

The positive reserve requirement is set so that there is a 1 in 365 chance that the demand[3] could exceed available generation. As the generation mix and leadtime[4] change, the risks change and therefore the reserve level changes.

In this report we have concentrated on the 4 hour ahead positive reserve requirement, known as STORR (Short Term Operating Reserve Requirement).

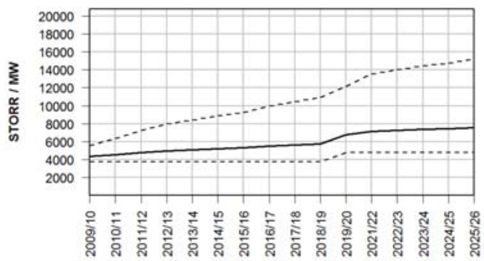
Positive Reserve Requirements Per Year – Gone Green Scenario

The table and graph below details the average[5] value of STORR under our 'Gone Green' scenario:

Year	Installed Capacity / MW					Demand / MW	Wind Forecast Error (rmse - % of cap.)[6]	STORR / MW
	Wind	Nuclear	Coal	Gas	Other			
2009/10	2,228	10,894	28,166	27,181	10,539	58,400	50.00%	4,352
2010/11	3,802	9,679	28,166	28,074	9,383	56,700	50.00%	4,554
2011/12	5,795	9,444	28,166	29,364	9,383	55,900	47.79%	4,777
2012/13	7,677	9,444	28,166	29,799	9,431	56,100	45.57%	4,972
2013/14	9,086	9,444	22,428	31,034	9,946	55,900	43.36%	5,086
2014/15	10,681	9,444	22,060	32,234	10,176	56,700	41.14%	5,206
2015/16	12,198	9,444	20,120	35,231	7,796	56,800	38.93%	5,296
2016/17	14,888	9,444	20,970	34,331	8,346	57,000	36.71%	5,477
2017/18	17,378	9,444	21,720	33,437	8,746	57,200	34.50%	5,610
2018/19	19,928	8,363	21,720	33,912	9,196	57,700	32.29%	5,720
2019/20	22,258	10,033	21,679	32,706	9,645	57,900	30.00%	6,783
2020/21	24,599	11,233	17,745	31,918	9,939	57,600	30.00%	6,957
2021/22	26,799	10,548	17,745	31,918	9,999	57,200	30.00%	7,122
2022/23	28,130	11,748	17,745	31,918	10,264	57,100	30.50%	7,256
2023/24	28,955	13,418	14,461	33,158	10,280	57,100	31.00%	7,354
2024/25	29,530	11,008	14,461	32,366	10,380	57,000	31.50%	7,434
2025/26	30,605	12,658	14,461	32,999	10,770	57,000	32.00%	7,557

[3] More precisely demand post demand side response
[4] Leadtime of National Grid's control room decision process, ranges from 24 hours to 4 hours
[5] A time-weighted mean
[6] For example: the root mean squared error, at a leadtime of 4 hours, for 2010/11 is forecast to be 510MW

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



With the currently planned arrival of larger generation units in 2019, the largest credible generation loss increases from 1320MW to 1800MW. This increases the response requirements significantly[7] at that time. In order to meet that requirement National Grid needs to be able to part-load responsive plant, which sterilises the usable headroom on those units. Therefore STORR increases at that time.

Wind generation output is more difficult to forecast accurately than conventional generation. Hence STORR increases each year as more wind generation connects to the system in order to cover the uncertainty in wind output.

In addition, the range of wind output increases, and therefore the range of STORR increases.

The maximum positive reserve requirements are caused by high forecast wind output. Therefore the conventional stations that are forecast to be idle would be available to meet the majority of this requirement.

Conversely, the minimum requirement is caused by low forecast wind output.

This requirement for reserve can, in principle, be met entirely using the STOR contract. Alternately, the requirement could be met entirely within the balancing mechanism. As National Grid is required to schedule reserve at least cost, the decision to enter into a reserve contract will be based on an economic assessment.

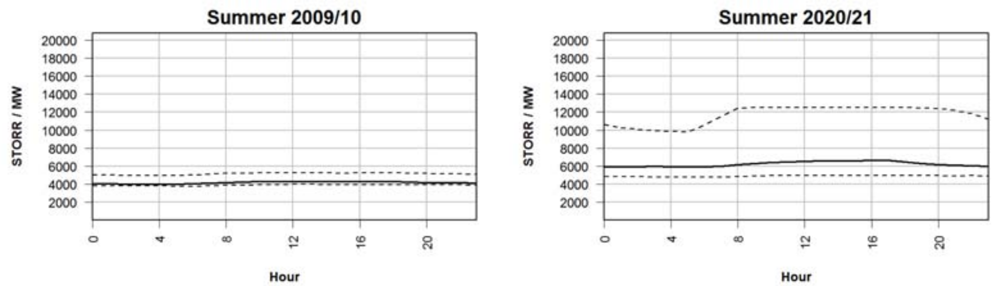
[7] See Balancing Services Frequency Response Requirements report: http://www.nationalgrid.com/uk/Electricity/Balancing/services/FutureRequirements/

Diurnal and Seasonal Shape of Positive Reserve Requirements

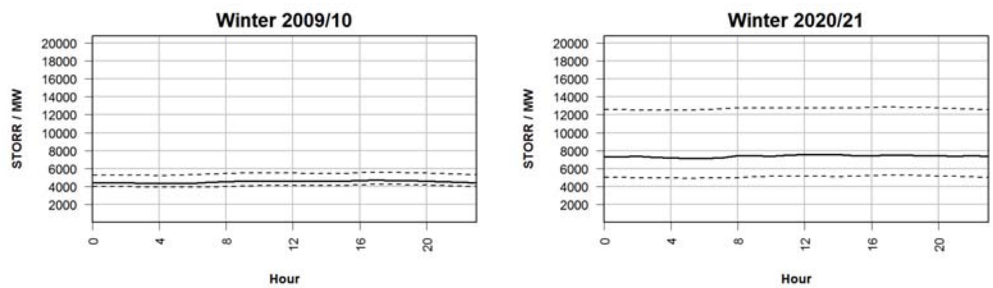
The requirement for positive reserve changes as demand forecast error changes. As demand forecast error is significantly lower overnight[8], it makes sense to look at the diurnal and seasonal shape of the requirement.

The graphs below show the diurnal shape of the requirements during the winter[9] and the summer[10]. As before: the minimum, average and maximum values are all plotted.

Summer



Winter



Demand forecast error is lower overnight, therefore the positive reserve requirement is lower overnight.

In addition, due to the amount of market synchronised plant, National Grid rarely has to take any action overnight to meet the positive reserve requirement. Typically, National Grid needs to take action to ensure sufficient reserve is available between 07:00 and 22:00 and this is reflected in the STOR service windows[11].

[8] Two demand effects are much easier to forecast overnight: peoples behaviour and illumination
[9] Average requirement over engineering weeks 47- 50 (i.e. last two weeks in November, first two weeks in December)
[10] Average requirement over engineering weeks 27-31 (i.e. July)
[11] The STOR windows for every year until 2018/19 are published as part of the tender sheets here: http://www.nationalgrid.com/uk/Electricity/Balancing/services/reserveservices/STOR/

Changes from 2009/10 to 2020/21

As the yearly summary suggested, the main change is an increase of the average (and range) of requirements caused by increased wind capacity.

An additional step change increase in STORR is caused by the introduction of 1800MW power stations.

In 2020/21, during periods of low demand and high wind output, National Grid may have to constrain the wind output to accommodate the plant minimum levels and solve the following operational issue:

- As the transmission system cannot store energy, demand must be larger than the minimum output level of the synchronised non-wind power stations plus wind output.

One possible alternative would be to de-synchronise conventional generation, but this may exacerbate the second operational issue:

- In order to meet the positive reserve requirement, the amount of available [12] non-wind power plus wind output must be larger than the sum of demand and STORR.

Therefore, when both issues are a concern, curtailing the wind output (reducing the range of wind forecast errors and consequently STORR) is the only way to meet both issues at once. The reduction in STORR (the positive reserve requirement) can be seen on the graph as a reduction in the maximum positive reserve level overnight in 2020/21.

As the wind fleet is unlikely to be generating near full output at the times of minimum demand[13], this constraint has the effect of reducing the wind production by 2%[14] of the unconstrained value over 2020/21.

[12] For STORR, the 4 hour ahead requirement, this means: the maximum amount of power available from non-wind sources in 4 hours time.
[13] See page 17 of the 2020 Initial Consultation: http://www.nationalgrid.com/uk/Electricity/Operating+in+2020/
[14] From 72TWh to 70TWh.

Negative Reserve

Negative reserve can be best described by referencing positive reserve.

Positive Reserve allows National Grid to deal with unforeseen demand increase and/or generation unavailability. Similarly, negative reserve allows National Grid to deal with unforeseen demand decrease and/or embedded generation increase.

Negative Reserve Requirements Per Year – Gone Green Scenario

The table and graph below details the average value of negative reserve under our 'Gone Green' scenario:

Year	Installed Capacity / MW					Demand / MW	Negative Reserve Requirement / MW
	Wind	Nuclear	Coal	Gas	Other		
2009/10	2,228	10,894	28,166	27,181	10,539	58,400	1,721
2010/11	3,802	9,679	28,166	28,074	9,383	56,700	1,721
2011/12	5,795	9,444	28,166	29,364	9,383	55,900	1,721
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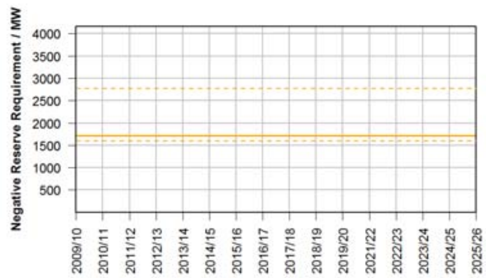
2024/25	29,530	11,008	14,461	32,366	10,380	57,000	1,721
2025/26	30,605	12,658	14,461	32,999	10,770	57,000	1,721

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



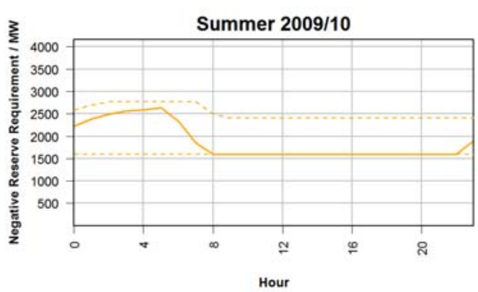
Potential demand losses are usually larger than potential over generation, therefore the main driver of the negative reserve requirement is the magnitude of the largest credible demand loss . In practice this largest demand loss is caused by the potential loss of an exporting interconnector circuit.

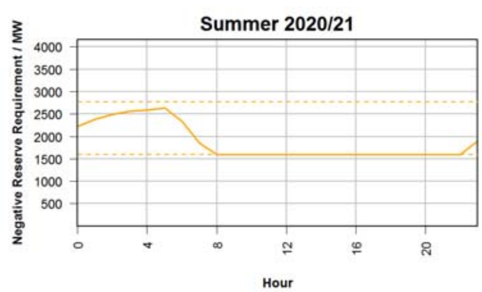
As the range of demand losses over the year isn't affected, the range of possible requirements doesn't change.

Diurnal and Seasonal Shape of Negative Reserve Requirements

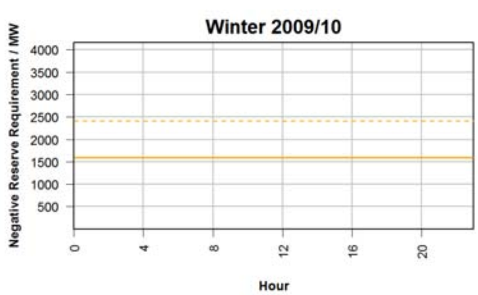
The graphs below show the diurnal shape of the requirements during the winter and the summer. As before: the minimum, average and maximum values are all plotted.

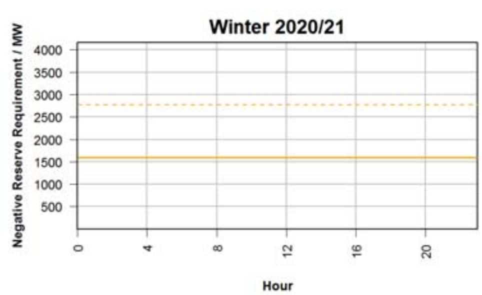
Summer





Winter





The maximum credible demand loss tends to be larger overnight, therefore the requirement is larger overnight.

In practice, National Grid rarely needs to take actions for the negative reserve, when actions need to be taken it is invariable during the summer overnight periods (i.e. periods of minimum demand).

Changes from 2009/10 to 2020/21

The range of requirements during the day increases, this is due to commissioning of a larger interconnector circuit.

For the purposes of this document: no change in the shape of demand has been assumed. If demand levels overnight were to rise (caused by electric vehicle charging) then the negative reserve requirement would decrease and be less likely to result in actions.

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