Background to the NETS SQSS Clauses Under Consideration

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Background to the NETS SQSS Clauses Under Consideration

Clauses 7.7.2.1 and 7.12.2.1 of the NETS SQSS restrict the loss of power infeed risk associated with a secured event on a single DC converter to the *normal loss of infeed risk* (1320MW). This restriction was initially placed due to the lack of reliability data for large *DC converters*. A review in 2012, GSR013, concluded that the likelihood of a *DC converter* fault is too high to allow a recommendation to increase the loss of infeed risk allowed for such an event.

There have been several changes since the latest review for these requirements in 2012. These include:

- an increase in the targeted installed capacity of offshore wind generation and a drive to connect these not only in the most economic and efficient way but also in a way that minimises the environmental impact of such connections; and
- a change to the frequency control methodology with the discontinuation of having to restrict frequency drop associated with infeed losses below the normal loss of infeed risk to a minimum of 49.5Hz and replacing that with an annual assessment process that specifies the main parameters of frequency control strategy that would guarantee that frequency excursions below 49.5Hz are limited in both frequency and duration.

The Holistic Network Design process identified that it is desirable to install some DC links with loss of infeed risk above 1320MW. This allows better optimisation of designs and coordination between different projects. It would also reduce the number of routes required to connect windfarms of capacity above that level.

Taking all these factors into account, it is necessary to review the restriction imposed by clauses 7.7.2 and 7.12.2 on the loss of *infeed loss* risk and, if appropriate, change the reference in these clauses to refer to the *infrequent loss of infeed risk* instead of the *normal loss of infeed risk*.

Detailed Assessment and Considerations

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Benefits associated with the Increase of the Loss of Infeed Risk allowed for Offshore DC Converters

The following considerations were debated in the GSR030 Workgroup, which considers wider issues. These were included in this Proposal after consultation with the GSR030 Workgroup members.

Economic Benefits
The HND predicts savings of approximately £5.6 billion. This arises from the recommended design which leads to an additional £7.6 billion of capital costs due to the additional offshore infrastructure but this is outweighed by the £13.1 billion savings in constraint costs that are expected to result from the additional network capacity provided.

Environmental Benefits
There is an expected 33% reduction in the environmental footprint associated with offshore cables connecting to shore as a result of the HND design.

In addition, increased utilisation of offshore wind should result in a cumulative reduction in CO_2 emissions from gas powered generation between 2030 and 2032 by 2 million tonnes.

The reduced number of landing points also reduces the need for onshore infrastructure.

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Risks Arising from the Increase of the Loss of Infeed Risk allowed for Offshore DC Converters

Only one risk is identified. That is the impact on frequency management

Impact on Frequency Management

An increase to the maximum loss of infeed risk permitted for any single *DC converter* would affect:

- The cost of frequency response services required to ensure that for all secured events the system frequency does not drop below 49.2Hz and is restored to above 49.5Hz within 60 seconds.
- With this cost set by the largest loss prevailing in real time, once the 1800MW nuclear units start operating, any 1800MW wind capacity will have a minimal impact on this cost.

Due to the delivery timescales of offshore windfarm connections and the current contracted completion date for the large nuclear units [2029 according to the Transmission Entry Capacity (TEC) Register], this impact component is marginal.

The number of events per annum resulting in frequency dropping below 49.5Hz:

- This number of events is influenced by the frequency control strategy applicable at the time as set out in the *Frequency Risk and Control Report*. Assuming this will continue to recommend securing the largest infeed loss to 49.2Hz but not set a value on the infeed loss that would need to be secured to 49.5Hz, a revision of the requirements in 7.7.2 and 7.12.2 are likely to result in an increase in the number of instances of the frequency dropping below 49.5Hz in GB.

Frequency Risk and Control Report (FRCR) | National Energy System Operator

Risks Arising from the Increase of the Loss of Infeed Risk allowed for Offshore DC Converters

If only one 1800MW offshore windfarm is connected to the National Electricity Transmission System through a single *DC converter*, the number of events following which the frequency will drop below 49.5Hz will increase as the number of faults/annum affecting the converter increases.

If multiple 1800MW offshore windfarms connect to the NETS each through a single *DC converter*, the number of events following which the frequency will drop below 49.5Hz will be determined by the total number of these windfarms and the reliability of each of their converters. In general, 10 windfarms each connected through a converter that is likely to trip once every year will have a similar impact on the number of frequency excursions below 49.5Hz as a single 1800MW windfarm connected through a converter that is likely to trip 10 times/annum.

As the number of single *offshore DC converters* with 1800MW infeed loss risk increases, it is likely that the number of frequency excursions below 49.5Hz will increase. This may result in these events being frequent enough to become an unacceptable frequency condition. In such a case, NESO will have to procure frequency response services to manage the number of such events to a level that is deemed acceptable.

HVDC converter reliability (trip/annum)	Expected number of frequency excursions with frequency dropping below 49.5 Hz (event/annum) [1]
0	1.59019151
1	1.931744021
2	2.273296532
3	2.614849043
5	3.297954065
10	5.00571662

[1] Numbers were calculated using the methodology used to produce the *Frequency Risk and Control Report* with one offshore windfarm set to a capacity of 1800MW and its level of reliability set to the levels on the left-hand column.

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Risks Arising from the Increase of the Loss of Infeed Risk allowed for Offshore DC Converters

The potential requirement for NESO to ensure that frequency does not drop below 49.5Hz for certain events and the costs associated with meeting such requirement.

The frequency control requirements are reviewed annually, and the recommendations are published in the 'Frequency Risk and Control Report'. One of the factors that is considered in this review is the likelihood of events when frequency drops below 49.5Hz and whether this likelihood is high enough to be considered unacceptable or not.

As noted previously, the impact of allowing *DC converter* faults to result in a loss of infeed risk above the normal loss of infeed risk and up to the infrequent loss of infeed risk is that the number of events causing the frequency to drop below 49.5Hz will increase. The increase will depend on the number of DC converters with such loss of infeed risk and the reliability of these converters.

If this number of events becomes unacceptable, NESO will have to procure frequency response to ensure that the frequency excursion resulting from the DC converter is limited to 49.5Hz rather than 49.2Hz. This will result in an increase in frequency response costs.

Frequency Risk and Control Report (FRCR) | National Energy System Operator

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Risks Arising from the Increase of the Loss of Infeed Risk allowed for Offshore DC Converters

For a single converter with 1800MW loss with certain reliability level to have no impact on the number of events with frequency dropping below 49.5Hz, NESO will have to operate to the 49.5Hz limit for a certain percentage of the time. This percentage and the additional frequency response cost associated with such operation are shown in the table for a range of reliability levels.

We note that some increase in the number of frequency excursions may be acceptable. Hence, the numbers below assume worst case.

HVDC converter reliability (trip/ annum)	Expected number of frequency excursions with frequency dropping below 49.5 Hz (event/annum)[1]	% of time the converter loss needs to be secured to 49.5Hz in order to negate its impact on the number of excursions below that level	Costs required to be incurred to negate the impact of converter loss on the number of excursions below 49.5Hz (£m/annum)[2]
0	1.59019151	0	0
1	1.931744021	18%	6.698
2	2.273296532	23.6%	8.772
3	2.614849043	26.3%	9.792
5	3.297954065	28.9%	10.778
10	5.00571662	31.3%	11.679

- The increase in frequency response costs as a function of the expected number of converter faults per annum is not linear.
- The likely level of expenditure is in the range of £9m/annum to £10m/annum for a converter that suffers a 2 to 4 faults/annum. This assumes the cost of procuring dynamic containment is £3.37/MWh.
- The maximum level of expenditure for a very unreliable DC converter (10 faults/annum)) is in the range of £12m/annum. This caters for securing the converter fault to 49.5Hz throughout the year.

[1] Numbers were calculated using the methodology used to produce the *Frequency Risk and Control Report* with one offshore windfarm set to a capacity of 1800MW and its level of reliability set to the levels on the left-hand column.
[2] Costs are calculated assuming the average cost of procuring dynamic containment service is £3.37/MWh. This is the average cost of the service in 2023/24.

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Risks Arising from the Increase of the Loss of Infeed Risk allowed for Offshore DC Converters

For multiple converters with 1800MW loss, the cost of additional frequency response services required to ensure the connections have no impact on the number of events with frequency dropping below 49.5Hz would be dependent on the number of converters, the reliability of each converter, and the correlation of wind output or interconnector flows at the affected sites.

With a 100% correlation of infeed:

- The costs associated with the additional frequency response for two *DC converters* (with each likely to suffer 2 faults/annum) would be identical to one converter that is likely to suffer twice as many faults.
- The costs associated with a large number of *DC converters* with a very low reliability level is likely to be capped at the same level as a single *DC converter* (£12m/annum) as the additional frequency response required to cover one of them will cover the others.
- However, due to the high level of correlation between wind levels across the GB offshore waters, the additional increase in cost is likely to be negligible.

Allowing 1800MW loss of infeed for the loss of an *offshore DC converter* may result in an increase of frequency response costs. This increase would be up to:

- £9m/annum for a fairly reliable single converter
- £12m/annum for multiple unreliable converters.

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Recommendation

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Recommendation

The balance of economic and environmental benefit against the impacts on frequency control performance/costs favours an increase of the Loss of Infeed Risk allowed for *offshore DC Converters* to the Infrequent Loss of Infeed Risk Clauses 7.7.2.1 and 7.12.2.1 of the NETS SQSS should be modified to reflect this

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