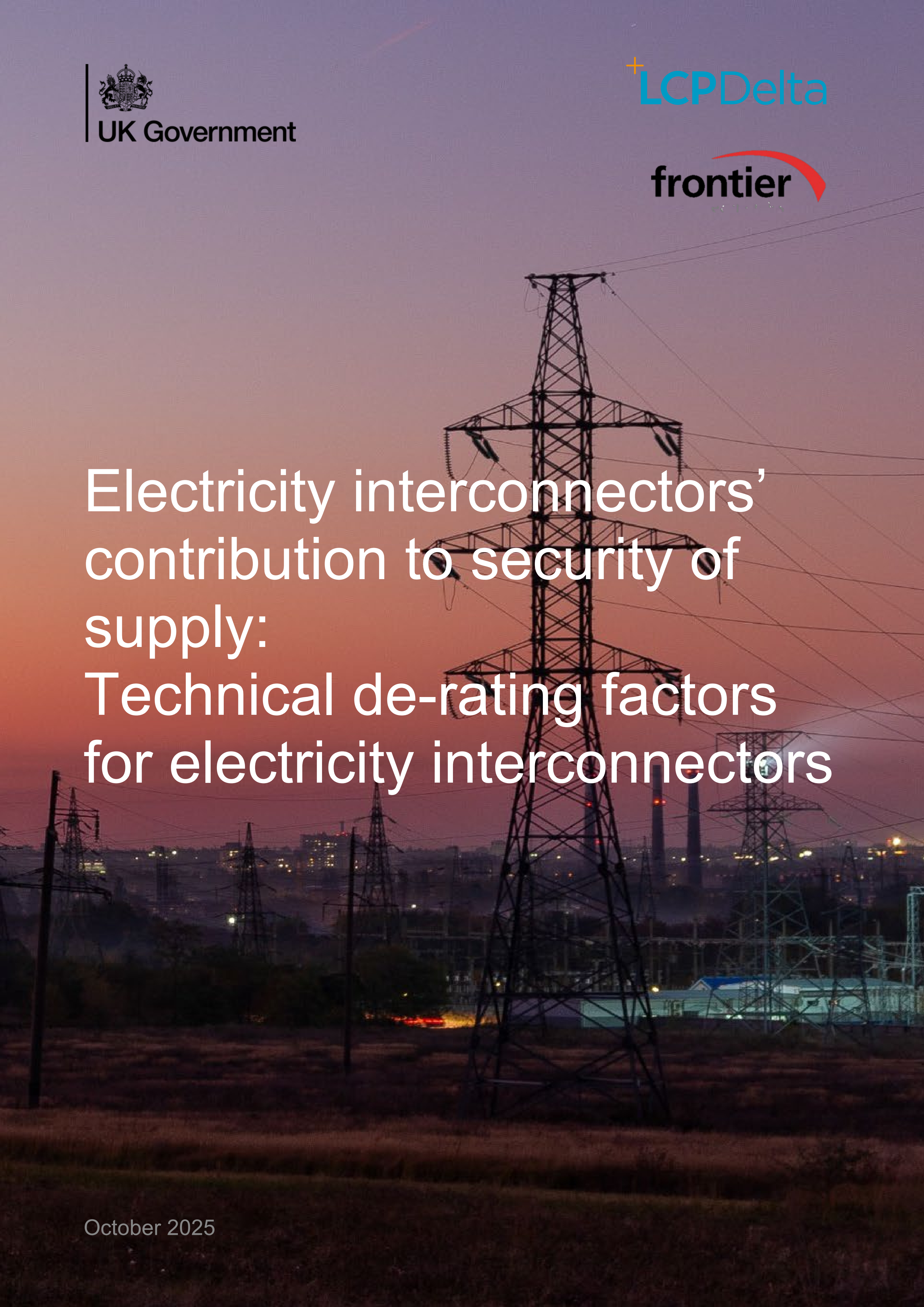


UK Government

LCPDelta

frontier

Electricity interconnectors' contribution to security of supply: Technical de-rating factors for electricity interconnectors

October 2025

Any enquiries regarding this publication should be sent to us at:
capacity.market@energysecurity.gov.uk

Contents

1. Introduction

The Capacity Market has been established to maintain capacity adequacy in the GB power system. Correspondingly, it rewards each technology type in line with their contribution to achieving this aim by the use of technology-specific de-rating factors. The methodology to calculate de-rating factors differs between different technology types and these are defined in The Electricity Capacity Regulations 2014[1] and the Capacity Market Rules[2]. Most generation technology types are updated in line with their historic availability during high-demand periods, while intermittent and duration-limited technologies use an Equivalent Firm Capacity-based (EFC) approach.

Electricity interconnectors with neighbouring countries can enter the Capacity Market. Their contribution to capacity adequacy is calculated through a mean availability approach, that reflects the contribution of each interconnector to capacity adequacy in the Capacity Market, as well as a technical de-rating that accounts for the capability of the interconnection equipment itself in maintaining availability.

The technical characteristics of an interconnector, such as age and technology type of the equipment, may affect the maintenance requirements and the probability of an outage. These present a different risk that needs to be considered when assessing the contribution of interconnectors to security of supply. Schedule 3A of the Capacity Market Rules obliges the Secretary of State to take into consideration the technical reliability of each interconnector when setting the Equivalent Firm Interconnector Capacity for each Capacity Market auction. This adjustment is carried out by applying the technical de-rating factor.

DESNZ have identified that there are currently issues with how technical derating factors are derived for interconnectors. Specifically, there is opportunity for greater transparency around the current methodology applied and more clarity on whether relevant considerations that should be included when calculating de-rating factors for a technology are covered under the current process e.g., ramp rates, unplanned outages. As such, DESNZ have commissioned LCP Delta to assess what the approach should be for deriving future interconnector derating factors.

This report outlines some of the possible approaches that could be taken for interconnector technical derating factors and provides a recommendation for DESNZ on the approach to take going forward. Technical derating factors using our recommended approach are also calculated. Note that this work was completed in early 2023, and therefore only covers market events as they were included in public databases at the end of 2022. Further updates would be required if they are to be used in a future Capacity Market auction.

1 https://www.legislation.gov.uk/ukdsi/2014/9780111116852
2 https://www.gov.uk/government/publications/capacity-market-rules

2. Possible Approaches

2.1. Capacity Market Rules

The Capacity Market Rules do not include any advice or instruction on the methodology for deriving interconnector technical de-rating factors and these values are not published. It is possible to estimate the technical adjustments applied by DESNZ based on the final interconnector de-rating factors and the market-specific ones proposed by the Panel of Technical Experts (PTE), assuming that PTE advice was accepted by the Secretary of State (Table 1). Technical de-rating factors do not appear to have changed in recent years, despite widely reported outages on various interconnectors.

Table 1: Estimated technical de-rating factors (DRFs) based on the parameters of the Capacity Market T-4 2026/27

Interconnector	Implied technical DRFs
IFA1	90%
ElecLink	99%
NSL	91%
EWIC	98%
Nemo	98%
Moyle	98%
IFA2	93%
BritNed	98%
VikingLink	92%

De-rating factors for conventional generation are currently wholly based on their availabilities and use historic outages data, as described in Chapter 2.3 of the Capacity Market Rules. A similar statistical approach has value for interconnectors, improving both predictability and cost-reflectivity. However, this needs further scrutiny due to the smaller population where each event can have a statistical significance.

Technical de-rating factors must be derived for each individual interconnector, as opposed to technology-level de-rating factors that consider the behaviour of tens or hundreds of individual plants. This is because each interconnector is different, and the technology is progressing in terms of the equipment used and risk of outages. This means that a fully statistical approach for new interconnectors based on historical availability of previous interconnectors may unfairly penalise interconnectors that were unavailable due to events outside their control, or not reward them appropriately for making additional technological improvements. As a result, it is recommended that flexibility should be maintained when calculating the technical de-rating factors to try and take these factors into account.

2.2. Repurposing the existing availability incentive model used by Ofgem

The cap and floor scheme is a regulatory framework implemented by Ofgem to incentivise and regulate the price-setting mechanism for electricity traded through interconnectors. Payments include an availability incentive, with a different availability target for each individual interconnector. These targets have been set using a publicly available model developed in 2013 by Sinclair Knight Merz (SKM)[3], and then regularly updated by GHD to ensure developments in converter (VSC) and cable technologies are captured.

The SKM model primarily focuses on the technical parameters of the cables and the converter stations that make up an interconnector to calculate its expected availability. It uses the Mean Time Between Failures (MTBF) and the Mean Time To Repair (MTTR) to calculate the likelihood of a failure of each individual component and the expected duration of a resulting outage to arrive at an overall expected availability value. Multiple severity sensitivities are provided for each variable, for example based on whether severe weather leads to restricted access. The model differentiates between different converter station technologies, such as monopole or bipole, onshore or offshore, among other characteristics. The model also includes information on different cable types, such as AC or DC, offshore or onshore, or whether the cable is buried or not, among other characteristics. Most of these variables are provided on a per unit length basis, and therefore the length of the interconnector directly feeds into the overall availability. Longer interconnectors therefore have considerably lower expected availabilities, as observed for VikingLink or North Sea Link. Finally, the annual scheduled maintenance is also incorporated into the calculation. It is worth noting that while cable failures are very time-consuming to repair, the vast majority of problems occur in the converter stations or onshore.

Model updates and adjustments made by GHD include up to date information concerning the reliability of HVDC schemes based on recent reports by the International Council on Large Electric Systems (CIGRE), adjustments to external failure rate of subsea cables due to improvements in risk assessment methodologies, and minor model adjustments to take into account a wider range of potential project characteristics.

There are various advantages to using the SKM model in determining technical deratings factors. These include:

- The SKM model is widely known by the sector due to its use by Ofgem as part of the cap and floor scheme and this familiarity will be important in securing buy-in from

[3] https://www.ofgem.gov.uk/consultation/cap-and-floor-regime-regulated-electricity-interconnector-investment-application-project-nemo

stakeholders, especially for interconnectors that had already been assessed as part of this process and have a published availability range. Any interconnector outside the cap and floor scheme may also be easily assessed using the method, as Ofgem publishes freely useable versions of the model[4] to maintain transparency.

- The simplicity of the SKM model means that no specialist engineering knowledge is required to use it.
- The model includes the majority of the key variables that would impact the technical availability of the interconnector. This includes cable length, converter substation technology, cable type and average time to repair faults.
- The model is already regularly updated by GHD to account for up-to-date information and developments in interconnector technology.

However, the SKM model has certain limitations when used in the context of deriving a technical de-rating factor. It produces an availability range, where the target availability represents a more optimistic ‘higher end’ of potential availability that an interconnector can reach. It also does not consider any commissioning issues and the potential for higher breakdown rates at the beginning of an interconnector’s lifetime. To address this, we used the minimum of the published availability ranges for each new interconnector in this report – this assumes the worst-case scenario for an interconnector, with worse weather conditions, higher maintenance needs and higher breakdown rates. We also propose retaining the unavailability caused by the annual scheduled maintenance as while the interconnector may be expected to schedule this outside high demand periods in the winter, it may be unable to predict these with sufficient accuracy.

Another limitation is that the simplicity of the SKM model means that certain characteristics of electrical circuits that are known to affect failure rates are not incorporated. The detailed circuit design, including the number of circuits, and whether their failure modes are independent or correlated between the circuits, is not included. There are also multiple published models using averaged historical data for cables of similar type, as well as multiple definitions for cables of similar type (e.g. voltage rating, insulation type, etc.). A combination of models may return more robust availability values, but any difference is likely to be small and would require extensive further work. It would also increase complexity, which may lead to reduced transparency and therefore reduced predictability as to the technical de-rating value that a new interconnector may expect. Due to this, we have focused our analysis on the SKM model rather than less well-known models.

Based on the above methodology, the following technical availabilities have been found in publications:

[4] https://www.ofgem.gov.uk/consultation/consultation-final-project-assessment-greenlink-interconnector-ireland-and-decision-greenlinks-needs-case-review

Table 2: Technical availabilities for each interconnector across different publications

Interconnector	Availability	Model version used
GB – Belgium (Nemo)	97.1% to 97.8%	SKM 2013[5]
GB – France (IFA 2)	95.9% to 97.04% with a proposed base target level of 96.59%	GHD 2018[6]
GB – Ireland (Greenlink)	97.15% to 97.89% with a proposed base target level of 97.55%	GHD 2020[7]
GB – Norway (NSL)	90.5% to 93.01% with a proposed base target level of 92.86%	GHD 2016[8]
GB – Denmark (VikingLink)	91.87% to 93.74% with a proposed base target level of 93.40%	GHD 2020[9]
GB – Germany (NeuConnect)	92.59% to 94.53% with a proposed base target level of 94.37%	GHD 2021[10]

ElecLink, one of the recently commissioned interconnectors, has not received a cap and floor agreement and therefore there is no published SKM model run for it. However, it is possible to run the SKM model using the published characteristics of the ElecLink interconnector, to arrive at an expected availability of 98.0%. As with all other interconnectors, this is the minimum of its availability range.

IFA1, BritNed, EWIC and Moyle are not in receipt of Ofgem's cap and floor agreement, so there is no equivalent publication. However, these interconnectors have over seven years of operational data and therefore theoretical availability does not factor into the calculation of their technical availability.

[5] https://www.ofgem.gov.uk/publications/cap-and-floor-regime-regulated-electricity-interconnector-investment-application-project-nemo
[6] https://www.ofgem.gov.uk/publications/final-project-assessment-ifa2-interconnector-france
[7] https://www.ofgem.gov.uk/publications/consultation-final-project-assessment-greenlink-interconnector-ireland-and-decision-greenlinks-needs-case-review
[8] https://www.ofgem.gov.uk/publications/consultation-final-project-assessment-nsl-interconnector-norway
[9] https://www.ofgem.gov.uk/publications/decision-final-project-assessment-viking-link-interconnector-denmark
[10] https://www.ofgem.gov.uk/sites/default/files/2022-04/GHD%20interconnector%20availability%20NeuConnect%20report.pdf

2.3. Historic outage data to determine availability figures

Interconnector deratings could also be determined based on historical outage data in a similar way to other technologies. The availability of conventional generation technologies is calculated using the Maximum Export Limit of plants during High Demand Settlement Periods, while correcting for outliers. Interconnectors do not have a Maximum Export Limit, but they do have to report their availability to REMIT. Using this historical data, we can see how often interconnectors have been on outage over the last five to seven years, which can inform the technical de-rating factors.

The key advantage of this approach is that it reflects the real-world performance of the interconnectors, reflecting the historical reliability of the infrastructure. The data can be valuable in understanding the frequency and duration of outages, as well.

However, this approach also comes with limitations that would need to be addressed:

- Not enough data: The nature of interconnectors means that a single technology-level value based on historical information may not be appropriate and new interconnectors will not have any availability data. An interconnector's first year of operation may also not be fully representative of their capabilities. This is apparent in the methodology used for conventional generators where seven years of data is used when calculating technical derating factors. Some new interconnectors may have similar properties to existing ones that do have historical information available, and therefore it may be possible to use this data to inform the new technical derating factor. However, an independent process would need to be established to ascertain that the new interconnector is sufficiently similar to an existing one for this approach. As such we would recommend that this approach is not used for new interconnectors and an alternative approach is used instead.
- Limited future predictability: while historic outages data provides useful insights, it does not guarantee future performance. Outages can occur due to a variety of factors, including equipment failures, extreme weather events, or operational errors, which may not be fully captured by historical data. We propose the introduction of a process where the Delivery Body and the PTE can scrutinise individual events, as detailed below.
- Data limitations: the quality and availability of historic outages data can vary based on the source of REMIT data. It may be incomplete or inaccurate, which can limit its usefulness for accurate assessment and analysis. Furthermore, some sources lack granularity and may not capture specific outage causes, durations, or impacts on different components of the interconnector system. We propose excluding pre-2016 REMIT data due to its different structure. The proposed scrutiny process carried out by the Delivery Body will also aid in addressing this issue.
- Changing system conditions: interconnectors may choose to upgrade their infrastructure, immediately improving their reliability. Some technical causes of failure may be more common under a System Stress Event rather than under normal

conditions. Historical data will not capture these aspects meaning a modelling approach could be more appropriate.

Overall, using historical data is likely to be unsuitable for new interconnectors however it should have a role to play once interconnectors have been in operation as it would reflect the real-world performance of the interconnector.

3. Recommended approach to interconnector de-rating factors

Based on our research, LCP Delta would recommend an approach that combines the use of the SKM model with historical data. This would allow the limitations of both approaches to be mitigated significantly while maintaining a simple and transparent approach. It is recommended that government retain the flexibility currently afforded to them in the Capacity Market Rules, while formalising as much of the process as possible. The below outlines the proposed approach in more detail along with a worked example:

3.1. Recommended Approach an events where the capacity reduction was caused by factors unrelated to the technical capabilities

Practical Implementation

The responsibility to calculate the technical de-rating factors currently falls on Government with no input from the Delivery Body or the PTE. The proposed formalised approach would allow for the delegation of some of these tasks.

We propose the following methodology based on the length of time that each interconnector has been available for and therefore the amount of availability data that is available on them.

- The technical de-rating factor for the first year of operation of a new interconnector would be the minimum of the availability range derived using the most recent SKM model, updated with any new engineering data published by CIGRE, an internationally trusted organisation. If an existing interconnector undergoes major refurbishment, it may be appropriate for it to be considered a new interconnector for the purposes of this methodology.

The Delivery Body has the skills and data available to carry out this assessment for each new interconnector, however any new approach would need to be agreed by DESNZ and the Delivery Body, and is subject to resourcing and timing constraints. The current Capacity Market Rules state that the determination of the technical derating factors is wholly owned by DESNZ, and therefore any change in the process would require a rule modification.

- An interconnector with between one and seven years of operation would see its original technical de-rating factor continuously adjusted using a moving arithmetic average methodology each year, in line with its observed availability during the winter period. Further detail is provided below.

- An interconnector with seven or more years of operation would have a technical de-rating factor defined in the same way as conventional generation, with some adjustments. Seven years was chosen as conventional generating technology uses availability data from the past seven years. Further detail is provided below.

We propose this approach in order to maintain predictability as an interconnector accumulates evidence of its availability over the years. This approach means that there should be no significant difference year-on-year in the technical de-rating factors, or between the interconnectors with or without seven years of operational data.

An alternative approach could use fewer than seven years of data before switching away from considering the original technical de-rating factor derived from the SKM model. As availability data accumulates on each interconnector, it may be possible to infer when operational data can be relied upon by itself using Bayesian statistics. However, this would introduce additional complexity, especially as a different solution may be found for each interconnector. It is worth noting that there may be alternative approaches to using seven years of data in the future as more data will make more detailed analysis possible. For example, the number of years of operational data necessary to derive the derating factors could be reduced for all technology types. Alternatively, more operational data from new interconnectors might allow for the consideration of an exponential decay on the SKM, with more recent years valued greater than older ones.

Interconnector availability calculations would closely resemble the calculations for conventional generation, as defined in the Capacity Market Rules:

- High Demand Settlement Periods (HDSP) are defined in the Capacity Market Rules as the periods of time when National Demand was above the 50th percentile of the demand in all the Settlement Periods falling between 7am and 7pm Monday-Friday, from the first day of December until the last day of February in each winter. National Demand data is available on the NESO Data portal[11].

The Delivery Body derives the HDSPs for each winter as part of its role to determine the de-rating factors for conventional generation.

- The actual availability of each interconnector in each of these periods can be obtained from the REMIT database. This is available from the ENTSO-E website[12] for the BritNed Interconnector and Elexon[13] for all other interconnectors. This data also includes information on the causes of the reduced availability, such as an instruction by the Transmission System Operator.
- REMIT data underwent considerable changes in 2016-17[14] in its reporting structure, therefore we do not propose using pre-2016 data due to the substantial differences in what is reported.

[11] https://www.neso.energy/data-portal/daily-demand-update/demand_data_update
[12] https://transparency.entsoe.eu/outage-domain/r2/unavailabilityInTransmissionGrid/show
[13] https://bmrs.elexon.co.uk/remit
[14] https://www.elexon.co.uk/mod-proposal/p329/

The Delivery Body has the skills to produce this analysis, including a breakdown of the unavailability causes, however any new approach would need to be agreed by DESNZ and the Delivery Body, and is subject to resourcing and timing constraints.

- In Methodology 1, the maximum potential availability for each interconnector in each period is simply the total capacity of the interconnector itself.
- However, we propose that particular settlement periods should be flagged where the maximum availability should be reduced to a lower level, if the cause of an outage was unavoidable, for example if the Transmission System Operator instructed so. We call this Methodology 2 in this report.

The Delivery Body has the skills to produce a summary of the causes of the different outages. We propose that the PTE or DESNZ would then be able to scrutinise these events and determine whether the cause was unrelated to the technical capability of an interconnector and its maximum capacity should be reduced for the corresponding settlement periods. The PTE may also revisit these decisions in later years, for example if enough operational evidence is gathered to confirm the non-repeatability of an event.

Events excluded when calculating the technical de-rating factor of an individual interconnector should still be considered by the Delivery Body. This is because it may be appropriate to include these types of events in future unknown non-delivery assumptions, provided there is no double counting with the sensitivities in the interconnector de-rating factor ranges already calculated for the Electricity Capacity Report. This process would ensure consistency with other technologies, as the Delivery Body already considers forced outages for them in the same way.

The Secretary of State would then be able to take into consideration the expert advice of both the Delivery Body and the PTE, while retaining some flexibility if the Government has access to additional information.

3.2. Worked Example for North Sea Link

The North Sea Link (NSL) interconnector became operational in October 2021 connecting GB to the Norwegian power system. This worked example illustrates how the proposed methodology would have been implemented to calculate its technical de-rating factors over the various Capacity Market auctions it has been eligible for.

The first Capacity Market auction that NSL participated in was the T-3 auction for delivery in 2022/23, taking place in early 2020. In the absence of operational information, the technical de-rating factor for this auction under the proposed methodology would be 90.49%, the low end of the availability range published as part of the Ofgem Interconnector cap and floor process[15] that used the most recent version of the original SKM model available at the time.

[15] https://www.ofgem.gov.uk/sites/default/files/docs/2016/10/ofgem_-_availability_model_update_-_final.pdf

This technical de-rating factor would be first reviewed in Spring 2022 following the first winter that NSL was operational for in 2021/22. During this winter, NSL's actual availability was 55.3% in the High Demand Settlement Periods assuming that its maximum potential availability was the total capacity of the interconnector itself. NSL's maximum flow was restricted during its commissioning period by the Norwegian system operator – setting the maximum potential availability as the maximum allowed flow, as proposed in our alternative approach, would return an actual availability of 71.0% for the winter 2021/22.

If the interconnector was in the first year of operation, the technical de-rating factor would be the minimum of the availability range derived using the most recent SKM model, updated with any new engineering data published by CIGRE.

If seven years of operational data is available, the formula would be the same as for conventional generating technology types:

$$\frac{\sum_1^7 TAA_i}{\sum_1^7 MPA_i}$$

MPAi stands for Maximum Potential Availability in a given year i, calculated by adding up the maximum potential availability as defined above for each High Demand Settlement Period. TAAi is the Total Actual Availability in a given year i, calculated by adding up the actual availability in each High Demand Settlement Period. The formula is calculated using operational data from the seven most recent years.

For interconnectors with between one and seven years of operational data, we have modified the formula above so that the original technical de-rating factor, derived from the SKM model, is continuously adjusted using actual availability data:

$$if\ n < 7, \frac{MPA_1 * DRF_{SKM} + \sum_1^n TAA_i}{MPA_1 + \sum_1^n MPA_i}$$

MPAi stands for Maximum Potential Availability in a given year i, calculated by adding up the maximum potential availability as defined above for each High Demand Settlement Period. DRFSKM is the technical de-rating factor derived using the SKM model. TAAi is the Total Actual Availability in a given year i, calculated by adding up the actual availability in each High Demand Settlement Period. The formula is only defined for n<7, as once seven years of operational data is available, the simplified formula above should be used. With each additional year of availability data, the original, SKM-derived technical de-rating factor is adjusted further by taking an overall average between it and the actual operational data.

In practice, the SKM-derived technical de-rating factor is incorporated as one year of virtual availability data until seven years of data becomes available. For simplicity, we propose using the maximum potential availability of the first year of the interconnector's operations as part of this virtual availability calculation, as this allows any adjustment due to Methodology 2 to be given appropriate weight. A limitation of this methodology is that it gives the impression that the first year of operations is being given double weight. Alternative formulations are possible and sensitivity analysis of these is expected to form part of any consultations that DESNZ and the Delivery Body might carry out. In the case of NSL, using the formula leads to an updated technical de-rating factor of 72.9% or 80.7%, depending on whether the maximum potential availability is defined as the total capacity of the interconnector, or the maximum flow allowed by the Norwegian system operator. This value would have then been first used in the 2022/23 auctions, taking place in early 2023 and procuring capacity for 2023/24 (T-1) and for 2026/27 (T-4). All auctions taking place between 2020 and 2023 would have used the original 90.49% value due to the lack of operational data.

The NSL interconnector was no longer under capacity restrictions over the winter 2022/23, with it being available 99.6% of the time in High Demand Settlement Periods, independent of the approach taken on maximum potential availabilities. Using the formula above would lead to updating the technical de-rating factors to 81.8% or 88.1% depending on the approach taken on the maximum potential availabilities. This value would have been used in the 2023/24 auctions, taking place in early 2024 and procuring capacity for 2024/25 (T-1) and for 2027/28 (T-4).

4. Results of Technical de-rating factor analysis

4.1. Implementing the proposed approach

We implemented the recommended approach described in 3.2 for all existing interconnectors for each of the past seven years, with the data presented below. In Methodology 1, we assumed that the maximum potential availability of each interconnector for each HDSP is its maximum capacity.

The results for Methodology 1 are outlined in the chart and table below where each year represents the corresponding winter. For example, the 2019 values include the cumulative availability for all winters until and including 2019/20. As there is no comparable pre-2016 REMIT data available, we used the 2016 REMIT availability data as the initial value for the proposed methodology for interconnectors that had been available since before 2016.

Figure 1: Chart displaying the Methodology 1 technical de-rating factors for interconnectors between 2016 and 2022

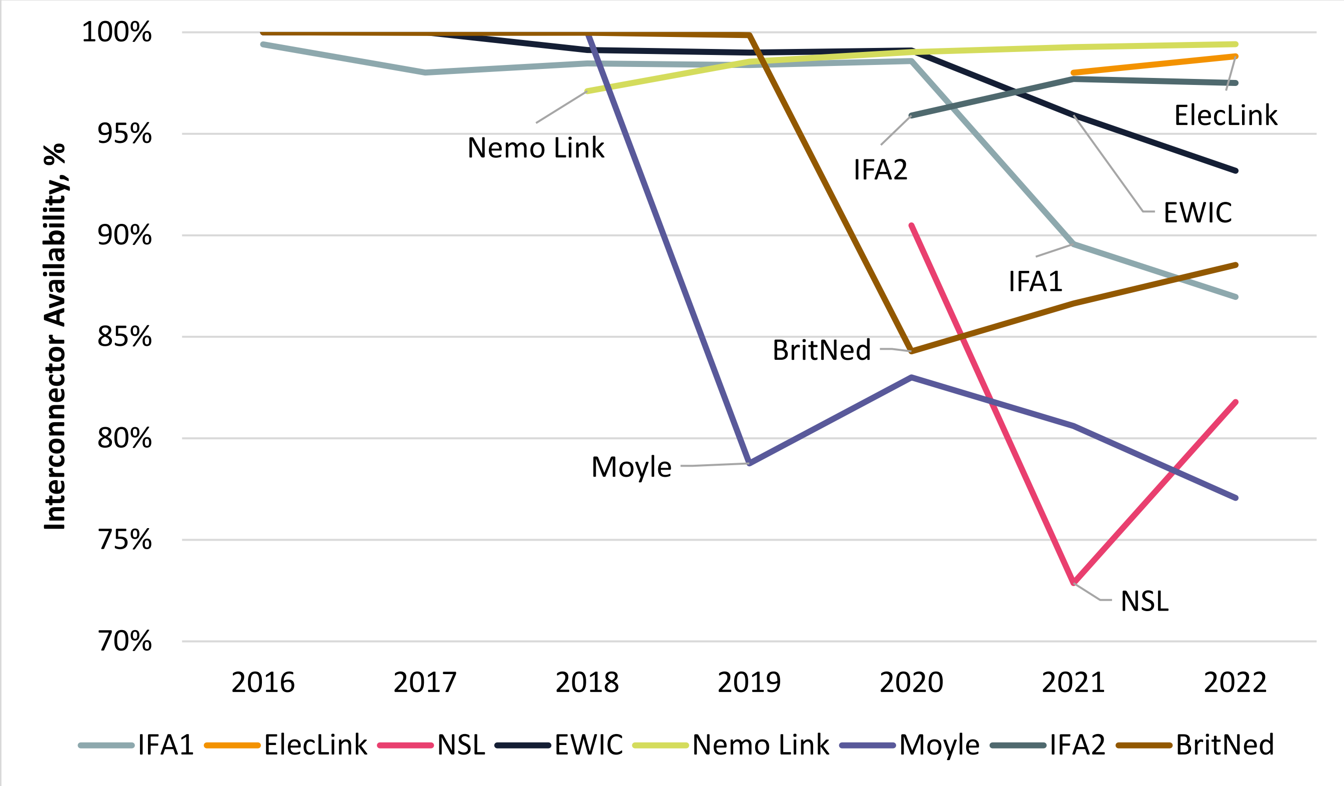

100%
95%
90%
85%
80%
75%
70%
Interconnector Availability, %
2016
2017
2018
2019
2020
2021
2022
Nemo Link
IFA2
ElecLink
EWIC
IFA1
BritNed
Moyle
NSL
IFA1
ElecLink
NSL
EWIC
Nemo Link
Moyle
IFA2
BritNed

Table 3: Methodology 1 technical de-rating factors for interconnectors between 2016 and 2022

Base case technical de-rating factors over time							
Name	**Year**						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
IFA1	99.4%	98.0%	98.5%	98.4%	98.6%	89.6%	87.0%
ElecLink	n/a	n/a	n/a	n/a	n/a	98.0%	98.8%
NSL	n/a	n/a	n/a	n/a	90.1%	72.7%	81.7%
EWIC	100%	100%	99.1%	99.0%	99.1%	95.9%	93.2%
Nemo Link	n/a	n/a	97.1%	98.6%	99.0%	99.3%	99.4%
Moyle	100%	100%	100%	78.8%	83.0%	80.6%	77.1%
IFA2	n/a	n/a	n/a	n/a	95.9%	97.7%	97.5%
BritNed	100%	100%	100%	99.9%	84.3%	86.6%	88.5%
Greenlink	n/a	n/a	n/a	n/a	n/a	n/a	97.2%
VikingLink	n/a	n/a	n/a	n/a	n/a	n/a	91.9%

The Methodology 1 returns highly volatile technical de-rating factors both across the individual interconnectors and over time. This is primarily due to outages that are largely outside of the interconnectors control or unusual events. Implementing it would lead to substantial drops in the estimated technical de-rating factors that are currently in use.

In addition to the results from Methodology 1, we have tested an alternative case to reduce some of the issues identified, labelled Methodology 2. This illustrates one potential outcome of the process to exclude certain events on the basis of expert judgement and analysis, as suggested in Chapter 3.1. For Methodology 2, we reduced the maximum availability for the following periods:

- Transmission System Operator-instructed reduction in capacity. This has been relatively common for the Moyle interconnector in recent years but has also been observed for EWIC and North Sea Link.
- IFA1 fire – the maximum availability was set according to the schedule published by IFA1 until it fully came back into service.

- BritNed outage – for the duration of the repairs after the 2020/21 winter cable outage, the maximum availability was set to 0 MW.

The maximum availability was not reduced to account for the entire depth of a given outage but to align with the stated availability in these time periods. For example, the Norwegian TSO restricted NSL flows to 1,050 MW during the initial commissioning months but it then also faced some unexpected partial outages, reducing the flow to 700 MW. The maximum availability was set to 1,050 MW for these time periods. The technical derating results after these adjustments can be seen below.

Figure 2: Chart displaying the Methodology 2 technical de-rating factors for interconnectors between 2016 and 2022

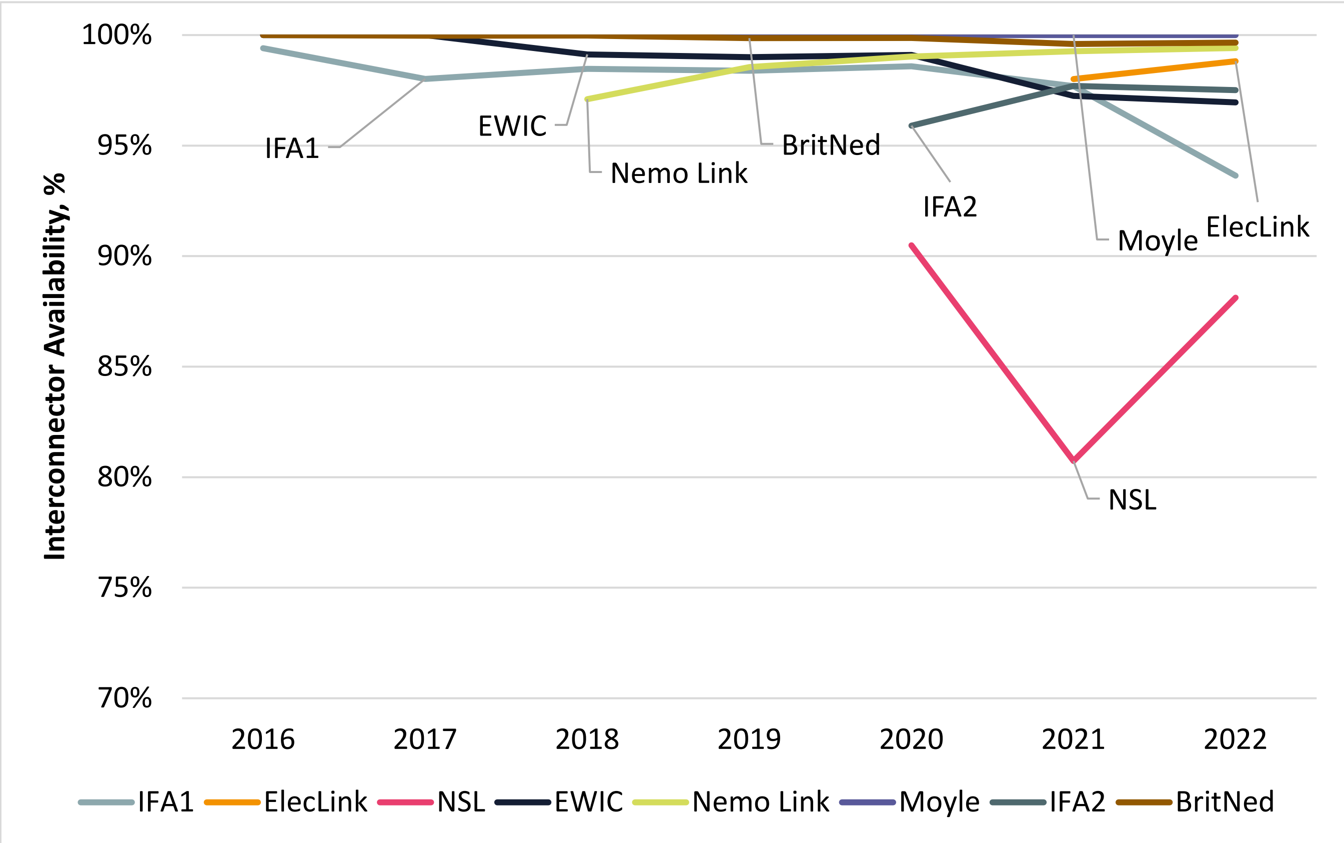


Table 4: Methodology 2 technical de-rating factors for interconnectors between 2016 and 2022

Alternative case technical de-rating factors over time							
Name	**Year**						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
IFA1	99.4%	98.0%	98.5%	98.4%	98.6%	97.7%	93.6%
ElecLink	n/a	n/a	n/a	n/a	n/a	98.0%	98.8%
NSL	n/a	n/a	n/a	n/a	90.1%	80.5%	88.0%
EWIC	100%	100%	99.1%	99.0%	99.1%	97.2%	97.0%
Nemo Link	n/a	n/a	97.0%	98.5%	99.0%	99.2%	99.4%
Moyle	100%	100%	100%	100%	100%	100%	100%
IFA2	n/a	n/a	n/a	n/a	95.9%	97.7%	97.5%
BritNed	100%	100%	100%	99.9%	99.9%	99.6%	99.7%
Greenlink	n/a	n/a	n/a	n/a	n/a	n/a	97.2%
VikingLink	n/a	n/a	n/a	n/a	n/a	n/a	91.9%

Adjusting events where the capacity reduction was caused by factors unrelated to the technical capabilities of the interconnector returns a more predictable trend for technical de-rating factors while still improving reflectivity by leading to small annual adjustments. The technical de-rating factors proposed for the T-4 Capacity Market auction for delivery in 2027/28 would also lead to much smaller adjustments to the existing values, maintaining predictability.

In particular, we can observe the following behaviour for individual interconnectors:

- Moyle had its availability reduced by the Transmission System operator for the entire winter 2019/20 and has experienced similar periodic reductions each winter since then. Implementing Methodology 1 approach would have brought down the Moyle technical de-rating factor to less than 80% following the 2019/20 winter and it would have stayed around 80% since then. Using Methodology 2 ensures that Moyle is not unfairly penalised for this, with its availability and therefore technical de-rating factor remaining at 100%.
- Similar behaviour can be observed for the EWIC interconnector, this also saw its availability forcibly reduced by the Transmission System Operator, but to a lesser

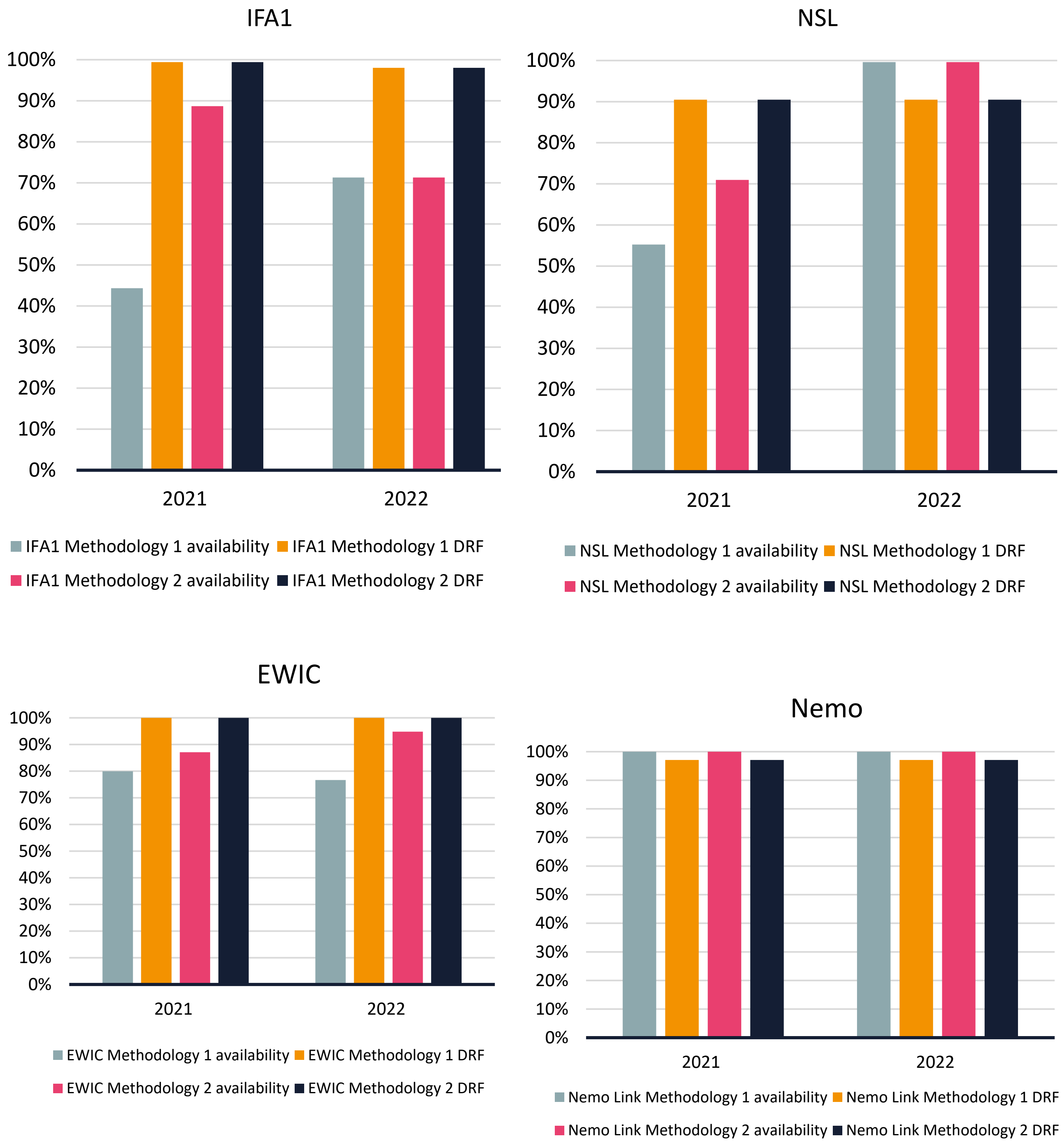
extent. In Methodology 1, it would still see its technical de-rating factor reduced to below 95%, but in Methodology 2, it remains over 97%.

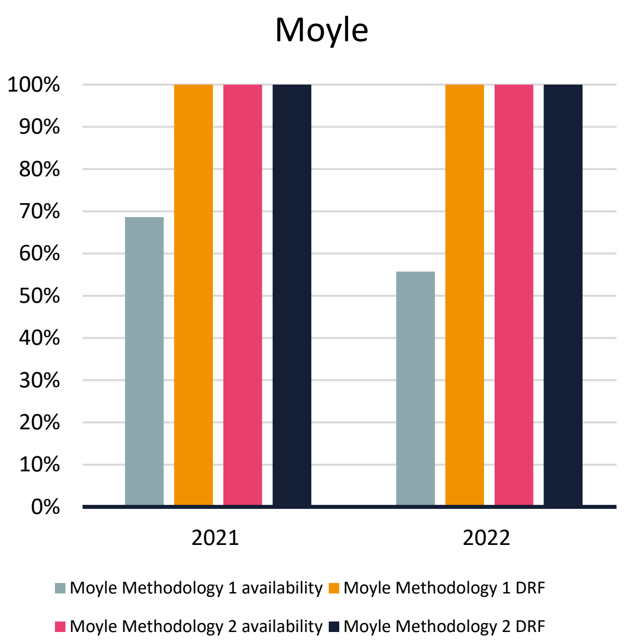
- North Sea Link was commissioned in autumn 2021 but had its capacity limited by the Norwegian Transmission System Operator. In Methodology 1 scenario, this would reduce its de-rating factor to less than 75%, but Methodology 2 ensures that it would not be penalised for this. Its technical de-rating factor still remains the lowest – this is not surprising, as it is by far the longest interconnector that had a substantially lower availability target compared to the other ones in receipt of the Ofgem cap and floor scheme.
- The interconnector BritNed only had one major incident in recent years, but this put it out of commission for months in the middle of winter. This incident would follow it for years when setting its technical de-rating factor, despite the fault having been fixed – the technical de-rating factor would drop to 84% before slowly climbing back over the years. Methodology 2 ensures that the BritNed technical de-rating factor remains unaffected by this incident and stays at 100%.
- The fire at the IFA1 terminal in September 2021 reduced the availability of the interconnector for over a year as sensitive instruments were being procured during the repair works. The interconnector did not fully shut down during this time and the other half continued to undergo regular maintenance and experienced some minor outages. In Methodology 1, both these minor outages and the effect of the fire would be included in the technical de-rating factors that are set four years in advance, reducing the de-rating factor to under 90%. In Methodology 2, the technical de-rating factors remain close to the historic averages.
- Two interconnectors were yet to start operations at the time the analytical work in this report was completed in early 2023 (VikingLink and Greenlink), these are proposed to use their availability targets as defined by the SKM model (91.9% and 97.2%, respectively) as their technical de-rating factor until operational data becomes available for them.
- Three interconnectors have not suffered any major outages that required special consideration in recent years (IFA2, Nemo Link and ElecLink), therefore the proposed technical de-rating factors are the same in both Methodology 1 and Methodology 2 – typically, well over 95%.

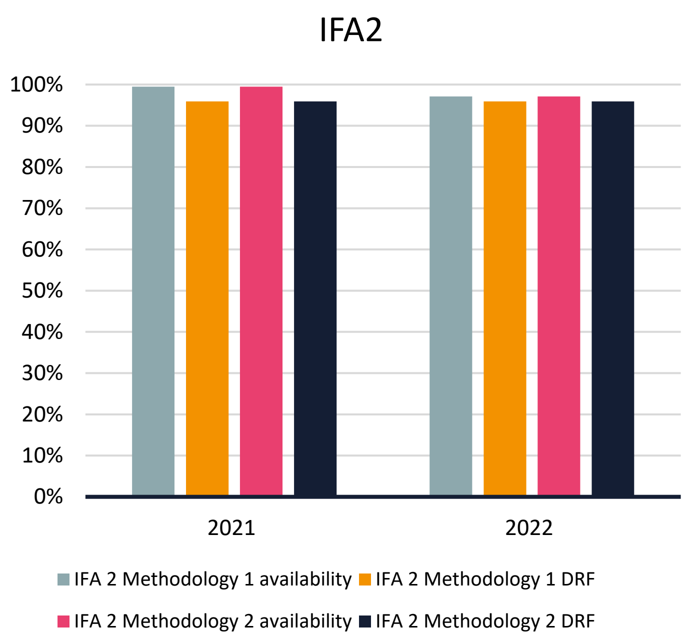
4.2. Comparison to real-life observations

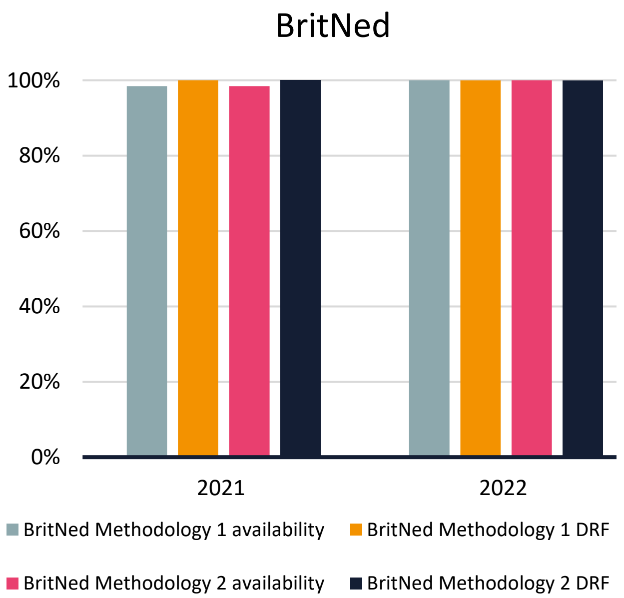
Interconnectors normally participate in the T-4 auctions that procure capacity four years ahead of the delivery year. In practice, this means that the technical de-rating factor updated based on availability data in a given winter will impact the calculation of the interconnector's contribution to security of supply several years into the future. For example, following winter 2016/17, the availability data would feed into the de-rating factors used in the 2017/18 auctions, which would procure capacity for the 2021/22 delivery year. Due to this delay, the lack of comparable pre-2016 REMIT data and the number of new interconnectors that have come online in recent years, comparison to real-life observations is limited to 2021 and 2022 for most interconnectors. In the graphs below, we compare the availability of each interconnector in a given delivery year with the technical-derating factor that would have applied to it under our proposed methodology.

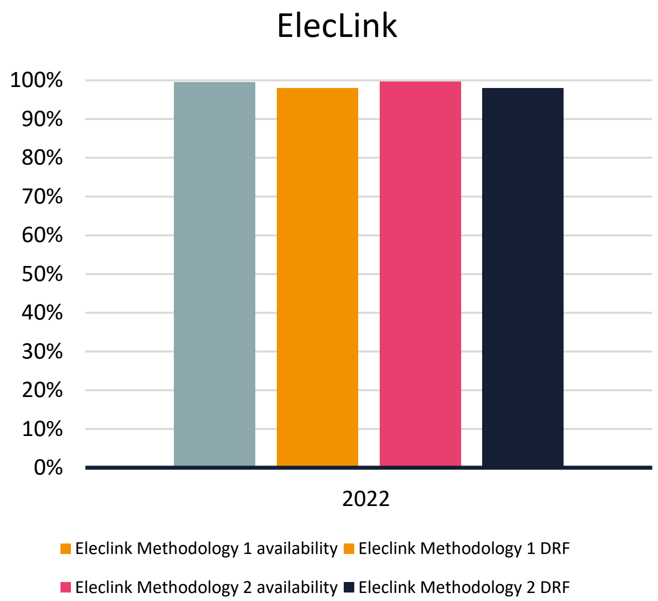
Figure 3: Proposed technical de-rating factors compared to the actual availability in the T-4 delivery year they would have applied for.











The comparison reveals that technical de-rating factors do not have a strong predictive power for the availability of a given interconnector due to the considerable in-built delay. In particular, we can observe the following behaviour for individual interconnectors:

- The fire at the IFA1 terminal in September 2021 greatly reduced the availability of the interconnector. Additional issues at the site meant that even when using the reduced maximum flow as the maximum potential availability, the actual availability was low. However, the technical de-rating factors applied to the 2021/22 and 2022/23 delivery years would have been set based on availability information in the 2016/17 and 2017/18 delivery years, when IFA1 had much higher availability.

- The technical de-rating factor of North Sea Link would have been set by the original SKM model-based availability for both delivery years included in this comparison. In practice, NSL had a difficult commissioning process with its maximum capacity affected by both instructions from the Transmission System Operator and equipment issues. Neither of these could have been foreseen in 2019 when its technical de-rating factor was set.
- In future years, it is possible for the impact to be reversed. Apart from its 2020 incident caused by outside forces, the BritNed interconnector never had an availability below 98.5%. However, Methodology 1 would lead to it having a relatively low technical de-rating factor for years, which is unlikely to reflect the actual availability to be recorded.

Overall, the comparison to real data illustrates the difficulty of predicting availability of interconnector four years ahead of time with ‘shock events’, like the IFA1 fire having a major impact on availability that could not be predicted. However, for most of those interconnectors that did not have any ‘shock events’ our methodology shows reasonably good alignment to the actual availability. Ignoring ‘shock events’ as suggested in Methodology 2 avoids an undue and long-lasting influence of these on technical de-rating factors.

5. Overall recommendations

In this report, we deliver a new set of technical de-rating factors to be used as part of the Secretary of State’s work in determining interconnector’s contribution to security of supply. We also propose a new, formalised methodology on how these technical de-rating factors can be kept up-to-date annually, both for existing interconnectors and for new ones. The new approach incorporates both engineering information on the physical characteristics of individual components of an interconnector, and the capability to update these values annually as availability information becomes available.

We carried out analysis to show what the impact of adopting such an approach would be according to two cases. In Methodology 1, we simply calculated the availability of each interconnector while assuming that it should be able to deliver at maximum capacity, leading to highly volatile results. We proposed calling upon the Panel of Technical Experts to examine each major outage that led to these results over the past few years to see if any should be excluded due to the event being outside the reasonable control of the interconnector. We explored this approach by removing all of these events and adjusted the availability calculation to illustrate the full impact of this approach. This has led to a more stable technical de-rating factor over the years but may reduce reflectivity, with the technical de-rating factors diverging from observed availability.

We recommend that the Government adopt an approach similar to Methodology 2 as presented in this report to account for any outages that may have been outside reasonable control of the operators. The actual adapted approach is expected to lead to different results than the ones presented in this report depending on the discretion of the PTE and insights from the Delivery Body relating to each event. The final roles and responsibilities between DESNZ, the Delivery Body and the PTE is expected to be agreed at a later date. DESNZ may choose to take the proposed methodology forward or apply any slight modifications towards a final methodology.

We note that Offshore Hybrid Assets are expected to come online in the coming years, with a potential contribution to security of supply. The methodology to consider their technical de-rating factors is outside the scope of this project but we expect that a similar approach may be appropriate to consider if OHAs are considered eligible for the Capacity Market.

This publication is available from: https://www.gov.uk/government/publications/capacity-market-technical-derating-factors-for-electricity-interconnectors