Panel of Technical Experts

Report on the National Grid ESO Electricity Capacity Report 2022

July 12, 2022

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Preliminary Comments & Summary of Recommendations

1. The role of the Panel of Technical Experts (“PTE”) is to scrutinise with impartiality and to contribute to the quality assurance of the annual Electricity Capacity Reports by National Grid ESO. The purpose is to provide technical advice to inform the policy decisions at BEIS for the subsequent Capacity Market auction procurements, through this report and informal consultations.

2. The annual scrutiny cycle for this PTE report started in August 2021 with consideration of several special projects being undertaken by National Grid ESO related to their modelling. These deliberations continued through the autumn. By April and May 2022, the PTE were presented with the initial results from the modelling for the 2022 ECR.

3. The PTE members who prepared this report are Professor Derek Bunn (Chair), Dr Guy Doyle, Professor Nick Jenkins, Professor Frank Kelly and Lisa Waters.

4. In fulfilment of our role, we have scrutinised National Grid ESO’s 2022 Electricity Capacity Report on the target capacity for the proposed T-1 Auction for delivery year 2023/24 and the T-4 Auction for the period(s) commencing 2026/27, and this document presents our conclusions.

5. Through our previous reports (2014-2021), the PTE has made 65 recommendations in total (of which 8 were from 2021) for improving the methodology and reliability of the modelling by which target capacities are calculated. National Grid ESO has taken actions on most of these as reported in Section 2.5 of the ECR. As usual, we make some recommendations for future work. In doing so the PTE are mindful of the need for the appropriate processes and procedures to be followed ahead of any changes that may be undertaken.

6. The PTE has engaged in relevant discussions with National Grid ESO, BEIS and Ofgem during the process of National Grid ESO formulating the Electricity Capacity Report 2022. We are satisfied with the constructive and timely consultations and believe that all parties have worked well together in formulating the analysis and recommendations.

7. The overall analytical approach has been similar to previous years, updated with new information. We have been provided with the modelling documentation and assumptions required for our scrutiny.

8. We agreed on the sensitivities that went into the estimation and the application in the ‘Least-Worst Regret’ criterion to determine capacities to procure.

9. We have considered the target capacity recommendations by National Grid ESO and make the following recommendations:

    - For T-1, we accept the recommendation of 5.8GW in the ECR. We recognise that it will be a high procurement but set in the context of the higher requests by the Secretary of State for extra capacity for 22/23, it appears to be prudent.
    - For T-4, we accept the 43.9 GW recommendation in the ECR and note that this is slightly lower than the T-4 request in the previous 2021 ECR. Again, we recommend a detailed reconsideration of the supply-side of the Base Case and the non-delivery sensitivities in the autumn.

10. Without having direct evidence to suggest reductions to these targets, the PTE has a responsibility to be concerned about potential over procurement and the consequent costs to society. We anticipate that more information will become available in time for any autumn adjustments and suggest that a careful re-evaluation of the supply-side of the Base Case and the non-delivery assumptions be undertaken at that time. At the time of writing, the geopolitical concerns for gas supplies to Europe are considerable and we note they were not taken into account in the ECR. How the geopolitical situation may evolve for 23/24 and 26/27 is highly speculative and we agree that there is no strong evidence to change the base-case assumptions at this point, notwithstanding the need to maintain the high non-delivery sensitivities in the analysis.

11. We summarise our recommendations for interconnector de-rating factors below.

PTE Recommended Country De-rating Factors		
	2025/26	**2026/27**
Ireland	50%	55%
France	76%	70%
Belgium	66%	65%
The Netherlands	68%	62%
Denmark	69%	60%
Norway	91%	91%

12. Overall, we were very satisfied with the open and constructive process of engagement with National Grid ESO and BEIS. We thank them for their extensive efforts to develop clear and timely analysis and address many of the technical issues which we have raised. We have also taken note of various industry comments invited by National Grid ESO on the approach to interconnector derating estimation.

Recommendations

The new recommendations in our report are listed below. The numbering follows on from the 65 Recommendations in previous PTE reports.

Recommendation 66: To accelerate the work on the statistical representation of peak demand uncertainty around the Base Case for the T-1 and T-4 years with a clear identification of what uncertainties can be modelled statistically and what are being left to expert judgement.

Recommendation 67: Analysis of the price elasticity of demand by market segments in order to better understand the underlying demand under current high prices and potentially project future high price sensitivity more accurately.

Recommendation 68: To consider if the capacity of facilities providing ancillary services is being accounted for properly in the resource adequacy calculation under stress events.

Recommendation 69: To investigate if network infrastructure constraints present a material degradation of the achievement of the reliability standard for capacity adequacy.

Recommendation 70: To consider the use of operational data for estimating wind derating factors instead of, or in combination with, the model-based EFC approach used at present.

Recommendation 71: To consider the use of operational data for estimating battery derating factors instead of, or in combination with, the model-based EFC approach used at present.

Recommendation 72: To expand the statistical analysis of ICDRFs to fully understand the implication of bimodal distributions for individual flows and their correlations on the aggregate and individual risks of GB interconnections.

Recommendation 73: The modelling parameters in the ECR related to the reliability standard are not well matched to the preferences and policies of procurement. It would improve the relevance of the ECR exercise if BEIS were to reinstate its intention to review the reliability standard and its implementation.

Introduction

Role of the Panel of Technical Experts

13. The Government commissioned, through an open and transparent procurement process, an independent Panel of Technical Experts (the PTE) for the enduring Electricity Market Reform (EMR) regime, commencing in February 2014. The role of the Panel of Technical Experts (PTE) is to scrutinise with impartiality and to contribute to the quality assurance of the annual Electricity Capacity Reports (ECRs) by National Grid ESO, in its role as Delivery Body for the Capacity Market. The purpose is to provide technical advice to inform the policy decisions at BEIS for the subsequent Capacity Market auction procurements.

14. The PTE's first report on National Grid's analysis to inform Capacity Market decisions was published in June 2014. This is the PTE's ninth report, focused on the modelling and results of National Grid ESO's recommended capacity to secure for the 2026/27 T-4 auction and for the 2023/24 T-1 auction.

15. The background of the members and terms of reference of the PTE are published on the Government website.[1]

16. This report has been prepared for BEIS by Professor Derek Bunn (Chair), Dr Guy Doyle, Professor Nick Jenkins, Professor Frank Kelly and Lisa Waters.

Scope

17. The scope of the PTE's work is to impartially scrutinise and quality assure the analysis carried out by National Grid ESO for the purposes of informing the policy decisions for the Capacity Market procurement. This includes scrutinising: the choice of models and modelling techniques employed; the inputs to that analysis (including the ones BEIS provides); and the outputs from that analysis - scrutinised in terms of the inputs and methods applied. The PTE review whether the analysis is robust and fit for the purpose of Government taking key policy decisions. This includes, for example, considering potential conflicts of interest National Grid ESO or others involved might have in influencing the analysis.

18. The PTE has no remit to comment on the Capacity Market mechanism design, its regulation or wider EMR policy, Government's objectives, or the deliverability of those objectives, unless otherwise requested. Furthermore, aspects of risk excluded from the National Grid ESO analysis, such as political risk, are also excluded from our consideration. The PTE's Terms of Reference mean it cannot

[1] https://www.gov.uk/government/groups/electricity-market-reform-panel-of-technical-experts

comment on affordability, value for money or achieving least cost for consumers. These matters are outside the PTE's scope and therefore from this report. Nevertheless, the PTE is mindful of the need to avoid the costs to consumers of over-procurement. The role of the Panel is a technical function and not a forum for policy commentary or for advising the Government on its objectives, the policies being implemented or policy decisions surrounding them. This means the Panel does not have a role in advising how the analysis should be interpreted for the purpose of those policy decisions, but we have commented where those impact the modelling and parameter setting in the ECR.

Process

19. During the course of the PTE's work, National Grid ESO has presented its methods, assumptions and outputs in relation to their core task of recommending the auction target capacity in the Capacity Market and the PTE has had opportunity to question National Grid ESO during the development of its analysis and recommendations.

20. To carry out its work, the PTE met with National Grid ESO, BEIS and Ofgem regularly during the autumn/winter 2021/22 to discuss development projects, the production plan and modelling outputs for 2022. Subsequently, the PTE provided interim views to BEIS before presenting preliminary drafts of this report for further considerations and feedback from BEIS, Ofgem and National Grid ESO.

21. The PTE has generally focussed more closely on the areas that appeared to be of highest impact and greatest uncertainty. Key areas that emerged included:

    - Demand evolution
    - Non-delivery estimation and aggregation
    - Interconnector de-rating

22. As required by the PTE's Terms of Reference, the PTE also kept in mind the potential for National Grid ESO to be confronted by potential conflicts of interest. The PTE, throughout this process, has sought to mitigate this by carefully challenging assumptions and throughout the process the PTE has maintained a presumption that a natural tendency for any utility or TSO would be to slightly over-secure resources. We note that National Grid ESO would bear some of the loss of reputation for any blackouts, and bears none of the costs of over-procurement, and so could be expected to weight the possible risks of procuring less capacity more than they might credit the cost-savings. The PTE, however, has no evidence that would make us believe that National Grid ESO has substantially exploited its privileged position and hence there has been no conflict of interest concern up to the time of writing this report.

23. This report is not comprehensive nor is it a due diligence exercise, but the PTE believes that it has nevertheless identified some important issues that have material consequences. Accordingly, and in line with our approach in previous years, the PTE has not remarked on details of various matters which were raised and satisfactorily resolved or are part of on-going development.

24. This report has been prepared from information provided by BEIS, National Grid ESO and Ofgem and the collective judgement and information of its authors. We have also taken account of several written stakeholder responses to the interconnector derating material made public by National Grid ESO. Whilst this report has been prepared in good faith and with reasonable care, the authors expressly advise that no reliance should be placed on this report for the purpose of any investment decision and accordingly, no representation of warranty, expressed or implied, is or will be made in relation to it by its authors and nor will the authors accept any liability whatsoever for such reliance on any statement made herein. Each person considering an investment must make their own independent assessment having made whatever investigation that person or organisation deems necessary.

Commentary on Analysis and Results

Introduction and context

25. As in its previous ECRs, National Grid ESO lays out its modelling approach and its scenarios and sensitivities that frame its findings on the amount of capacity to secure in the auctions to meet the Government's reliability standard of 3 hours Loss of Load Expectation (LOLE). Whilst the 3 hours LOLE has been the expressed target, in practice it has been interpreted as 3 hours LOLE under a cautious ("Least Worst Regret", LWR) consideration over the range of sensitivities. This means that the LOLE in recent years has been much less than 3 hours both in the Base Cases and in the actual out-turns. Given the difficulty of communicating the LOLE target, we find it very useful to see in this year's ECR that the recommendations indicate how the anticipated de-rated margins compared to previous years.

26. The major elements in the analysis are domestic Demand and Generation, together with an increasing reliance upon Interconnection resources from neighbouring countries. The de-rating factors are also crucial, and we need to assess whether the overall methodology is fit-for-purpose. We therefore organise this section according to these main elements.

Demand

27. Forecasting peak demand is the natural starting point for the ECR, and the methodology undertaken by National Grid ESO followed the same principles as in previous years. The details however are steadily being refined and improved. The Underlying Demand is made up of metered National Demand (~75%), Demand met by Embedded Generation (~24%) and Demand Side Response (~1%). Forecasting peak demand is challenging as only 75% of demand is metered at the level of the transmission grid and this fraction is decreasing, as embedded generation increases. Peak National Demand has reduced by more than 11GW in the 10 years to 2020 although it increased by ~1 GW from 2020 to 2021. Demand forecasting has become increasingly difficult with changes in consumer engagement and embedded energy resources. We have discussed at length the steps taken by National Grid ESO to remain vigilant to these changes and have actively supported efforts to improve data on distributed resources. The impact of COVID-19 created particular difficulties in the forecasting of peak demand. These challenges have been compounded by uncertainty of the effect of the very high prices of electricity currently being experienced and government action that is taken to reduce their impact on some consumers.

28. Last year, two development projects addressing demand were proposed by PTE and taken forward by National Grid ESO to investigate uncertainties in estimates of peak demand used in the T-1 and T-4 Base Cases. These recommendations (PTE58 and PTE59) were:

> Recommendation 58: A more comprehensive feed-forward analysis of how all of the main drivers of demand will evolve from the existing situation to influence the T-1 and T-4 Base Case peak demands should be developed to enhance the insights from the FES scenarios. This should provide a more comprehensive and a more explicit representation of the ranges of uncertainty around the Base Case forecasts with these ranges of uncertainties being quantified as much as possible.
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> Recommendation 59: The previous Recommendation 52 regarding the factors affecting the evolution of peak demand and potential stress period behaviour should be re-visited soon given the importance of the drivers on the shape of peak demand and its impact on the capacities to secure, particularly the T-4 value.

29. In response, National Grid ESO proposed a comprehensive programme of work to improve understanding of the evolution of peak demand and uncertainty in the demand predictions used in the Base Cases. The programme of work that was proposed extends over 5 years with detailed activities identified for the 1st and 2nd years. Activities identified for the 1st year included:
    - Disaggregation of total demand and descriptive analysis of the elements making up demand;
    - Statistical analysis of annual energy/peak demand ratios;
    - Investigation of explicit sensitivities to the main drivers;
    - Investigation of the effect of Triad removal; and
    - Assessment of uncertainty of demand estimates used in the Base Cases.

30. Progress has been made in the 1st year of the programme of work with the definition of a comprehensive load model and analysis of the evolution over time of peak demand including the causes and evolution of losses in the transmission and distribution networks. However, if the current timescale of a development project lasting a further 4 years is maintained, any new analytical approaches will only become fully effective for T-4 in 2030. By that time there are likely to be major changes in the constitution of load, metering and flexible operation. Hence, we consider the five-year timescale on developing a better statistical model for peak demand to be too slow, notwithstanding the resource constraints at National Grid ESO.

31. We observed in our discussions of this work that while the statistical sampling-based analysis of annual peak demand to annual energy was a very useful ingredient and start in understanding the uncertainty ranges, it still requires further work on the uncertainty of the energy projections. We therefore reaffirm our encouragement to move this work towards developing a thorough

representation of P5 and P95 ranges for peak demand with a clear identification of what uncertainties can be modelled statistically and what is being left to expert judgement.

Recommendation 66: To accelerate the work on the statistical representation of peak demand uncertainty around the Base Case for the T-1 and T-4 years with a clear identification of what uncertainties can be modelled statistically and what are being left to expert judgement.

32. Given the importance of estimating peak demand robustly it is recommended that the programme of work proposed by National Grid ESO in response to PTE58 and PTE59 continues to receive priority. The work programme proposed for years 2-5 should be re-confirmed for next year recognising the changing economic conditions. In the context of this, particular consideration should be given to understanding the increase in peak National Demand that was experienced this year and may be due to reduction of the output of embedded generation and the anticipated changes to the Triad charging rules that were postponed by 1 year. We think a new emphasis on the price elasticity of demand of the various sectors may now be opportune given the potential for a new regime of high retail electricity prices to persist.

Recommendation 67: Analysis of the price elasticity of demand by market segments in order to better understand the underlying demand under current high prices and potentially project future high price sensitivity more accurately.

Domestic Supply

33. As seen last year, the non-delivery of Capacity Market plant is the key driver behind the level of the target capacity to be secured in both the 2023/24 T-1 and the 2026/27 T-4. The T-1 non-delivery results in a target of 5.8 GW, 4.6 GW higher than the 1.2 GW previously set-aside in 2019. The 43.9 GW target for the T-4 is also driven by the 3.2 GW non-delivery sensitivity. The PTE has considered issues around modelling non-delivery with National Grid ESO, BEIS and Ofgem over the course of their work.

34. The PTE is grateful to National Grid ESO for the work that they have done to respond to Recommendation PTE 61. National Grid ESO's analysis of past non-deliveries and non-availabilities showed more than 2 GW non-delivery (on average) per delivery year and a high case of 6.5 GW in 2020/21. The PTE considers non-delivery to be a cause for concern, and we welcome the ongoing

work around how National Grid ESO can better model it, so as to not leave the T-1 auction trying to secure more significant volumes of capacity than are likely to be available.

35. The PTE note that National Grid ESO's work to date around non-delivery has illustrated several issues:

    - There has been significant non-delivery of large thermal plant that could not have been reasonably foreseen, such as plant in administration;
    - The timing of the closure of the older nuclear plants continues to add to uncertainty;
    - Non-delivery by smaller, embedded plant seems more stable, but delayed or non-delivering plant could be visible to National Grid ESO in a more timely manner;
    - Closing plant over the winter results in a de-rating of zero that suggests non-delivery;
    - DSR non-delivery also seems to have increased; and
    - Significant levels of non-delivery only materialised after the T-1 auction (i.e. the last time BEIS can take action to secure capacity for the delivery year).

36. National Grid ESO had considered some of these issues in the changes made in the 2021 ECR, resulting in higher recommendations for the Capacity Market auction targets. However, the PTE notes that National Grid ESO's market intelligence could still be improved by more timely information provision.

37. We further note, as we did last year, that plant not submitting MELs (Maximum Export Limit) over the winter appear as non-delivery. This capacity may be able to generate in a Capacity Market Event, for example if the price were high enough or a Capacity Market Event is outside the winter months. It is also difficult to know when/if plant that was in administration will come back and National Grid ESO is reliant on REMIT data to signal return to service. However, the plant currently mothballed [i.e. Severn Power and Sutton Bridge generation assets], did not participate in last years' auctions, though we note BEIS's recent consultation on liquidity to facilitate their return this year.

38. The closure of Dungeness and expected closure of Hinkley Point B does leave less nuclear capacity available. However, with the role of interconnectors, the poor performance of nuclear plant both in the UK and interconnected markets, notably France, remains an issue. Hinkley Point C is now not due to be generating until in mid-2027, so is not relevant for the current Capacity Market

targets, but the PTE notes that other UK nuclear plant could close earlier than currently expected[2] and this risk therefore remains.

39. Generally, the way National Grid ESO's sensitivities seek to deal with the non-delivery issue is supported by the PTE, but we remain concerned that non-delivery can result in a larger capacity requirement in the T-1 auctions, which in recent years has increased the cost of the Capacity Market for consumers. It is not for the PTE to advise the Government on how much capacity it secures, but we have considered, with National Grid ESO, if further changes could be made to their modelling to better reflect the levels of non-delivery being observed. The PTE supports their project to explore alternative ways of modelling this uncertainty statistically around the Base Case.

40. A particular issue seen around non-delivery has been the lack of visibility to National Grid ESO when it has made its T-1 recommendations, and some did not actually become visible until the after the T-1 auction, so were not accounted for in the adjustment to the Demand Curve Update that occurs after prequalification. The levels of past non-delivery are higher than modelled in previous ECRs, leading to a change last year, which the PTE fully supported. This change has been carried forward this year and the PTE agrees that this does better reflect the non-delivery risk that has been observed.

41. As noted in PTE62, the information National Grid ESO has on non-delivery could be improved with the timing of the Capacity Market activities. While this is for BEIS and/or Ofgem to take forward, we very much hope the future reviews of the Capacity Market will consider the timing of all Capacity Market related events to try to add transparency to the process and better information to National Grid ESO's modelling in particular. Consideration could also be given to the ability of plants to declare themselves unavailable far earlier than the Capacity Market Rules currently allow.

42. There seem to be a number of views as to why non-delivery arises, including:
    - Non-delivery rules being too lenient;
    - Secondary trading being too difficult;
    - There is limited incentive to "over deliver" and early delivery is only likely for smaller plants;
    - For larger plant there is not enough large, eligible, non- Capacity Market plant for them to trade to; and
    - Black Swan events can significantly impact capacity in a manner that cannot be reflected in the LWR modelling.

[2] Hartlepool, Heysham 1 – are both due to close in March 2024.

43. There does seem to be some market response to non-delivery, with some plants staying open, notable larger thermal plant. However, the PTE notes that the hard coal closure date has probably discouraged coal plant owners from investing in their plant, so while open it may not be as reliable, and the PTE agrees with the way the older plant, opting out of the Capacity Market is derated to reflect this.

44. Consideration of the non-delivery uncertainty leads to an economic question about whether buying additional capacity in the T-4 auction results in better value for money for customers than ending up needing to secure additional capacity in the T-1 auction. The PTE recognises that for Government there is a risk that securing more capacity in T-4 could lock in unabated gas, making meeting net zero commitments more challenging.

45. On the modelling of non-delivery (PTE Recommendation 60) we welcome National Grid ESO's recognition that both the risk of non-delivery and over-delivery is potentially the only element of uncertainty that is not incorporated into the probabilistic LOLE calculation. We have discussed with National Grid ESO the work they have commissioned, which suggested that:

    - Modest levels of non-delivery (e.g. similar to past levels) could be modelled by an adjustment of the availability parameters through a non-delivery probability and, in the absence of common-cause events, modest non-delivery of the existing model would not need recoding;

    - Additional supplementary analysis could assess the impact of more extreme non-delivery, which may be difficult to model probabilistically because of the lack of data on unusual events.

    The PTE supports the distinction proposed by the commissioned work between non-deliveries for which there are sufficient data to estimate probabilities, and non-deliveries for which subjective judgements are required. The PTE agrees with National Grid ESO that the additional supplementary analysis required in the latter case may help decision makers understand the actions needed to mitigate the severe risks arising from extreme non-delivery even if these scenarios were not used in the actual decision-making process. It is important that this work is progressed as it would be an important step towards developing a fully stochastic approach to resource adequacy risk.

46. On the details of the non-delivery assumptions, the PTE believes that these have been sensible. As we have noted above, it would be useful if National Grid ESO knew earlier about non-delivery due to termination of Capacity Market Agreements. We have also proposed (PTE48) that the Capacity Market Registers should be linked to the Transmission Entry Capacity (TEC) Register

to ensure that the capacity rights for delivery align with Capacity Market obligations. Though we do note that there are sites where some of the capacity will be serving on-site customers, who if the plant is off will take power from the rest of the system. If they have TEC equal to their obligation that does not seem to create any issues.

47. The PTE notes that the additional over-delivery did not change the target capacity resulting from the modelling. As noted in previous years, we see little incentive for over-delivery except the economics of plant holding older plant onto the network. In light of the gas prices seen as a result of the Ukrainian crisis and the request by the Secretary of State to National Grid GESO to secure coal capacity, this may lead to more coal staying open to 2024. However, as the coal closure date is set, it would take a change in policy to see coal stay beyond October 2024.

48. Whilst it is not within the scope of the PTE Report to suggest new Capacity Market rule changes, we observe that rewards for over-delivery may be a way to balance the risks of under-delivery and improve the market response element in the non-delivery calculation.

49. The PTE has persistently raised concerns around the data National Grid ESO relies on for forecasting delivery by embedded plant, as well as setting deratings. While we acknowledge National Grid ESO did consult on changing the way the de-rating factors for embedded plant are calculated, as PTE53 proposed, the PTE agrees with respondents that output is not the same as availability. The PTE feels that this issue has now gone on long enough to justify some consideration of ways to address the fundamental data issues.

50. While our role is to comment on the modelling underpinning the ECR, this would be improved if the data available on embedded plant was improved. We have previously expressed our disappointment that National Grid ESO has not raised any changes to the industry codes to address this data issue. However, we note that there are a number of ways this could be done, such as putting more embedded plant into the Balancing Mechanism or requiring DNOs to publish availability and output data from larger distributed energy resource (DER) sites. With increasing volumes of DER this would not only benefit the Capacity Market but could be critical to National Grid ESO in taking the whole system approach that its Business Plan 2 envisages and Ofgem and BEIS propose for the new Future System Operator (FSO). Further it could create data sets on demand reduction, as well as embedded generation.

51. Ofgem did look at delivered energy from winter 2020/21, but did not share the findings of their investigations with the PTE. However, until data on DER starts to be systematically and robustly collected, the market will not understand the

full scale of over/under delivery from this section of the market and the de-rating factors applied to embedded assets will not be as accurate as desirable. We therefore continue to urge National Grid ESO, BEIS and Ofgem to consider how best to secure robust data on the DER market.

52. During our discussions with National Grid ESO, the PTE have noted that ancillary services are not self-despatched in a Capacity Market Event (if, under the Capacity Market Rules, they are Relevant Balancing Services). There are increasing volumes of ancillary services, often contracted for extended periods. Nevertheless, in the ECR, National Grid ESO assume that (apart from the reserve for largest loss) such contracted plant would be generating in a stress event. Some of the new services, such as Dynamic Containment, may, furthermore, provide only limited energy in a stress event depending on the system state. The PTE therefore suggests that National Grid ESO should consider removing a quantity of balancing services from the available peak generation to recognise this.

Recommendation 68: To consider if the capacity of facilities providing ancillary services is properly being accounted for in the resource adequacy calculation under stress events.

53. The PTE has previously recommended, with increasing interconnection, that performance of HVDC cables should be considered (PTE56). We have also become concerned by the increasing levels of transmission constraints within the GB market. While the large majority of constraints arise from Scotland into England, impacting more renewable generation, they have also been seen in a number of other areas where they could limit conventional generation and interconnector flows. We recognise that the Capacity Market is about resource adequacy and not network performance, but it would be useful to understand to what extent the achievement of the reliability standard in practice may be affected by the network infrastructure.

Recommendation 69: To investigate if network infrastructure constraints present a material degradation of the achievement of the reliability standard for capacity adequacy.

54. Hydrogen and CCUS are not in the 5-year forecasts and the PTE agreed with National Grid ESO that these are reasonable assumptions. However, we may see some of these projects progress faster in light of the market shocks we have recently witnessed and we welcome National Grid ESO keeping developments under review.

55. The PTE notes that for the coming winter, not only did BEIS choose to buy all available capacity in the T-1 auction, but it is now asking National Grid ESO to seek to secure further capacity for the coming winter. We welcome the commitment by National Grid ESO to keep the impact of the tragic Ukrainian crisis under review, but we consider this to be a Black Swan event that would not have altered the target capacity if modelled in 2018 for the 2022/23 T-4 auction. The PTE had previously asked National Grid ESO to review Black Swan events (see PTE46 report 2020) and agreed with National Grid ESO that the inclusion of such events does not materially alter the target capacity.

Domestic De-Rating Factors

56. National Grid ESO has used the same methodology for calculating the derating factors as last year and so there are comparatively few aspects to comment on.

57. Most conventional generation technologies are seen to have de-rating factors in the high 80%'s to mid-90%'s, while coal and nuclear are closer to 80%. The main changes on last year's values are nuclear – down 2% (to 78%) and DSR down 7% to 71.5%.

58. Figure 45 in the ECR shows considerable variation in availabilities between years, especially for coal (61% to 91%) and biomass (77% to 94%). Coal bounced back to 88% in 2021/22 interrupting a previously downward trend. Nuclear plant availabilities have varied from 72% to 88%, with a generally declining trend. Gas plant dominated by CCGTs shows much less variability at 88% to 95%, but even the peak number achieved in 2016/17, is lower than what is typically recorded in many jurisdictions operating single buyer models with high penalties for unavailability.

59. For the variable renewable generation technologies – wind and solar PV – National Grid ESO uses the incremental Equivalent Firm Capacity (EFC) approach as before. This is forward-looking approach which simulates the value of each Variable Renewable Energy (VRE) technology independently using the Unserved Energy Model (UEM) to estimate the equivalent capacity of firm generation for an incremental unit in a system at 3 hours LOLE. As previously, wind has a much higher EFC than solar PV (which is to be expected given that PV is not available in the evening peak). The wind derating factors have not changed markedly, with offshore showing greater values. Solar EFCs have changed with T-4 increasing by 1.7% to 5.0%, and T-1 increasing by 1.1% to 3.3%. National Grid ESO says these increases reflect the interplay with electricity storage, which impacts the role PV can play in long duration outages. Whilst the

PTE endorses the forward-looking, model-based approach to derive derating factors from EFCs, we think that sufficient data has now been accumulated to at least back-test these models and perhaps integrate a more statistical approach into the modelling. This raises the question of whether the use of a model-based equivalent firm capacity (EFC) is the best approach to estimating the contribution and derating factors of wind. While the calculation of EFC has been supported by the PTE, we believe that the data sets for operational wind may now be sufficient to look at the de-ratings on the same basis as for conventional plant.

Recommendation 70; To consider the use of operational data for estimating wind derating factors rather, or in combination with, the model-based EFC approach used at present.

60. Derating for batteries, which is also calculated on an EFC basis, shows moderate changes from last year's ECR, with derating factors slightly reduced for the T-1 and the T-4. The time duration threshold covering 95% of stress events for which the derating factor matches that set by hydro pumped storage (HPS) has been extended again to 6 and 9.5 hours in the T-1 and T-4 auctions, versus 4.5 and 5.5 hours last year. We note that this occurs with a marked discontinuity in the derating value trend (see ECR Figures 7 and 8). This may be an artifact of merging two approaches together or it may indicate that the many more hours duration would be required to match HPS plant derating based on historical data. We note there is some further explanation of the step changes in Annex A.7 of the 2022 ECR. Our concern is that as the share of variable renewables increases on the GB system the EFC derating factors of duration limited storage will decline, as the share of longer duration stress events increases. We expect that National Grid ESO will continue to monitor these derating factors.

61. The technologies being deployed in the storage market are expected to experience degradation in a way not historically seen from hydro-pumped storage. While this is being addressed in the deratings applied to storage entering the Capacity Market, it will also need to be considered in the way storage adds to capacity adequacy over time. Lithium-ion batteries degrade both with the number of cycles and calendar life, and there is the possibility of significant degradation after five years of daily discharge. Also, lithium-ion batteries are not a uniform class of assets, but the fleet may be made up of a number of different chemistries. The PTE recognises that this is not an easy issue to model but believe data on storage performance will need to be collected to inform future modelling. This could be addressed as part of improved data collection from all DER that we continue to believe is necessary

62. There is presently a rapid increase of the capacity of battery energy storage being planned and installed, and the 2021 FES scenarios that achieve the net zero target by 2050 anticipate between 9-16 GW of electricity storage by 2030.

There are also developments in the technology of the battery-converter systems and in ancillary services markets and operating practices. A comprehensive study of the most appropriate methodology for the calculation of the derating factors for duration limited storage was completed in November 2017. Given the increase in the capacity of batteries currently being planned and installed on the GB system it is recommended that this methodology should be reviewed in the light of experience of how batteries are being operated to ensure it remains appropriate.

63. As with wind, we question whether, as more operational data accumulates, it would be better to move away from model-based EFC analyses. There is considerable model risk in the current approach, not least because the assumption of storage being fully charged ahead of a stress event is questionable. We recommend further work on the model risk and the scope for a more empirical approach to derating factor estimation.

    Recommendation 71; To consider the use of operational data for estimating battery derating factors rather, or in combination with, the model-based EFC approach used at present.

64. Derating for turn-down, demand side response (DSR) continues to be estimated based on the availability of non-BM STOR. There is a widespread view that DSR exhibits duration limits, either from genuine demand turndown capability or back-up generation. This remains on National Grid ESO's to do list, pending identification of appropriate data. The PTE suggest that, as with embedded generation, collecting more data on how DSR actually responds to market conditions may be useful. We therefore reiterate the value of our previous **Recommendation 63.**

Interconnector De-Rating Factors

65. Interconnector analysis has always been challenging. Firstly, because of their nature: they are transmission links but inject energy resources into the GB network like generators. Secondly, because an assessment of their contribution under stress events is quite hypothetical as there is an absence of sufficient historical evidence on flows under stress. As a consequence, the resource contribution and derating factor analyses are essentially model-based. The PTE recognises the difficulties and has been generally supportive in the modelling improvements. This year, the modelling process is similar to 2021, based upon the DDM and Afry BID3 model, but with updated assumptions.

66. Following PTE55, we are pleased to see a comprehensive listing of the assumptions in the Appendix A.11 of the ECR. We were also grateful for industry feedback on the methodology consultation issued by National Grid ESO earlier in the year.

67. The analysis undertaken by National Grid ESO using BID3 is based upon the capabilities of the interconnectors to deliver power into GB at times of stress. Thus, the modelling is necessarily contrived to create the stress. There are two aspects to the modelling. For the procurement targets, National Grid ESO model the interconnector flows with their own and Afry BID3 base cases assumptions, and scenarios, put these results into the DDM and calculate an EFC for total interconnection. There is an uplift on GB demand to get the GB LOLE close to around 3 hours. This is because the interconnector flow distribution in the DDM is a function of system margin, so the DDM needs data points that cover the full range of margin (as set out in EMR 72 development project). The DDM uses this to calculate an EFC. This effectively provides a total derating factor for the interconnections. The modelling section on individual interconnector derating factor estimation is slightly different. GB demand is again scaled up, and the same Afry Base Case is assumed, but with ranges of scenarios and sensitivities specific to particular countries. Last year, the PTE placed most emphasis upon the scenario that related to the harmonised ENTSO-E targets, since that provided a coherent policy framework. This year, we note that the ECR no longer produced a separate scenario for this harmonised target as most countries are evolving close to 3 hours LOLE. We have therefore given more emphasis to the Base Case results, with some considerations to sensitivities. We note that with this approach the consistency of the implicit derating of interconnectors for the DDM procurement analysis and the determination of individual country derating factors is more transparent.

68. Although margins may become tighter for T-4, they are perhaps not as tight as we considered in T-4 for the 2021 ECR last year, since last year the PTE recommendations did not focus upon the Base Case expectation. ESO and the PTE are not using the ENTSO-E harmonisation standard this year. Furthermore,

with the geopolitical energy security concerns across Europe, countries are less likely to lower margins. If other countries behave like GB, they may be more risk averse than usual in keeping capacity on the system.

69. The main change in the interconnector modelling this year has been the more detailed Monte Carlo simulations. By undertaking a more extensive analysis of the simulations, estimation of the density function of the ICDRFs for each interconnector, rather than mean value has been possible. This has revealed bimodal distributions with the interconnectors either flowing fully or not flowing at all, the mean values effectively reporting the ratio of each. This insight is consistent with the economic theory of market arbitrage and may have new implications for risk in the DDM as well as the average country specific derating factors. Furthermore, this new data analysis facilitates correlation studies of interconnector flows from the market models which may have even greater implications for aggregate risk in the EFC calculation. It may also have implications for the market response from interconnectors included in the non-delivery sensitivity calculation. In the light of this, the PTE strongly recommends an extension of this work. We sense that this work may lead to an increase in the risk assessment of interconnector flows and a lowering of the ICDRFs but we have insufficient basis for quantifying that at the moment.

    Recommendation 72: To continue the statistical analysis of ICDRFs to fully understand the implication of bimodal distributions for individual flows and their correlations on the aggregate risk of GB interconnections.

70. In addition to derating the economic flows, PTE requested transparency on the technical deratings subsequently applied to these figures by BEIS. We have examined these and note that they are currently being updated.

71. In our deliberations on the ranges of derating factors produced in the ECR, we have followed the principle of anchoring upon the Base Case and considering a weighting of the upside and downside of the ranges around it. We are mindful of the risk posed by French nuclear outages, as well as the political risks to gas supplies in Germany, but also, in contrast, to the potential for an economic downturn in Europe. In particular, we do not consider that the geopolitical risks to European gas supplies should appear in the derating factors at the moment, but rather in the non-delivery sensitivities. This could change however, if there a new structural assumptions of flow restrictions that affect the availabilities of gas-fired generation in Germany. As yet, these have not been modelled. We are aware of the future plans from ENTSO-E and ACER for direct participation by generators in cross-border capacity remuneration schemes but have taken the view that GB will not be involved in this for T-4 and that within the EU, it should not fundamentally change the capacities for interconnector flows. Similarly, the loss of market coupling post EU Exit, whilst increasing trading frictions, has not been deemed detrimental to the GB imported resource availabilities at times of stress.

Further consideration of loss of trading efficiency at short notice (e.g., 4 hours for a Capacity Market event) should be monitored.

72. The PTE is also aware of the previous "cannibalisation" modelling which suggests that, as more interconnector capacity becomes available, individual derating factors will systematically fall. Finally, being a model-based analysis, the PTE is cautious about model risk. All models are simplifications, and we consider, on balance, that real-world frictions are likely to create flows somewhat below those derived from the modelling. Nevertheless, in the commentaries provided by National Grid ESO in the ECR, and with the use of Afry base case assumptions, there are compensating factors affecting the derating factors.

73. The new simulation analysis which reveals the bimodal flows causes us to consider that the downside risks may be greater than previously assessed. We observe from Figure 52 in the ECR for the Base Case that the probabilities of zero flows into GB are approx. 9%, 18%, 25% and 28% respectively for France, Belgium, The Netherlands and Denmark and this ordering matches the Base Case derating factors reported in the ECR as France 88, Belgium 80, NL 75 and Denmark 70. These differences are despite the expectation that the high degree of meshed connections in the transmission network might lead to them performing similarly under stress events.

74. Taking all of these factors into consideration we also undertook a careful comparison with the previous year's derating factors and the reasons why they may change this year. Given the very wide ranges presented in the ECR, and the implied uncertainty, we have been pragmatic in not seeking to unduly create excessive year by year changes in the recommended ICDRFs.

75. With all of these issues under consideration, we have proposed the following derating factors (with our 2025/26 recommendations for comparison):

PTE Recommended Country De-rating Factors		
	2025/26	**2026/27**
Ireland	50%	55%
France	76%	70%
Belgium	66%	65%
The Netherlands	68%	62%
Denmark	69%	60%
Norway	91%	91%

76. For Ireland, considering the range reported in the ECR, the maximum is 94% whilst the minimum is 14%, which is similar to last year. Last year and the year before, we recommended 50%. The Base Case result is 85% and the lowest simulations relate to an extreme scaling down of thermal capacity. Security considerations may make this less likely. We also note there is only an approx. 5% chance for zero flow (Figure 52 in ECR), the second lowest after Norway. Thus, we are inclined to lift this year's recommendation to 55%.

77. For France, in the ECR, the maximum is 97% whilst the minimum 30% is due to the French nuclear outage sensitivity. We recommended 76% last year and the year before. We take a more cautious view than previous years, with the nuclear conditions in mind, and suggest 70%.

78. For Belgium, the maximum is 95% whilst the minimum 31% reflects the French nuclear sensitivity. We note the delayed phase-out of Belgian nuclear so far, with the potential for more. Last year we recommended 66% and, with the analysis suggesting an ordering below France, we suggest 65%.

79. For The Netherlands, in the ECR, the maximum is 92% whilst the minimum at 51% is with the French nuclear sensitivity. Last year we suggested 68% and this year we recommend 62%, following the analytical ordering below Belgium and France.

80. For Denmark, in the ECR, the maximum is 91% whilst the minimum is 48% with the French nuclear sensitivity. Last year was 69%, but taking into account the 28% probability of zero flows and the ordering below NL in the analysis, we recommend 60%.

81. For Norway, in the ECR the maximum is 100% whilst the minimum is 84% depending mainly upon hydro conditions. Last year we recommended 91% and propose the same again.

82. In making these recommendations, we have formed a view based upon the results and commentary in the ECR. As with the ECR, there has been no attempt to guess the progress and implications of the geopolitical crisis in European gas from Russia for T-4. This was outside the scope of the ECR and we leave it for the Government to assess and adjust accordingly.

Methodology

83. The PTE has always made a number of recommendations in its previous reports. Last year's (2021) PTE report made 8 new recommendations, numbered from 58 to 65 (continuing on from the previous years' numbering). All these recommendations, along with others raised by BEIS, Ofgem and National Grid ESO's internal post review/update process were considered by National Grid ESO.

84. National Grid ESO assesses which recommendations to pursue, delay or, in effect, reject by using a multi-criteria scoring system. This gathers a number of projects that have been suggested by National Grid ESO itself, BEIS and Ofgem as well as our recommendations and ranks them for action within limited resource and time constraints, according to subjectively awarded scores against the criteria of "Impact/ Materiality", "Effort/Resource" and "Priority", with Priority being double-weighted. BEIS consults the PTE on scores, but the PTE is not involved in the final selection.

PTE 2021 Recommendations which led to development projects taken forward.	**PTE Comments**
Recommendation 58: A more comprehensive feed-forward analysis of how all of the main drivers of demand will evolve from the existing situation to influence the T-1 and T-4 base case peak demands should be developed to enhance the insights from the FES scenarios. This should provide a more comprehensive and a more explicit representation of the ranges of uncertainty around the base case forecasts with these ranges of uncertainties being quantified as much as possible.	Two development projects addressing demand were taken forward by NGESO, in response to PTE58 and PTE59, to investigate uncertainties in estimates of peak demand used in the T-1 and T-4 Base Cases. NGESO proposed a comprehensive programme of work to improve understanding of the evolution of peak demand and uncertainty in the demand predictions used in the Base Cases. The programme of work that was proposed extends over 5 years with detailed activities identified for the 1st and 2nd years.
Recommendation 59: The previous Recommendation 52 regarding the factors affecting the evolution of peak demand and potential stress period behaviour should be re-visited soon given the importance of the drivers on	Progress has been made in the 1st year of the programme of work with the definition of a comprehensive load model and analysis of the evolution over time of peak demand including the causes and

the shape of peak demand and its impact on the capacities to secure, particularly the T-4 value.	evolution of losses in the transmission and distribution networks. Given the importance of estimating peak demand robustly it is recommended that the work programme proposed for years 2-5 should be re-confirmed for next year recognising the changing economic conditions. Particular consideration should be given to: 1) the price elasticity of demand of the various sectors with very high electricity prices, 2) the increase in peak National Demand that was experienced this year and may be due to reduction of the output of embedded generation, and 3) the anticipated changes to the triad charging rules that were postponed by 1 year.
Recommendation 60: The Root Sum of Squares or Simple Summation approach to multiple non-delivery risks needs to be fundamentally reconsidered in terms of the independence of the risks involved, or their dependence on common mode drivers, and their possible market responses induced. We suggest a more flexible rationale be developed based upon the characteristics of the different non-delivery risks.	The commissioned work concluded that modest levels of non-delivery can be modelled by adjusting the station availabilities currently used in the LOLE calculation with a non-delivery probability, but more extreme non-delivery would need supplementary analysis to help decision makers understand the actions needed to mitigate more severe risks. The PTE hope that this work is progressed.
Recommendation 61: An empirical analysis of all past non-deliveries (and non-availabilities), as well as evident market responses, should be undertaken to look for any possible drivers of dependence between technologies, relevant CM auction clearing prices and average energy market prices.	The PTE is grateful to NGESO for the work that they have done to respond to recommendation PTE 61. NGESO's analysis of past non-deliveries and non-availabilities showed more than 2 GW non-delivery (on average) per delivery year and a high case of 6.5 GW in 2020/21. The PTE considers non-delivery to be a cause for concern. The paucity and non-stationarity of the data may not permit a robust statistical modelling approach.

Recommendation 65: Further analysis of the availability of DSR and Embedded Resources in Europe at the times of GB stress should be undertaken.	NGESO has set out in Chapter 5 their updated European scenario assumptions and note that there is little evidence on the availability of DSR and embedded resources. This year NGESO has been able to look at whole fleet imports from Europe at tight hours. A striking conclusion, reported in Section 5.2.5, is that at the modelled tight hours the derating factor distribution is bimodal, with the interconnector fleet either at full capacity (with probability about 0.5) or are at low levels (less than 30% with probability about 0.1).

PTE Previous Recommendations Not Taken Forward	**PTE Comments**
Recommendation 62: BEIS and Ofgem should consider the timing of all CM related activities each year in order to allow pre-qualification and auction results to better inform National Grid ESO's modelling and give parties longer to deliver new build plant after the T-4 auction**.**	Significant levels of non-delivery materialise after the T-1 auction, i.e. after the last time BEIS can take action to secure capacity for the delivery year. The PTE make a number of comments (in the Domestic Supply section) on how the visibility for NGESO of non-delivery could be improved by more timely information provision. This recommendation does not relate to modelling and needs to be considered by BEIS and Ofgem.
Recommendation 63: A more thorough analysis of the duration limits for turn-down DSR should be undertaken.	NGESO are not aware of any data sets that are readily available to assess this, and intend to explore other potential options with BEIS, Ofgem and the PTE.
Recommendation 64: The consistency of the implicit derating of interconnectors for the DDM procurement analysis and the determination of individual country derating factors should be made more transparent.	

85. The Least Worst Regret (LWR) outcome is essentially determined by the most pessimistic and the most optimistic of the scenarios and sensitivities considered. This year the capacities-to-secure for both the T-4 and the T-1 auction were determined by a pessimistic sensitivity for non-delivery and the optimistic Leading the Way scenario. We remain concerned that the extent of non-delivery has become so large that the market arrangements, to provide a regular retainer payment to reliable forms of capacity in return for such capacity being available when the system is tight, may not be operating efficiently. If the market arrangements are failing, the modelling assumptions in the ECR are undermined. Whilst it is outside the scope of the PTE Report to propose changes to the Capacity Market rules, we can take the opportunity to highlight administrative frictions that should demand attention.

86. Finally, in the LWR calculation of regrets, National Grid ESO assume a cost of excess capacity at £49/kW/year (NETCONE) and an energy unserved cost (Value of Lost Load (VoLL)) of £17,000/MWh. Neither of these values have been altered since the beginning of the Capacity Market auctions. We are aware that these values have an endogenous relationship to the reliability standard of 3 hours LOLE. We also observed that the LOLE of 3 hours has not been the actual target for the Base Case in practice, but for a risk averse sensitivity derived from the LWR calculation. The result of this is that a much lower LOLE has been achieved over recent years and indeed has been targeted. Procurement policy has sought to maintain comparable derated margins going forward to those that have comfortably been experienced most recently. Thus, in this year's ECR, the recommendation of 5.8GW for T-1 would lead to a LOLE of 0.4 hours and a derated margin of 6.5% if the Base Case occurs. In the ECR, it is justified by being consistent with recent margins and "appropriate in order to provide greater resilience to credible downside risks such as non-delivery" (p7). The same justification is provided for the T-4 procurement of 43.9GW giving a LOLE under the base case of 0.3 hours and a derated margin of 6.1% (p9). We therefore recommend that a fundamental re-evaluation of the expressed nature of the reliability standard is timely in order to match the modelling parameters in the ECR to the security inclinations of National Grid ESO and recent policy determinations of the government. Without this, as the uncertainties in resource adequacy increase with more renewables and consumer engagement, the mismatch between future ECRs and ultimate procurements will increase and the ECR exercise will lose its relevance.

Recommendation 73: The modelling parameters in the ECR related to the reliability standard are not well matched to the policies of procurement and it would improve the relevance of the ECR exercise if BEIS were to reinstate its intention to review the reliability standard and its implementation.

Conclusion on Target Capacities

87. Overall, we note the continued improvement in methodology for producing the ECR and whilst we have, as usual, presented a number of recommendations, we hold the opinion that the work is comprehensive and thoroughly undertaken. We endorse its fitness-for–purpose. We recognise the market has altered significantly since the Capacity Market started and therefore the modelling challenges have changed. We wish to express our appreciation of the constructive manner through which National Grid ESO and BEIS have engaged with the PTE.

88. For T-1, we accept the recommendation of 5.8GW in the ECR. We recognise that it will be a high procurement but set in the context of the higher requests by the Secretary of State for extra capacity for 22/23, it appears to be prudent. Nevertheless, we recommend a detailed reconsideration of the supply-side of the Base Case and the non-delivery sensitivities in the autumn.

89. For T-4, we accept the 43.9 GW recommendation in the ECR and note that this is slightly lower than the T-4 request in the previous 2021 ECR. Again, we recommend a detailed reconsideration of the supply-side of the base case and the non-delivery sensitivities in the autumn. In setting the target for T-4, BEIS will implicitly be considering what may be required at the subsequent T-1 for the same year and explicitly recognising some of this in any set-aside. Purchasing more or less at T-4 with T-1 in mind is a delicate issue. PTE57 previously raised the issue of optimal procurement across these two opportunities, although work on that recommendation became awkward to formulate in practical terms. We do not make a further recommendation to re-activate PTE57, but we note that there is scope for further thinking on this topic.

90. Thus, without having direct evidence to alter these targets, the PTE is concerned not only about the current energy supply risks, but also about potential over procurement and the consequent costs to society. We anticipate that more information will become available in time for any autumn adjustment and that a careful re-evaluation of the supply-side of the Base Case and non-delivery assumption be undertaken.

Quality Assurance

91. Previously followed procedures continue to provide QA and these are closely aligned with BEIS's internal QA processes. The PTE previously requested details of the ECR Quality Assurance methodology and this was reproduced in Annex 2 of PTE's 2016 report.

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