ESO BALANCING COST METRIC

A report to Ofgem

NOVEMBER 2020

AFRY
ÅF PÖYRY

AFRY is an international engineering, design and advisory company.

We support our clients to progress in sustainability and digitalisation.

We are 17,000 devoted experts within the fields of infrastructure, industry and energy, operating across the word to create sustainable solution for future generations.

Making Future

CONTACT DETAILS

Simon Bradbury
simon.bradbury@afry.com
+07969981178

Ian Wallace
ian.wallace@afry.com
+07384215972

AFRY Management Consulting provides leading-edge consulting and advisory services covering the whole value chain in energy, forest and bio-based industries. Our energy practice is the leading provider of strategic, commercial, regulatory and policy advice to European energy markets. Our energy team of over 250 specialists offers unparalleled expertise in the rapidly changing energy markets across Europe, the Middle East, Asia, Africa and the Americas.

TABLE OF CONTENTS

1 INTRODUCTION 5
1.1 Context 5
1.2 Background 5
1.3 Overarching principles 6
1.4 Structure of this report 6
2 BASIS FOR DETERMINING WIND CONDITIONS 7
2.1 Wind metric 7
2.2 Definition of 'normal' wind conditions 9
2.3 Definition of 'high' and 'low' wind conditions 11
3 SETTING EX-ANTE BENCHMARKS 14
3.1 Mapping historic wind conditions and costs 14
3.2 Derivation of ex-ante benchmarks for 'normal' wind conditions 17
3.3 Derivation of ex-ante benchmarks for 'high' and 'low' wind conditions 29
3.4 Ex-ante benchmarks outcome 29
4 APPLYING BENCHMARKS AND MONITORING PERFORMANCE 30
4.1 Applying benchmarks 30
4.2 Monitoring performance 30
5 ADDITIONAL ELEMENTS OF BALANCING COST METRIC FRAMEWORK 32
5.1 Ex-ante adjustments 32
5.2 ESO reporting 33
6 SUMMARY OVERVIEW AND NEXT STEPS 35
6.1 Balancing cost framework summary 35
6.2 Steps needed to finalise methodology and benchmark values 40

1 Introduction

This Section introduces the focus of and context for this report.

1.1 Context

The Draft Determination (DD) relating to the forthcoming incentive arrangements for National Grid Electricity System Operator (ESO) included proposals relating to the performance metric framework that will be used to monitor ESO activities. The framework includes a performance metric relating to the ESO's balancing costs. This report focuses on a possible framework for the balancing cost metric.

While this report includes numbers relating to balancing costs and potential benchmarks, it is not intended to provide the basis for cost benchmarks for the upcoming incentive period.

1.2 Background

The DD included a proposal to adapt the balancing cost metric to factor in the impact of wind on balancing costs. Two possible options for achieving this were suggested:

— **Option 1: ex-ante wind adjusted benchmarks**. This involves definition in advance of cost benchmarks to apply in 'typical wind', 'above typical wind' and 'below typical wind' conditions. At the end of each month, the relevant monthly benchmark is identified based on observed wind conditions and actual costs are compared against this.

— **Option 2: ex-post wind adjusted benchmarks**. This involves definition in advance of cost benchmarks to apply in 'typical wind' conditions only. At the end of each month, the benchmark is adjusted based on observed wind conditions to reflect the relationship between wind conditions and outturn costs. This produces an ex-post tailored monthly benchmark against which actual costs can be compared.

DD consultation respondents that commented on the proposal, including the ESO, were supportive of the intent of the specific wind adjustment. The ESO expressed a preference for a straightforward and transparent methodology and so favoured Option 1 and the associated ex-ante adjustment process.

In light of the feedback, we suggest that Option 1 forms the basis for the wind adjustment methodology. The approach outlined below, therefore, works on the basis of ex-ante definition of benchmarks for different wind conditions.

1.3 Overarching principles

Making adjustments to cost benchmarks to account for wind conditions has the potential to introduce complexity to the metric design. However, we are aiming to develop a methodology that is simple in its approach and transparent to stakeholders. With this in mind, the methodology has the following features:

- **Focus on wind conditions at national level**. Wind conditions and penetration vary by location throughout the system, with potentially varying effects on balancing costs. However, in the interests of simplicity, the proposed methodology works at a national level.
- **Focus on wind conditions at monthly resolution**. The methodology does not look to consider wind conditions and balancing costs at the half-hourly or daily level. Instead, drawing on previous analysis suggesting a strong relationship between wind conditions and balancing costs at a monthly resolution, the methodology operates at a monthly granularity.

While these features may miss some subtleties of the effects of wind conditions on outturn balancing costs, we feel that the methodology provides a sensible balance between the objective to reflect the impact of wind on costs and simplicity.

1.4 Structure of this report

This report is structured as follows:

- Section 2 considers the basis for determining wind conditions;
- Section 3 focuses on a potential approach for setting ex-ante benchmarks;
- Section 4 outlines a suggested approach for applying benchmarks and monitoring performance;
- Section 5 considers additional elements of the framework, namely ex-ante adjustments and additional reporting; and
- Section 6 provides a summary overview of the potential framework and sets out next steps.

2 Basis for determining wind conditions

This Section considers a potential approach for determining wind conditions to use when accounting for the impact of wind conditions on balancing costs within the balancing cost performance metric.

2.1 Wind metric

The wind adjustment methodology requires a clear approach for identifying and classifying the underlying wind conditions. Input data to be used in wind condition classification needs to be readily available, both in historical timescales to factor into benchmark setting and prospectively to allow for outturn condition determination.

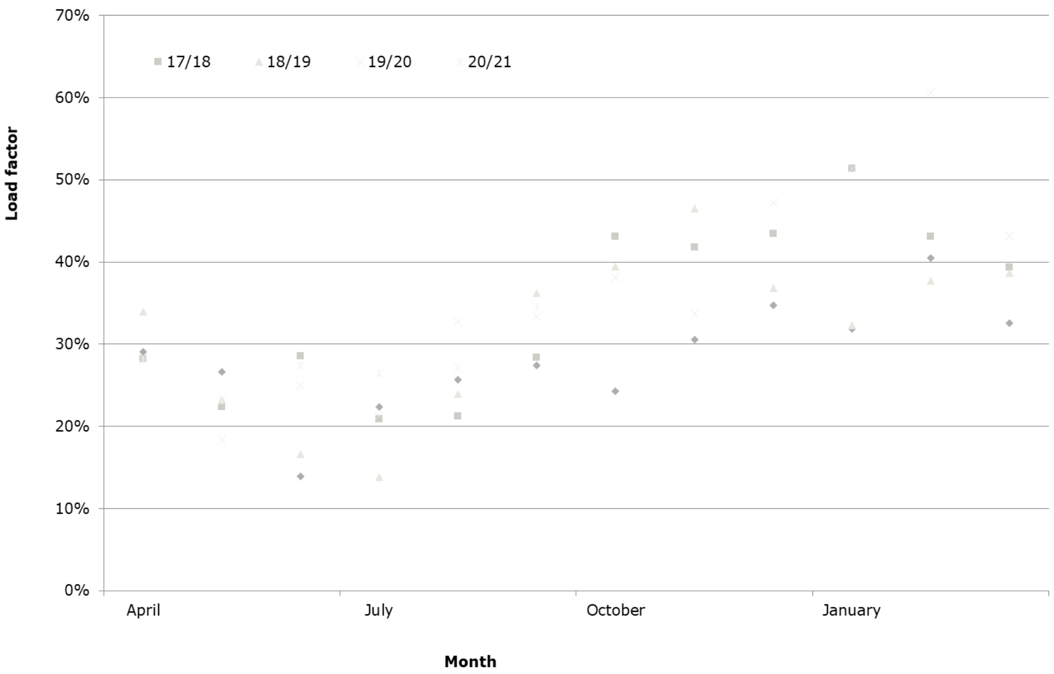
Actual wind speeds are not seen as an ideal metric for classifying the wind conditions due to their availability. They are difficult to obtain at the correct locations – wind speeds can vary dramatically for different latitudes, longitudes, and heights – and wind speed data is not freely and readily available to the public.

One metric that is readily available is the load factor of wind generation units. Load factors act as a good proxy for wind conditions – there is a strong correlation between wind speed and wind power generation. The load factor can be calculated by dividing the actual generation of a power plant by the installed capacity of the plant. Both of these values are freely and readily available to the public. For the analysis presented below, these values have been obtained based on data from Elexon. To derive a single national load factor, the sum of all plants' output is divided by the total installed capacity of all plants. This derivation allows plants and locations to be weighted according to their size. Wind condition derivations benefit from using a wide historical dataset, as having more data points will generally lead to higher quality and more accurate results. However, it is also necessary that the data used is comparable to current conditions. Looking at historical data, there is an upward annual trend in the monthly load factors until the 2016/2017, after which there is no discernible year on year trend. As such, the analysis for defining the normal, high, and low wind conditions within this document is based on monthly data from 2016/2017 onwards.

Some potential issues with using load factors to classify wind conditions have been considered. In addition to not being a perfect correlation between wind speed and generation output, the actual generation of power plants will have incorporated within it any actions taken by the plant to constrain output, especially those actions instructed by the ESO. One way of mitigating against potential ESO actions is to use unwound wind – that is, adding the MWh of accepted wind bids and offers (BOAs) to the generation of wind plants before dividing by the sum of capacities – in the classification process. This does, however, add a layer of complexity to the calculation. The remaining analyses in this section have been done using both the straightforward outturn generation and the unwound wind to compare the approaches.

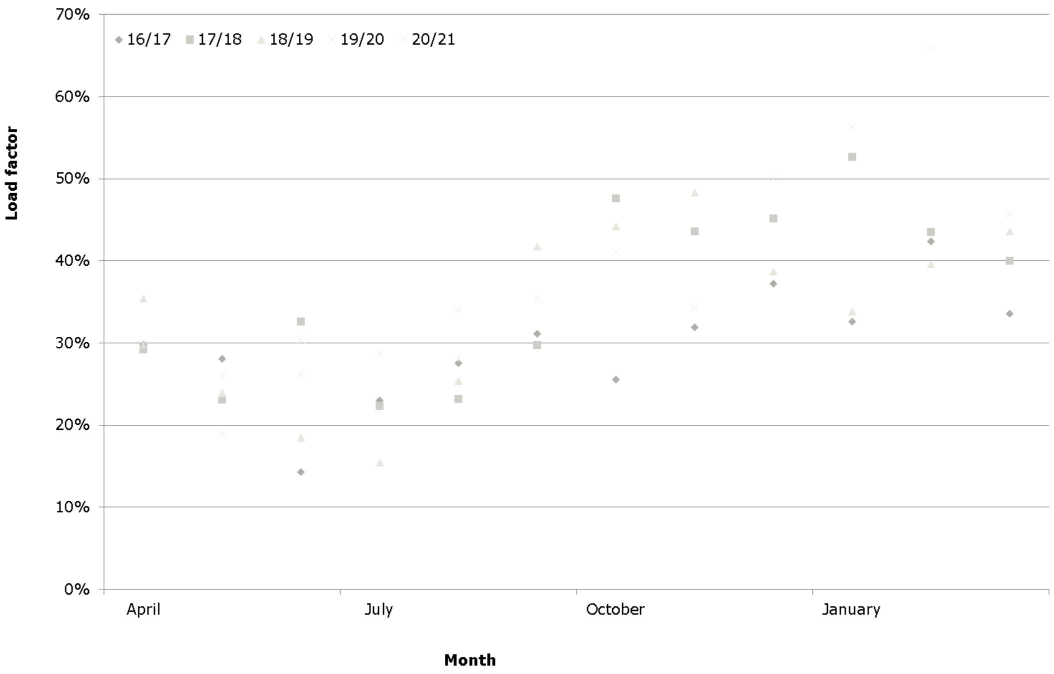
The load factors for the financial years from 2016/17 and to 2020/21 (to September) using generation and unwound wind can be seen in Exhibit 2.1 and Exhibit 2.2, respectively.

Exhibit 2.1 – Historical monthly average load factors using generation



Source: Elexon data.

Exhibit 2.2 – Historical monthly average load factors using unwound wind



Source: Elexon data.

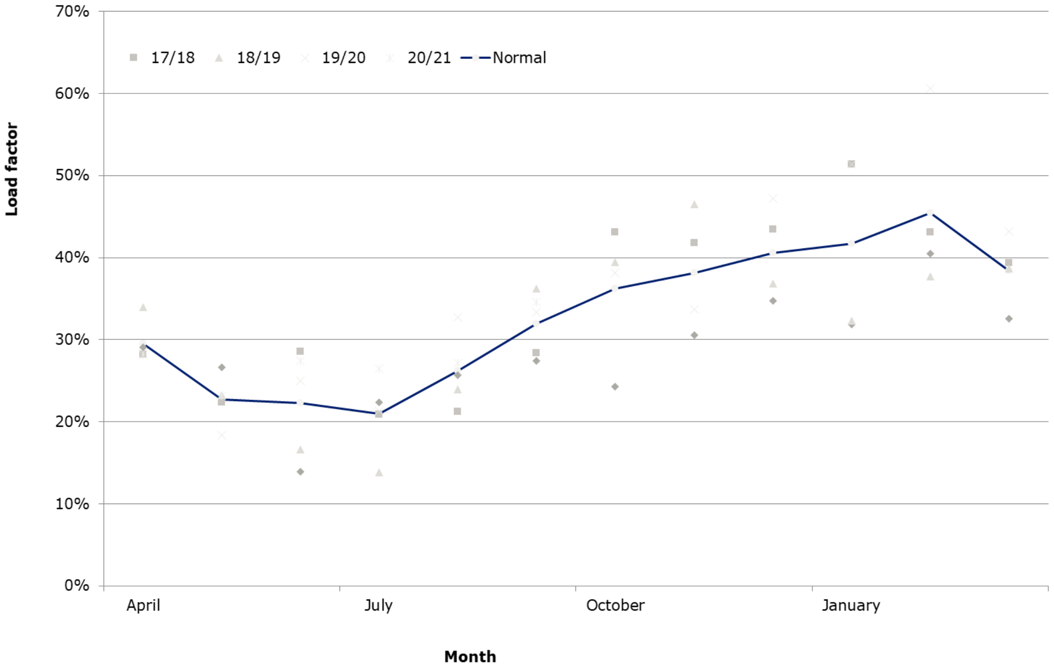
2.2 Definition of 'normal' wind conditions

Wind conditions vary throughout the year, with higher load factors typical during the winter months. The proposed methodology reflects this by taking a month-specific approach to the definition of 'normal' wind conditions.

Each month is considered separately, and the 'normal' wind conditions are centred around the average of the load factors for a particular month. This has the advantage of allowing the 'normal' conditions to change in accordance with any new data coming in or old data being omitted.

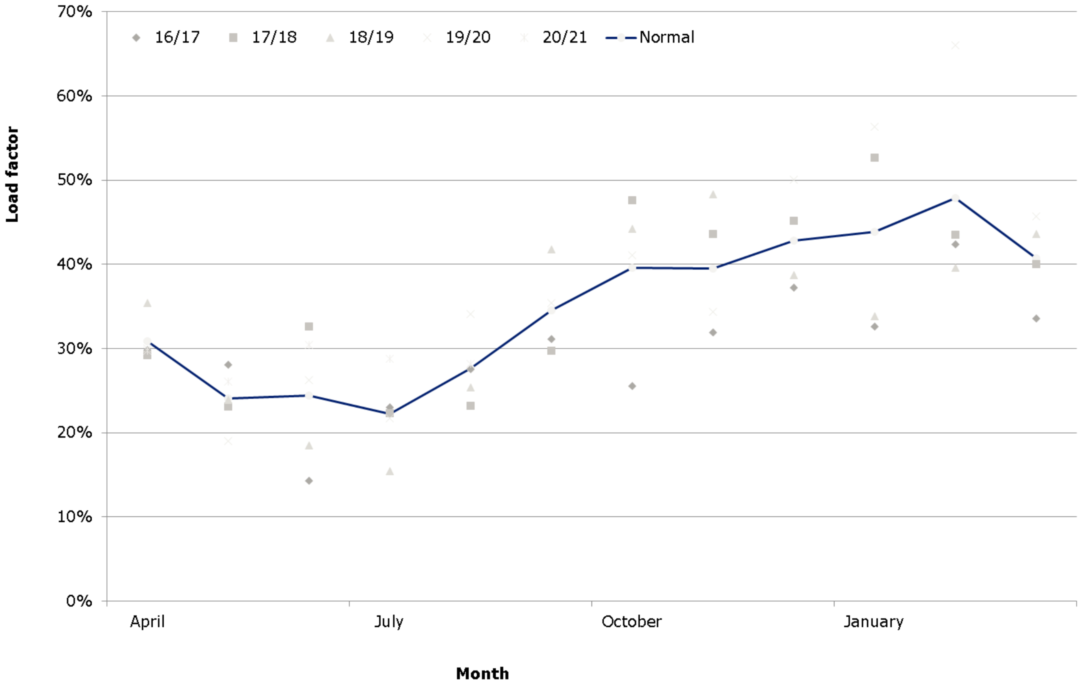
In general the load factors take on a sinusoidal shape, with lower percentages seen in Summer and higher percentages being seen in Autumn and Winter. Exhibit 2.3 and Exhibit 2.4 compare historical load factors with the 'normal' load factors as derived from 2016/17 onwards for generation and unwound wind approaches, respectively.

Exhibit 2.3 – Central 'normal' trend line for monthly load factors using generation



Source: AFRY Management Consulting analysis based on Elexon data.

Exhibit 2.4 – Central 'normal' trend line for monthly load factors using unwound wind



Source: AFRY Management Consulting analysis based on Elexon data.

2.3 Definition of 'high' and 'low' wind conditions

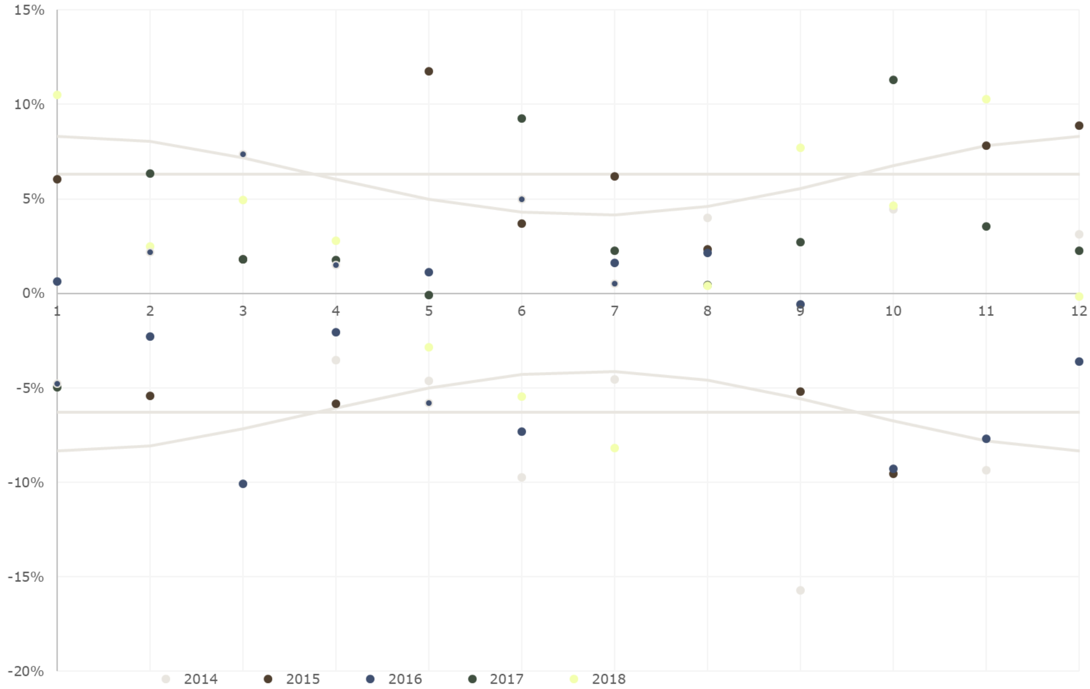
Taking the seasonal normal load factor for each month as the basis, the methodology then defines thresholds to be used to classify 'high' and 'low' wind conditions.

As a general approach, the goal is to create a simple formula to generate thresholds for the normal band so that roughly 15% of the months will be above the normal band and 15% of the months will be below the normal band. To keep the derivation as simple as possible, the formula should be the same for each month, and ideally would be symmetric, with the same deviation above and below the average.

Two separate methodologies were considered. The first methodology would add/subtract a percentage of each month's average load factor. This would mean that months with higher load factors would have a larger band than months with lower load factors. The second methodology would add/subtract a set percentage point from each month's average load factor. This would mean that the size of the normal band would be the same in each month and independent of the average load factor for that month.

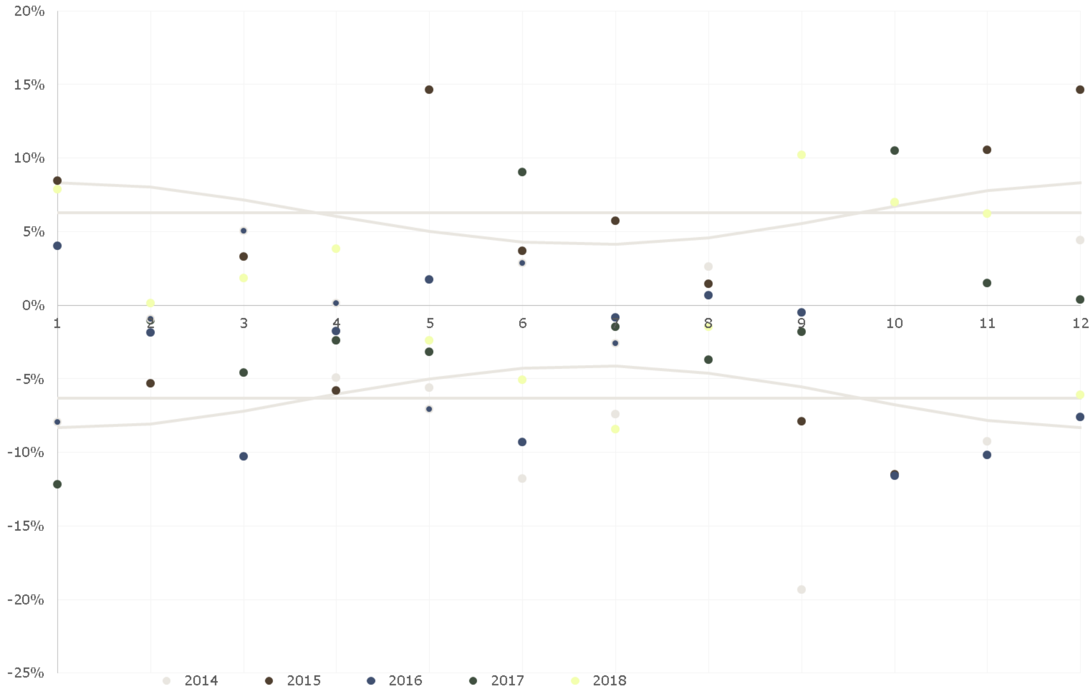
Using historical data, two methodologies for creating the high and low bands were examined. Both a percentage change (±20%, 0.8x and 1.2x) and a fixed percentage point change (±6.3pp) and were considered over the different months. The fixed percentage point change is simpler to understand, however a consideration that wind might vary more during the higher load factor months had to be checked. Exhibit 2.5 and Exhibit 2.6 below show representative bands under both methodologies using generation and unwound wind, respectively. The first methodology band can be seen as the curved lines which contract during the middle months. The second methodology band is shown via the horizontal lines. Both the 20% change and the 6.3pp change were chosen as this put approximately 70% of the points in the normal wind category in either load factor calculation, allowing enough wind to breach the high/low bands while still keeping the majority as normal.

Exhibit 2.5 – Possible bands for monthly load factors using generation



Source: AFRY Management Consulting analysis based on Elexon data.

Exhibit 2.6 – Possible bands for monthly load factors using unwound wind



Source: AFRY Management Consulting analysis based on Elexon data.

Both methodologies result in bands that satisfy the goal of having roughly 15% of the data points both above and below the normal band. Given that both methodologies achieve this, in order to keep the calculations as simple as possible, the second approach, which adds a set amount to each month, is suggested for use.

Comparing the results in this section using the generation or unwound wind as load factors, we can see that there is a small impact. Of the 67 months considered between April 2014 and July 2019, 61 (91%) were classified the same regardless of type of load factor used. Two months that switched from 'Normal' to 'High' when switching from generation to unwound wind were equalled by two months switching from 'High' to 'Normal'. There were a further two months that moved from 'Normal' to 'Low' when switching from generation to unwound wind. Given its relative simplicity, the analysis in the following sections is shown only for the load factors calculated using generation.

3 Setting ex-ante benchmarks

This Section considers a potential approach for determining ex-ante balancing cost metrics to apply in different wind conditions. This does not consider any other potential adjustments that may feed into the balancing cost metric.

3.1 Mapping historic wind conditions and costs

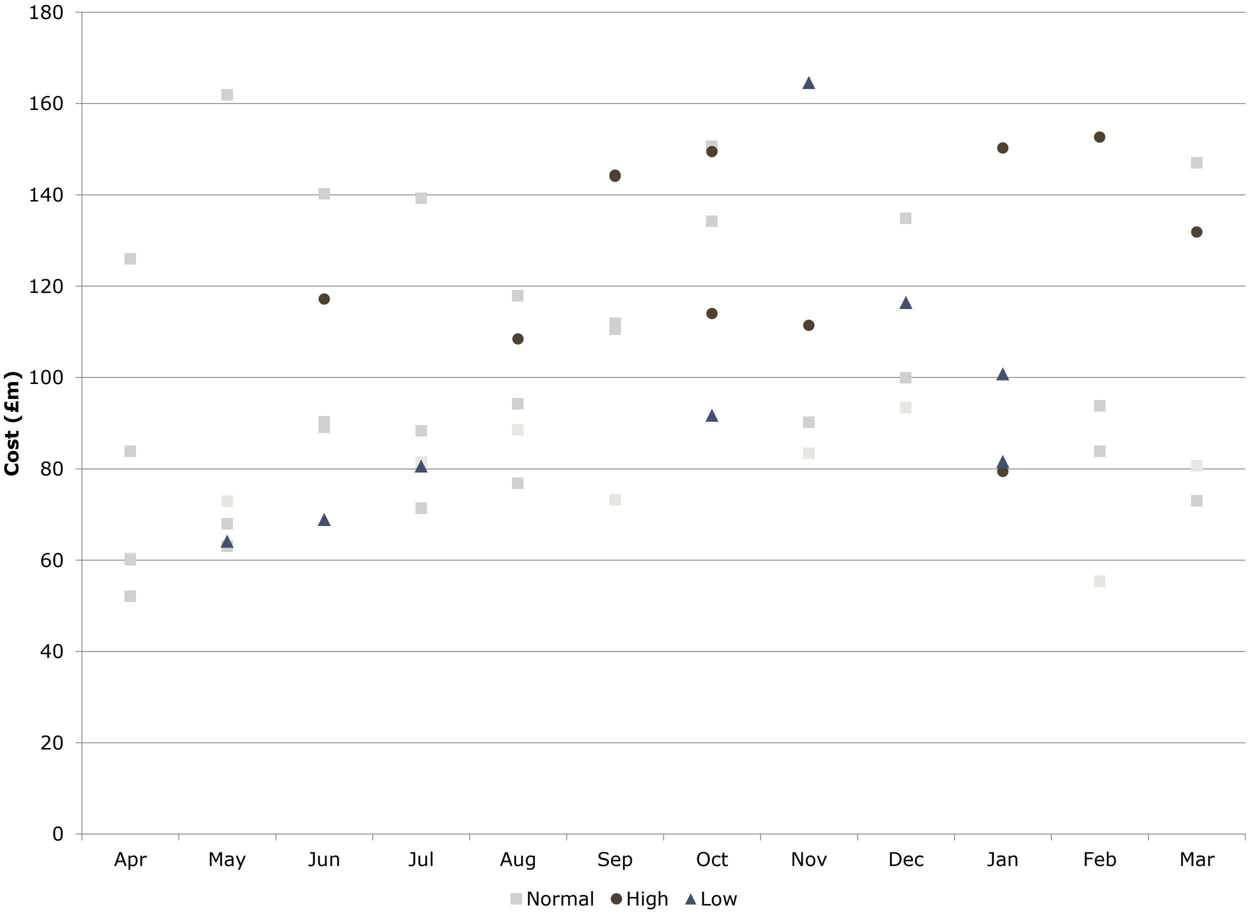
Using the wind classification methodology presented above, we can review historical data and identify past months in terms of their deemed wind conditions. This is an important input step for the derivation of ex-ante cost benchmarks, which, as discussed further below, makes use of historical balancing costs.

For the future analysis, we consider the 55 months from April 2016 to October 2020. In this period, using the analysis from Section 0, we obtain 36 months sitting within the 'normal' wind conditions, with 11 months classified as 'high' wind conditions and a further 8 months classified as 'low'[1].

Exhibit 3.1 plots each monthly balancing cost while classifying the month into its corresponding wind condition. The general trend shows an expected pattern, with the 'high' wind months' circles typically being near the top of their respective months and the 'low' wind months' triangles typically being near the bottom. There are notable exceptions, such as the 'low' wind month November 2016, where there were non-wind factors – in this case, unplanned French nuclear plant outages – that could account for the break in the general trend.

[1] Considering the monthly balancing costs for each of these months, the 'normal' months have an average cost of ~£96m, while the 'high' and 'low' months have averages of ~£127m and ~£98m, respectively. The average value across the 'low' months is skewed by outturn in November 2016 during which there were unplanned French nuclear outages. If this month is excluded, the average cost across the remaining 'low' months is ~£87m.

Exhibit 3.1 – Monthly total balancing costs with wind condition classification



Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data and Elexon settlement data.

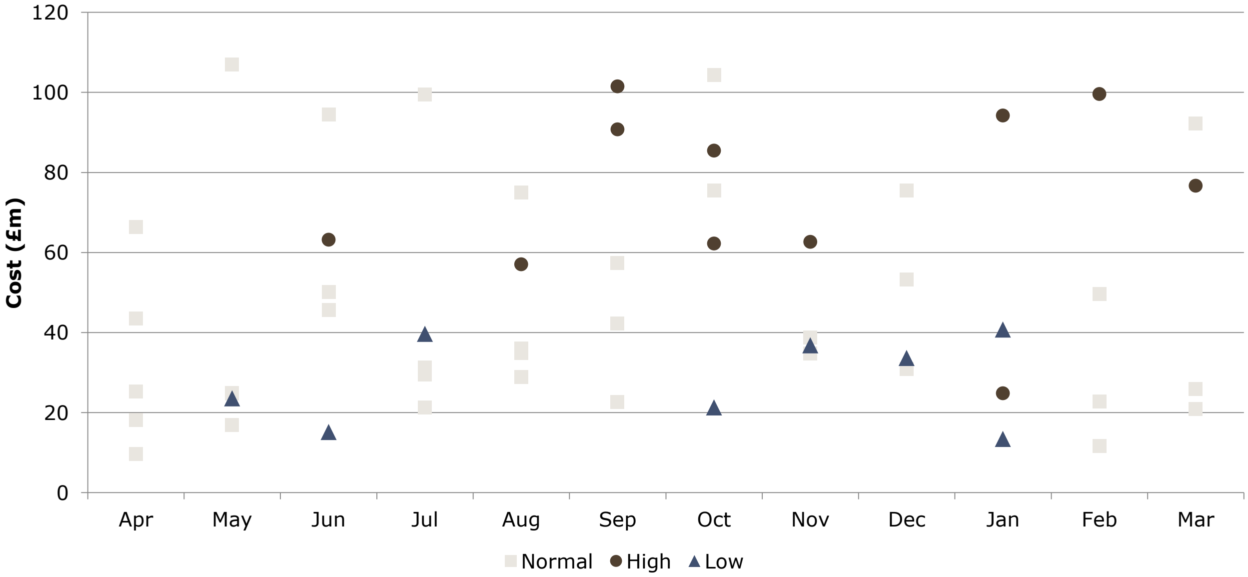
While the focus of the balancing cost related performance metric is on costs in their entirety, it is informative to consider the relationship between sub-component costs and different wind conditions. To provide insight in this regard:

- Exhibit 3.2 focuses on constraint cost components[2];
- Exhibit 3.3 focuses on energy balancing cost components[3]; and
- Exhibit 3.4 focuses on remaining balancing costs[4].

These charts indicate that there is a strong relationship between constraint cost outcomes and wind conditions (i.e. higher costs in higher wind months, lower costs in lower wind months), with energy balancing and other costs exhibiting a much more limited relationship between these cost outturns and wind conditions.

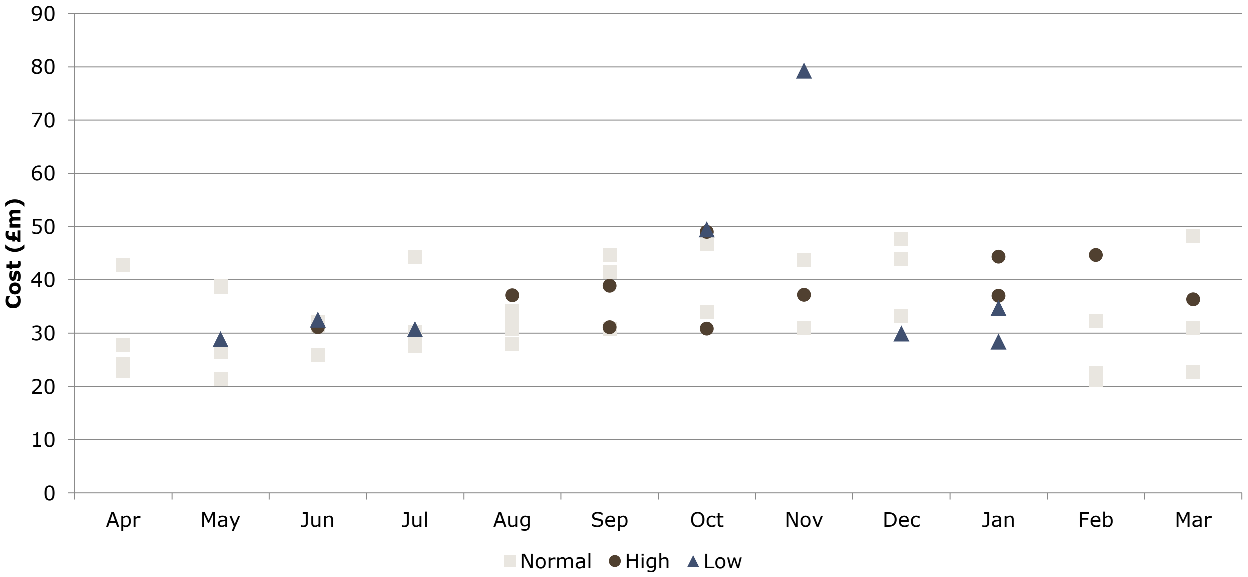
[2] Constraint cost components in MBSS reports.
[3] Energy imbalance, operating reserve, STOR, negative reserve, fast reserve, response and other reserve in MBSS reports.
[4] Reactive, black start, RoCoF, SBR & DSBR, and minor components in MBSS reports.

Exhibit 3.2 – Monthly constraint related balancing costs with wind condition classification



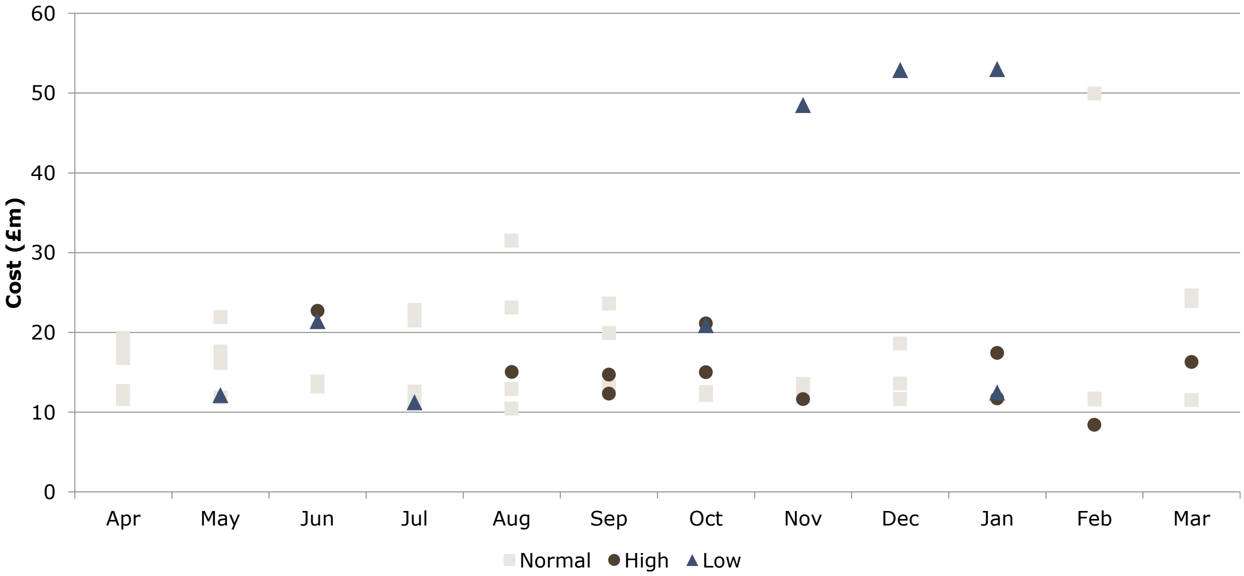
Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data and Elexon settlement data.

Exhibit 3.3 – Monthly energy balancing related balancing costs with wind condition classification



Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data and Elexon settlement data.

Exhibit 3.4 – Monthly other balancing costs with wind condition classification



Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data and Elexon settlement data.

3.2 Derivation of ex-ante benchmarks for 'normal' wind conditions

3.2.1 Recap of current approach

The current approach for determining monthly benchmark costs involves the following steps:

- an annual rolling average cost value is determined for a year as the average of the cost in that year plus the costs in the two years either side of that year (i.e. the rolling average for 2016 is the average from 2014-2018 inclusive);
- the linear trend from the rolling averages is then extended into the future and used as the basis for the annual benchmark values for upcoming years; and
- the annual benchmark values are distributed across the months based on each month's share of overall spend in the most recent year.

The DD highlighted the potential for variations to this approach to potentially amend the historical averaging approach and the derivation of monthly benchmarks.

3.2.2 High-level methodology features

The proposed approach for derivation of ex-ante benchmarks for 'normal' wind conditions considered below has the following features:

- **Historical averaging**: Instead of a 5 yearly rolling average approach with linear extension, ex-ante benchmarks are based on average costs over the most recent historical years. The current approach arguably downplays the effects of more recent cost trends, which increases the call for adjustment factors. Assuming that more recent outturn costs are considered to be reasonable, adopting a simpler averaging approach has the potential to allow for better reflection of more recent experience in the derivation of cost benchmarks.

— **Monthly benchmarks**: Historical cost averaging is done at a monthly resolution, so monthly benchmarks are set based on average costs in the relevant month over the historical averaging period. This allows the monthly allocation to reflect the pattern of cost distribution between months over the historical averaging period as a whole. It also allows the wind conditions for the historical months to be reflected in benchmark setting.

Note that any adjustments to raw balancing cost data that are considered appropriate to account for irregular events or non-valid costs are not considered explicitly in the sections below. However, the scope for adjustments to be made is expected to be possible if considered appropriate and this topic is returned to in Section 5.1.

3.2.3 Collation of data set for benchmark derivation

The historical data set to be used to derive cost benchmarks conditions will contain a blend of normal, high and low wind months. In order to derive cost benchmarks for normal wind conditions, it is not appropriate to use raw historical costs linked to high or low wind months. But rather than stripping out these data points and leaving gaps in the dataset available for benchmarking, we suggest that historical costs for high and low wind months are instead adjusted to reflect the typical delta in monthly costs observed in high and low wind months.

The mapping between historic wind conditions and costs included in Section 3.1 highlighted that the overall balancing cost impact of wind conditions is linked to constraint cost impacts in particular. Given this, there are two approaches for normal cost benchmark derivation:

1. all balancing costs together; and
2. differentiation between constraint costs and other balancing costs.

These options are explored further in Exhibit 3.5.

Exhibit 3.5 – Normal cost benchmark derivation approaches

Process step	All balancing costs together	Differentiation between constraint costs and other balancing costs
1. For each historical month with a 'normal' wind classification	— Take the outturn balancing cost as is as the basis for that month's entry	— Take the outturn balancing cost as is as the basis for that month's entry
2. For each historical month with a 'high' wind classification	— Take the outturn balancing cost and adjust it downwards by a high wind delta adjustment with the resultant figure taken as the basis for that month's entry	— Take the outturn balancing cost in respect of energy balancing and other costs as the basis for that month's entry for this cost component — Take the outturn constraint cost and adjust it downwards by a high wind delta adjustment as the basis for that month's entry for this cost component — Take the combination of the above as the basis for that month's entry
3. For each historical month with a 'low' wind classification	— Take the outturn balancing cost and adjust it upwards by a low wind delta adjustment with the resultant figure taken as the basis for that month's entry	— Take the outturn balancing cost in respect of energy balancing and other costs as the basis for that month's entry for this cost component — Take the outturn constraint cost and adjust it upwards by a low wind delta adjustment as the basis for that month's entry for this cost component — Take the combination of the above as the basis for that month's entry

The approach for deriving the high/low wind deltas will be influenced by the limited number of available data points. As mentioned in Section 3.1, of the 55 months of data considered in this document there are 11 months of high wind conditions and 8 months of low wind conditions, with variable distribution across different months of the year.

On the basis that the main balancing cost impact of wind is on constraint costs, focusing on constraint cost differences under different wind conditions provides an option for determining the high/low wind deltas. Across the 55 months considered relevant average constraint cost values are as follows:

- average costs in normal wind months: ~£50m;
- average costs in high wind months: ~£65m to £75m; and
- average costs in low wind months: ~£30m.

To use these values to determine deltas, we suggest the following:

- express deltas in percentage terms as it may be difficult to derive robust monthly adjustment values in monetary terms; and
- allow for asymmetry in upward and downward deltas, as appropriate.

For illustration purposes within the subsequent sections, we apply high/low wind deltas as outlined in Exhibit 3.6, which differentiates based on the normal cost benchmark derivation approach linking back to the options presented in Exhibit 3.5. Based on the approximate constraint cost variations mentioned above, we apply deltas of +/-30% in the context application of deltas to constraint costs only. As constraint costs account for roughly 50% of overall balancing costs on average, we apply deltas of +/-15% in the context of application of deltas to all balancing costs. Details concerning the development of appropriate delta values need to be developed further during implementation.

Exhibit 3.6 – Illustrative high/low wind delta values

Delta	All balancing costs together	Differentiation between constraint costs and other balancing costs
High wind delta	+15% Derived normal overall balancing costs for historical high wind months set such that the observed high wind outturn costs are 15% higher than the derived normal balancing cost benchmark	+30% Derived normal constraint costs for historical high wind months set such that the observed high wind outturn costs are 30% higher than the derived normal cost constraint benchmark
Low wind delta	-15% Derived normal overall balancing costs for historical low wind months set such that the observed low wind outturn costs are 15% lower than the derived normal balancing cost benchmark	-30% Derived normal constraint costs for historical low wind months set such that the observed low wind outturn costs are 30% lower than the derived normal cost constraint benchmark

The two approaches presented above are expected to lead to a similar endpoint in terms of overall benchmark levels and will retain a focus on performance in terms of overall balancing costs. But there is a trade-off between the two. The application of deltas to constraint costs only potentially allows for more precision in the definition of deltas, but introduces a little more complexity. Conversely, focusing on balancing costs as a whole is more straightforward as a process, but may be less precise.

Given expectations of similar outcomes from either approach, the next Sections adopt the approach involving application of deltas to constraint costs only.

3.2.4 Historical averaging process and options

With a data set of historical monthly balancing costs for normal wind conditions derived, benchmark costs can be established. The suggested approach is based on historical averaging over the most recent years. Within this, there are choices in respect of the time period for historical averaging and weightings, if any, between different historical years.

The process and analysis below initially assumes equal weightings are applied to the years used in the historical averaging process. For clarity, weightings are as indicated in Exhibit 3.7.

Exhibit 3.7 – Equal weightings for years used in averaging process

Historical averaging period (years)	Equal weighting across all years (%)				
	Y-1	Y-2	Y-3	Y-4	Y-5
1	100	n/a	n/a	n/a	n/a
2	50	50	n/a	n/a	n/a
3	33.3	33.3	33.3	n/a	n/a
4	25	25	25	25	n/a
5	20	20	20	20	20

On the basis of equal weighting between relevant years, Exhibit 3.8 shows indicative monthly benchmark costs for normal wind conditions using different historical averaging periods.

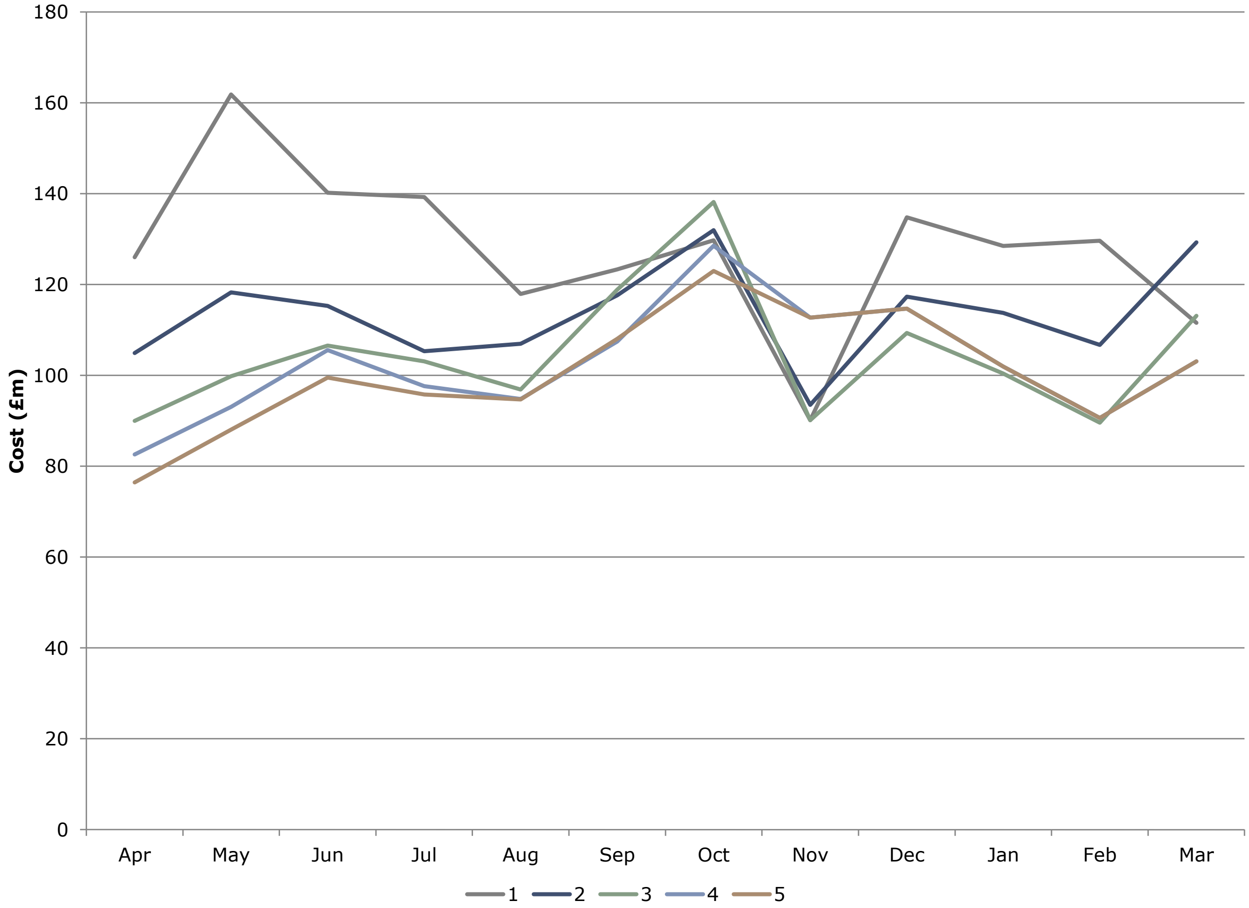
The following insights can be drawn from Exhibit 3.8:

- **Month on month relativity**: There is a fairly consistent pattern of relative monthly cost benchmarks throughout a year when considering historical averaging time periods of between 2 and 5 years. For example, each of the historical averaging approaches considered result in higher benchmark values in October.
  A different month on month pattern is seen if the most recent 12 months only are taken as the basis for the benchmark, with the disruptive effects of Covid-19 a factor in this.
- **Month on month variability**: Shorter averaging periods result in sharper month on month variations, while longer averaging periods provide a smoother outcome between months (as may reasonably be expected given more limited data points with shorter averaging periods).

Indicative monthly benchmark outcomes: Shorter averaging periods result in higher indicative cost benchmarks, which is reflective of higher outturn costs over more recent years. On average, a two year historical averaging approach results in an increase in monthly benchmarks of around £9m compared to a three year historical averaging approach. Similarly, the average monthly benchmark based on the last 12 months of data is around £14m higher than the two year historical averaging equivalent. Differences in indicative cost benchmarks are smaller between the longer averaging periods.

To highlight these outcomes, the relativities between benchmarks based on different averaging periods are illustrated in Exhibit 3.9.

Exhibit 3.8 – Indicative monthly benchmark costs based on different historical averaging periods and equal weighting between years



Notes: 1. Data up to and including October 2020 is included in the analysis. 2. Historical averaging takes the most recent data points for the relevant month.
Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data.

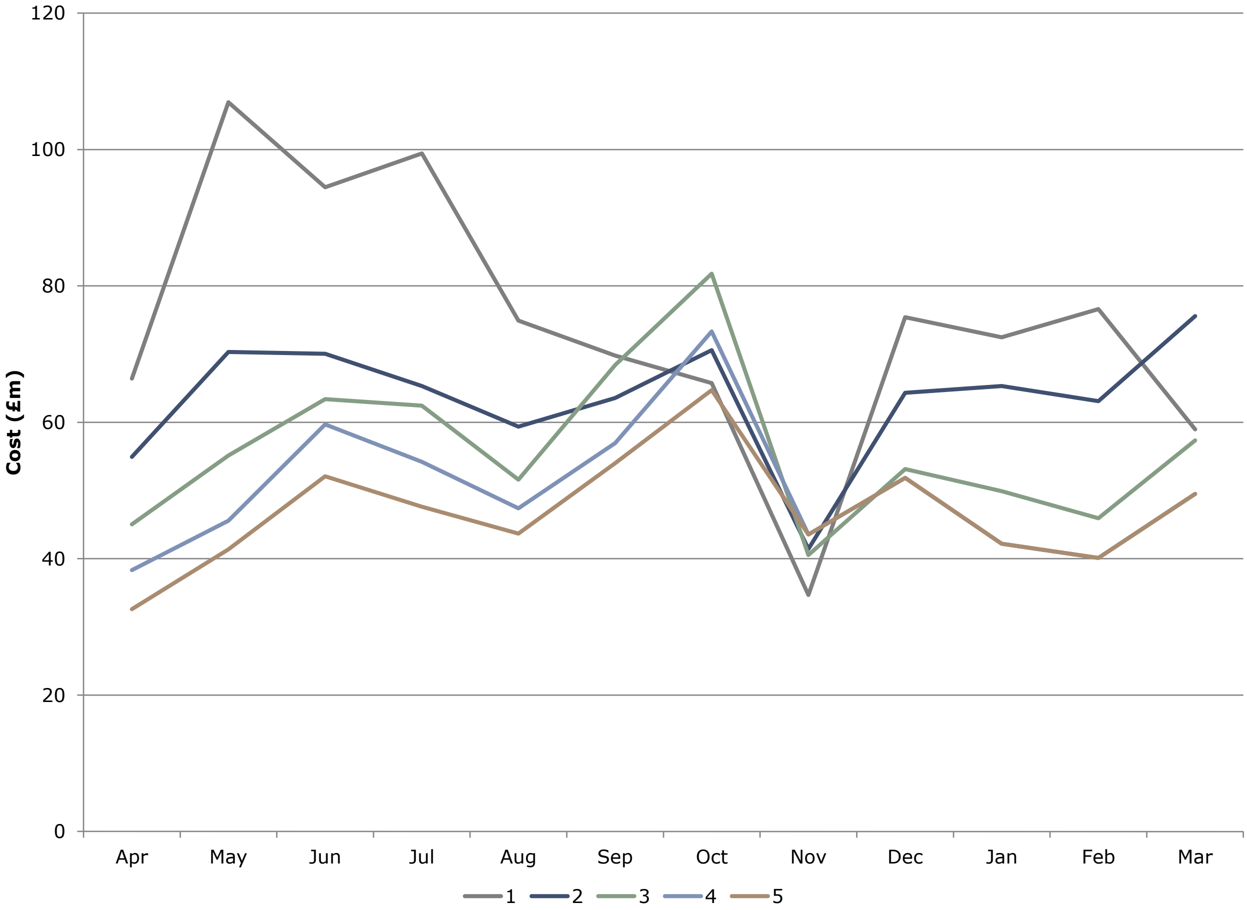
Exhibit 3.9 – Indicative benchmark costs based on different historical averaging periods and equal weighting between years

Historical averaging period (years)	Implied indicative annual benchmark (£m)	Average indicative monthly benchmark (£m)
1	1,533	128
2	1,361	113
3	1,256	105
4	1,232	103
5	1,208	101

Notes: 1. Data up to and including October 2020 is included in the analysis. 2. Historical averaging takes the most recent data points for the relevant month.
Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data.

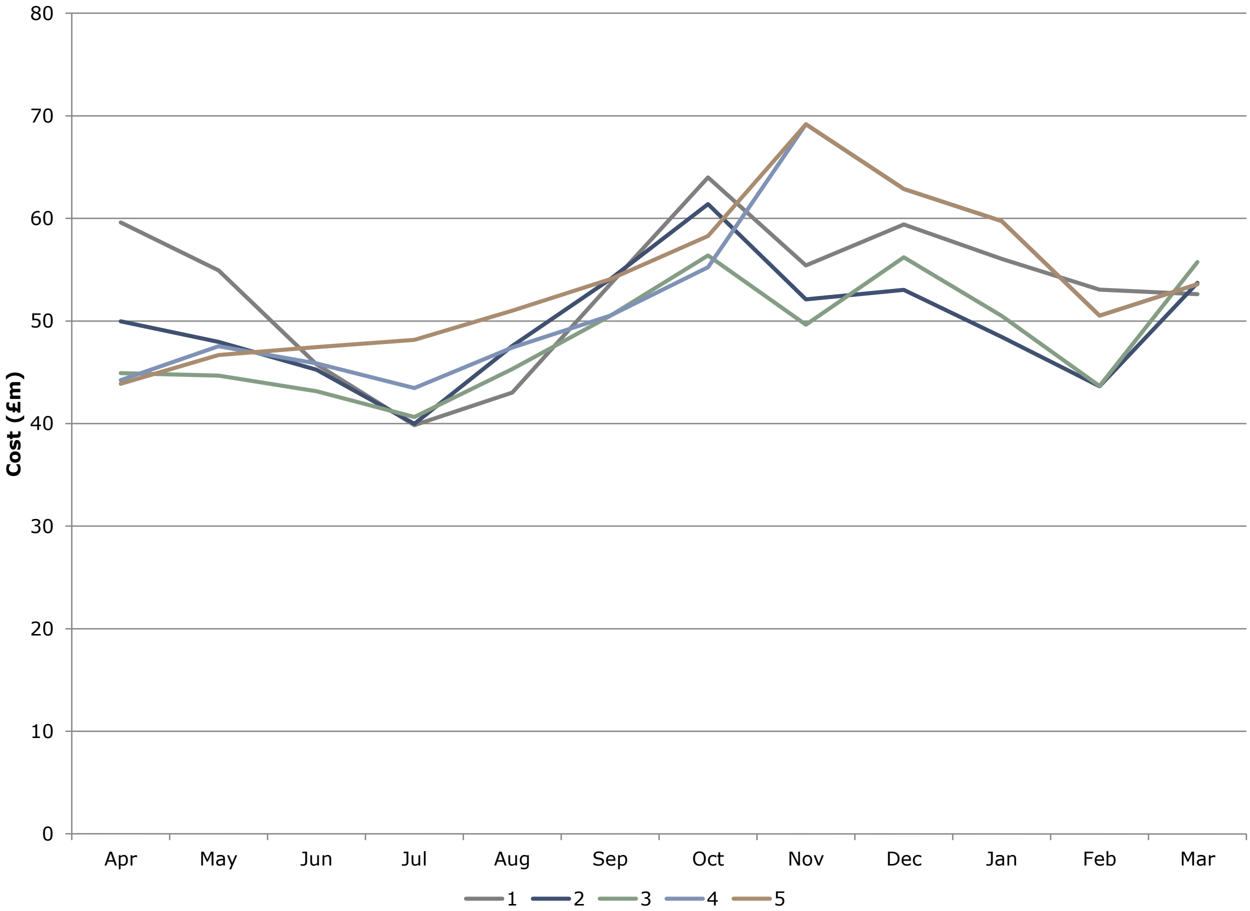
To dig into the effects of different historical averaging periods across different balancing cost components, Exhibit 3.10 and Exhibit 3.11 present equivalent information to Exhibit 3.8, but for constraint costs only and for non-constraint costs only. This highlights greater variability over different averaging periods for constraint costs than for the non-constraint costs.

Exhibit 3.10 – Indicative monthly benchmark costs for constraint cost only based on different historical averaging periods and equal weighting between years



Notes: 1. Data up to and including October 2020 is included in the analysis. 2. Historical averaging takes the most recent data points for the relevant month.
Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data.

Exhibit 3.11 – Indicative monthly benchmark costs for non-constraint costs only based on different historical averaging periods and equal weighting between years



Notes: 1. Data up to and including October 2020 is included in the analysis. 2. Historical averaging takes the most recent data points for the relevant month.
Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data.

Adopting alternative weightings for the relevant historical years changes the outcomes. To illustrate, alternative weightings are considered in the analysis below, as shown in Exhibit 3.12 alongside the equal weightings for purpose of comparison. These alternative weightings apply a higher weight to more recent years, with the implication that these years are assumed a better guide to potential future costs than earlier years[5].

[5] Recent evidence appears to support this assumption, but it should be tested further.

Exhibit 3.12 – Illustrative weighting options for years used in averaging process

Historical averaging period (years)	Equal weighting across all years (%)					Higher weighting for more recent years (%)				
	Y-1	Y-2	Y-3	Y-4	Y-5	Y-1	Y-2	Y-3	Y-4	Y-5
1	100	n/a	n/a	n/a	n/a	100	n/a	n/a	n/a	n/a
2	50	50	n/a	n/a	n/a	70	30	n/a	n/a	n/a
3	33.3	33.3	33.3	n/a	n/a	50	30	20	n/a	n/a
4	25	25	25	25	n/a	40	30	20	10	n/a
5	20	20	20	20	20	30	25	20	15	10

Exhibit 3.13 and Exhibit 3.14 show indicative monthly benchmark costs derived using different historical averaging periods applying, respectively, equal and non-equal weightings as shown in Exhibit 3.12.

Comparison between Exhibit 3.13 and Exhibit 3.14 suggests generally higher indicative benchmark values are derived if greater weight is placed on more recent years. This is illustrated further in Exhibit 3.15, which compares the outcomes for different historical averaging periods with equal and non-equal weightings (based on weightings shown in Exhibit 3.12).

Exhibit 3.13 – Indicative monthly benchmark costs, equal weighting

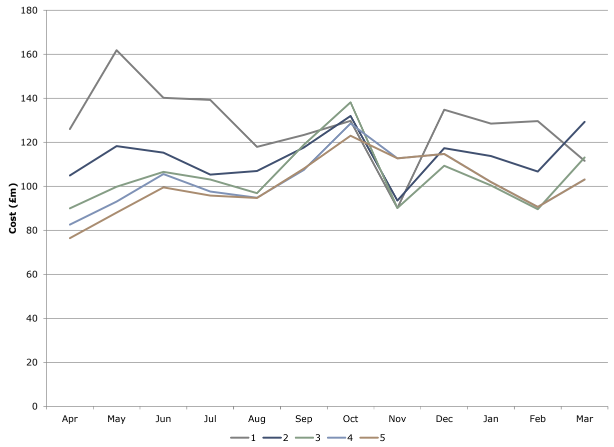


Exhibit 3.14 – Indicative monthly benchmark costs, unequal weighting

Exhibit 3.15 – Indicative benchmark costs based on different historical averaging periods and different weighting between years

	Equal weighting		Unequal weighting	
Historical averaging period (years)	Implied indicative annual benchmark (£m)	Average indicative monthly benchmark (£m)	Implied indicative annual benchmark (£m)	Average indicative monthly benchmark (£m)
1	1,533	128	1,533	128
2	1,361	113	1,429	119
3	1,256	105	1,332	111
4	1,232	103	1,295	108
5	1,208	101	1,253	104

Notes: 1. Data up to and including October 2020 is included in the analysis. 2. Historical averaging takes the most recent data points for the relevant month.
Source: AFRY Management Consulting analysis based on National Grid ESO balancing cost data.

Based on the analysis above, we make the following observations in respect of the historical averaging process and options:

3.2.4.1 Averaging period

There are trade-offs in terms of historical averaging period choice, as illustrated in Exhibit 3.16.

Exhibit 3.16 – Pros and cons of different historical averaging period approaches

	Pros	Cons
Shorter averaging period	— More reflective of more recent experience; faster adjustment in benchmark setting to latest outcomes — Reduces potential need for ex-ante adjustments	— Smaller number of input data points, increasing importance of delta values to adjust for historical high or low wind months — Less stable benchmark values year on year
Longer averaging period	— Larger number of input data points, reducing importance of delta values to adjust for historical high or low wind months — More stable benchmark values year on year	— Less reflective of more recent experience; slower adjustment in benchmark setting to latest outcomes — Increases potential need for ex-ante adjustments

The historical averaging period choice involves a judgement call based on these trade-offs. Our perspective is as follows:

- **1 year**: Taking the most recent year only as the basis for future benchmark setting inherently makes use of the smallest number of data inputs and involves an implicit assumption that the most recent outturn costs and conditions are the most appropriate basis for future benchmark setting. It is important for recent experience to be reflected, but to rely solely on the most recent 12 months of data risks locking any anomalies in outcomes into future benchmarks. On balance, our perspective is that it is preferable to have a longer averaging period than 1 year.
- **4-5 years**: Averaging over 4 or 5 years of historical data provides benefits in terms of available data points and year-on-year stability in benchmarks. However, in light of system evolution over more recent years and the potential for continued change in the coming years, this risks locking in more outdated experience that may have less relevance going forward and under-representing more recent experience. On balance, our perspective is that it is preferable to have a shorter averaging period than 4-5 years.
- **2-3 years**: In the current environment, an historical averaging period within this range appears to strike an appropriate balance in terms reflection of experience over the recent time horizon and data point availability.

3.2.4.2 Weighting

The motivation for potentially differential weightings between historical years is to allow greater weight to be attached to different years. In the current context, this is most likely to mean the potential for higher weightings for more recent years. Our perspective is that this goal is potentially better achieved through shortening the historical averaging period, rather than adopting different weightings. In addition, the differentiated approach introduces more complexity and involves a degree of arbitrariness in terms of allocating weightings. Therefore, our suggestion is that each historical year used in the averaging process should have equal weighting in the absence of any substantiation for differentiated values.

3.3 Derivation of ex-ante benchmarks for 'high' and 'low' wind conditions

The process outlined above will produce monthly benchmark values for normal wind conditions. The framework additionally needs monthly benchmark values for both low wind conditions and high wind conditions, such that an ex-ante cost benchmark is available for each month under all three sets of wind conditions.

Derivation of monthly benchmark values for both low wind conditions and high wind conditions makes use of the high and low wind adjustment deltas derived through either of the methods referred to in Section 3.2.3. The envisaged process is as follows:

- **'High' wind cost benchmark**: apply the high wind adjustment delta to the monthly 'normal' wind cost benchmark in order to derive a monthly 'high' wind cost benchmark; and
- **'Low' wind cost benchmark**: apply the low wind adjustment delta to the monthly 'normal' wind cost benchmark in order to derive a monthly 'low' wind cost benchmark.

3.4 Ex-ante benchmarks outcome

Based on the preceding steps, for each incentive year, the proposed approach is expected to produce the following in terms of ex-ante cost benchmarks:

- 12 monthly 'normal' wind cost benchmark values;
- 12 monthly 'high' wind cost benchmark values; and
- 12 monthly 'low' wind cost benchmark values.

These benchmarks will then be used throughout the incentive year to monitor and report performance, as discussed further in the next Section.

4 Applying benchmarks and monitoring performance

This Section sets out an approach for applying the different wind condition benchmarks and for monitoring of performance relative to them.

4.1 Applying benchmarks

In respect of an incentive year, the following steps will need to be followed to select the appropriate monthly cost benchmark and to aggregate these to derive the annual cost benchmark:

- **Wind conditions classification**: Data relating to wind load factors will need to be gathered and processed each month in order to allow for classification of wind conditions for each month. The outcome from this, including the final classification and supporting details, will need to be published to provide transparency to stakeholders.
- **Relevant monthly cost benchmark selection**: After each month and based on the classification of its wind conditions, the appropriate cost benchmark value (normal, high or low) for that month can be identified and selected as the relevant cost benchmark to apply to that month.
- **Aggregation of annual cost benchmark**: After the completion of the year, the relevant monthly cost benchmarks selected, as outlined above, based on observed wind conditions will need to be combined to provide an annual cost benchmark.

4.2 Monitoring performance

Within-year and end of year reporting and performance assessment will be conducted with reference to the monthly and annual cost benchmarks established above. This ensures that outturn costs will always be compared to a benchmark value that is reflective of the outturn wind conditions in each month and over the course of a year.

To support performance assessment, the following reporting is expected to be needed:

- **ahead of the incentive year**:

  - monthly ex-ante cost benchmarks for each wind classification;
- **at end of each month within the incentive year**:
  - outturn wind conditions and resultant wind classification for the month;
  - relevant monthly cost benchmark based on wind classification, outturn costs for the month and resultant performance assessment;
  - year to date aggregation of monthly cost benchmarks, year to date outturn costs and resultant performance assessment; and
- **at end of the incentive year**:
  - as for within-year, but based on final outturn wind conditions and costs for all months.

The following framework is suggested for assessment of performance:

- **exceeding expectations**: 10% lower than the benchmark value;
- **meeting expectations**: within +/-10% of the benchmark value; and
- **below expectations**: 10% higher than the benchmark value.

These benchmarks are consistent with those used under the existing balancing cost performance metric.

5 Additional elements of balancing cost metric framework

This Section considers additional elements of the metric framework relating to ex-ante adjustments and repotting.

5.1 Ex-ante adjustments

5.1.1 Principles

The existing balancing cost metric features a number of ex-ante adjustments. These are made to account for events or factors for which the underlying drivers are not expected to be relevant for forthcoming incentive periods. The effect of the ex-ante adjustment is, therefore, to adjust for relevant events/factors for the purpose of prospective benchmark setting.

However, ex-ante adjustments have become relatively commonplace. Under the current incentive scheme, adjustments are made to account for Western Link availability, for an energy uplift and for a rate of change of frequency uplift. These types of adjustment increase the complexity of the metric framework and can hamper transparency.

Arguably, the current approach with a 5 year rolling average and linear interpolation has contributed to locking in for longer costs that may be unrepresentative, thereby driving calls for ex-ante adjustments. However, the more focused historical averaging process outlined in Section 3.2.4, which covers a shorter period and takes the most recent years directly into account, is expected to reduce the need for ex-ante adjustments.

Our suggestion is that the default position is for no ex-ante adjustments to be made when defining cost benchmarks. Instead, the narrative accompanying performance reporting should be the vehicle for highlighting drivers for deviation from the defined benchmarks.

This does not mean that the possibility of making ex-ante adjustments should be removed. Rather, the criteria for making potential ex-ante adjustments should have reasonably high thresholds and need appropriate demonstration/evidence to be progressed.

5.1.2 Covid-19 implications

Clearly, the Covid-19 pandemic has had an impact on balancing costs for 2020/21, largely through its downward effect on demand levels. This makes it a candidate for a possible ex-ante adjustment.

However, at this stage of the pandemic it is not clear how demand may respond once the broader situation begins to improve or when this may happen. On one hand, demand may begin to bounce back towards levels equivalent to those seen before the pandemic as normal patterns of behaviour resume. On the other hand, changes to working practices and economic activities observed since the pandemic began may persist. This uncertainty is significant, making the calculation of a robust ex-ante Covid-19 adjustment infeasible.

An alternative approach is to consider making an ex-post adjustment to modify benchmarks based on actual demand[6]. However, as things stand the basis for defining demand conditions and potential adjustments is unclear and the addition of a second ex-post adjustment (i.e. for demand as well as for wind) introduces additional complexity to the metric framework, compromising its transparency and accessibility for stakeholders.

Rather than attempting to account for the impacts of Covid-19, the suggestion is that during 2021/22 (and thereafter as appropriate), reliance is instead placed on regular reporting for demand (and other pertinent metrics) to explicitly compare 2020/21 levels to those being seen in 2021/22.

This can be woven into the reporting narrative and associated discussions. If this highlights that there are notable differences between 2020/21 and 2021/22 demand levels (and other metrics as appropriate), then the potential for an explicit adjustment for the 2022/23 incentive period can be considered.

5.2 ESO reporting

We acknowledge that ex-ante benchmarks will never be precise in terms of cost expectations for an upcoming incentive period, but rather cost guides. This means that accompanying reporting plays an important role in adding context for and details concerning balancing cost performance. Therefore, processes similar to the current monthly, quarterly and annual reporting will continue to be needed in respect of balancing costs.

Reporting can also be used to inform the balancing cost performance metric framework for future incentive periods. In this regard, the following supplementary reporting angles could be explored:

- **Influence of wind on outturn balancing costs**: The proposal for a wind adjustment within the balancing cost metric was informed by analysis highlighting a strong correlation between monthly wind

[6] This could be similar conceptually to the ex-post adjustment being proposed under the outturn wind condition adjustment approach.

conditions and costs. Similar analysis should be conducted periodically, with results disseminated through appropriate reporting channels, in order to inform the ongoing validity of the wind adjustment approach.

- **Other influences on outturn balancing costs**: Similar regression analysis can also usefully be conducted for other prominent balancing cost drivers, to provide further insights into the importance of different variables for outturn costs. This need not trigger any changes to the framework, but can simply enrichen stakeholder understanding concerning drivers for outturn costs. As examples, other variables considered during analysis earlier in this process included gas prices and solar generation. ESO can make suggestions in respect of possible candidate variables for such analysis.
- **'Normal' wind**: Given factors such as increases in turbine sizes and the addition of new sites, including more offshore, it is sensible to conduct analysis to allow for potential re-appraisal of the load factors that equate to 'normal' wind conditions for purposes of the wind adjustment process. This analysis can then feed into framework design for forthcoming incentive schemes.

These types of analysis could be included in the mid-incentive year and the end of incentive year reporting outputs.

6 Summary overview and next steps

This Section contains an overview of the proposed balancing cost framework, plus associated processes. It also identifies next steps for taking this towards implementation.

6.1 Balancing cost framework summary

6.1.1 Principles

The following points provide a summary of the principles that apply to the proposed balancing cost performance metric framework:

- underpinned by simple methodology to support transparency;
- option for ex-ante adjustments for cost benchmarks retained, but default position is that no such adjustments will be made[7];
- ex-post selection of appropriate predefined wind condition specific cost benchmark based on outturn wind to explicitly account for impacts of wind on balancing costs; and
- retains emphasis on importance of reporting to support stakeholder understanding of outturn costs and their drivers.

The following points provide a summary overview of the proposed balancing cost framework and associated processes:

6.1.2 Ex-ante benchmark setting

6.1.2.1 Basis for determining wind conditions

The first step is to establish a basis for determining wind conditions:

[7] The process summary below excludes ex-ante adjustments, but if one or more adjustments are needed, they are expected to be conducted as part of the data set collation process.

- focused on defining national wind conditions at a monthly resolution, using wind load factors (potentially adjusted to unwind BOAs) as the wind metric;
- requires definition of 'normal', 'high' and 'low' wind conditions for each month;
- wind classification informed by historical analysis of average monthly load factors covering the last 5-8 years;
- 'normal' wind based on central trendline through historical data points; and
- for simplicity, thresholds for 'high' and 'low' wind defined as fixed percentage point increment or decrement respectively to central trendline:
  - working suggestion that high and low thresholds are set such that 15% of observations are classed as 'high', 15% of observations are classed as 'low', meaning that the remaining 70% of observations are classed as 'normal'.

6.1.2.2 'Normal' cost dataset for use in benchmark setting

The next step involves establishing a 'normal' cost dataset for use in benchmark setting, including 5-8 years of historical data:

- allocate a wind classification to historical months, such that each is classed as 'normal', 'high' or 'low' in terms of wind conditions;
- based on analysis, derive a high wind delta adjustment and a low wind delta adjustment, each expressed in percentage terms; and
- create an adjusted historical monthly cost dataset for 'normal' wind conditions, based on historical data and the defined high/low wind deltas.

6.1.2.3 Setting cost benchmarks

Based on the 'normal' wind condition historical dataset, derive monthly cost benchmarks for the upcoming incentive year:

- based on historical averaging of costs for a specific month over recent years, derive a month specific cost benchmark for 'normal' wind conditions i.e. produce a 'normal' wind cost benchmark for each month of the year;
  - outturn costs from 'high' and 'low' wind months adjusted by delta values (to be applied to either all balancing cost components or to constraint costs only) to provide derived 'normal' values for purposes of the normal wind condition dataset;
  - working suggestion that historical averaging is based on data from most recent 2-3 years, with equal weighting between years, to reflect the latest experience and reduce the need for ex-ante adjustments;
  - by deriving the historical dataset for 5-8 years, the option to apply a longer historical averaging approach remains, however, if considered appropriate;

- taking the derived 'normal' wind monthly cost benchmarks, apply the high and low wind deltas (consistent with those used to derive the normal cost dataset) to derive a month specific cost benchmark for both 'high' wind conditions and 'low' wind conditions; and
- the result for each incentive year is:
  - 12 monthly 'normal' wind cost benchmark values;
  - 12 monthly 'high' wind cost benchmark values; and
  - 12 monthly 'low' wind cost benchmark values.

6.1.2.4 Benchmark selection

Within each incentive year, the following steps will need to be followed to select the appropriate monthly cost benchmark and to aggregate these to derive the annual cost benchmark:

- at the end of each month, determine the outturn wind conditions for the month and, based on the resultant wind classification, select the appropriate cost benchmark for that month; and
- at the end of the incentive year, the monthly cost benchmarks selected throughout the year can be aggregated to provide an annual cost benchmark.

6.1.2.5 Regular reporting

Ahead of each incentive year, the set of derived ex-ante cost benchmarks need to be reported (noting that benchmarks for March will be provisional, pending finalised input data availability for the most recent March). During each incentive year, reporting will be required as follows:

- at end of each month within the incentive year:
  - outturn wind conditions and resultant wind classification for the month;
  - relevant monthly cost benchmark based on wind classification, outturn costs for the month and resultant performance assessment;
  - year to date aggregation of monthly cost benchmarks, year to date outturn costs and resultant performance assessment; and
- at end of the incentive year:
  - as for within-year, but based on final outturn wind conditions and costs for all months.

6.1.2.6 Performance measurement

At the completion of each month and the incentive year as a whole, performance can be assessed and reported:

- performance assessed as exceeding, meeting or below expectations, as per the current approach, with working suggestion that existing performance thresholds are retained as follows:
  - exceeding expectations: 10% lower than the benchmark value;

  - meeting expectations: within +/-10% of the benchmark value; and
  - below expectations: 10% higher than the benchmark value

6.2 Steps needed to finalise methodology and benchmark values

In order to finalise the suggested methodology and carry it forward, the following activities are required in the upcoming period:

- **Review and refine approach**: review and refine as appropriate, while retaining simplicity and transparency in the approach, the suggested approaches for:
  - **Wind metric**: e.g. outturn load factors or outturn load factors adjusted for accepted BOAs.
  - **Wind classification**: e.g. the shape of the seasonal normal load factor curve and the thresholds for treatment as high/low wind.
  - **Normal wind benchmarking**: e.g. 'normal' dataset construction, historical averaging and weightings.
  - **High/low wind deltas**: e.g. focus on constraint costs only or all balancing costs, data point availability, basis for deltas.
- **Benchmark values and deltas**: based on the refined approach and additional outturn data over the coming months, apply the methodologies to determine values to give effect to the metric.
- **Input data and reporting processes**: ensure that processes are set up to capture required input data and to disseminate, as well as outputs from ongoing monitoring.

TABLE OF EXHIBITS

Exhibit 2.1 – Historical monthly average load factors using generation 8
Exhibit 2.2 – Historical monthly average load factors using unwound wind 9
Exhibit 2.3 – Central 'normal' trend line for monthly load factors using generation 10
Exhibit 2.4 – Central 'normal' trend line for monthly load factors using unwound wind 10
Exhibit 2.5 – Possible bands for monthly load factors using generation 12
Exhibit 2.6 – Possible bands for monthly load factors using unwound wind 12
Exhibit 3.1 – Monthly total balancing costs with wind condition classification 15
Exhibit 3.2 – Monthly constraint related balancing costs with wind condition classification16
Exhibit 3.3 – Monthly energy balancing related balancing costs with wind condition classification 16
Exhibit 3.4 – Monthly other balancing costs with wind condition classification 17
Exhibit 3.5 – Normal cost benchmark derivation approaches 19
Exhibit 3.6 – Illustrative high/low wind delta values 20
Exhibit 3.7 – Equal weightings for years used in averaging process 21
Exhibit 3.8 – Indicative monthly benchmark costs based on different historical averaging periods and equal weighting between years 22
Exhibit 3.9 – Indicative benchmark costs based on different historical averaging periods and equal weighting between years 23
Exhibit 3.10 – Indicative monthly benchmark costs for constraint cost only based on different historical averaging periods and equal weighting between years 24
Exhibit 3.11 – Indicative monthly benchmark costs for non-constraint costs only based on different historical averaging periods and equal weighting between years 25
Exhibit 3.12 – Illustrative weighting options for years used in averaging process 26
Exhibit 3.13 – Indicative monthly benchmark costs, equal weighting 26
Exhibit 3.14 – Indicative monthly benchmark costs, unequal weighting 26
Exhibit 3.15 – Indicative benchmark costs based on different historical averaging periods and different weighting between years 27
Exhibit 3.16 – Pros and cons of different historical averaging period approaches 28

Quality control

Roles	Name	Date
Authors	Simon Bradbury Ian Wallace	November 2020
Approver	Simon Bradbury	November 2020

Document control

Report Identifier: 2020/41X387826/A

Version	Date	Comments
v300	November 2020	Final version

ÅF and Pöyry have come together as AFRY. We don’t care much about making history.

We care about making future.

AFRY Management Consulting Limited
King Charles House
Park End Street
OX1 1JD
Oxford
United Kingdom

Tel: +44 1865 722 660
afry.com
E-mail: consulting.energy.uk@afry.com