

## Spring 2013 NDM Analysis - Proposed Approach

### Background :

Ahead of each annual NDM analysis, it is customary to prepare a note for DESC setting out the proposed approach to the next NDM analysis. In particular, this note deals with the proposed overall approach to the analysis and the proposed approach to model smoothing.

The bi-annual assessment of model smoothing as applied to NDM demand estimation was presented to the DESC meeting on 8th November 2011. The results of the assessment supported the continued application of model smoothing in the manner currently applied. DESC agreed to continue to apply model smoothing in the manner currently applied. The next review of the application of model smoothing will take place in autumn 2013.

In addition DESC has previously agreed that should it become necessary due to limited sample strength, the data sets applicable to consumption bands 07 (14650 - 29300 MWh pa) and 08 (29300 - 58600 MWh pa) could be combined for both consumption band and WAR band EUC modelling in these consumption ranges. However the analysis from spring 2009 through to spring 2012 has not required such a combination of data to be applied.

Weather station changes are likely ahead of the start of gas year 2013/14 with work currently ongoing to understand impacts to the modelling approach. A revised version of the spring Approach document will be published once full impacts are known and can be explained.

The seasonal normal basis used during the modelling phase remains unchanged since the last update in spring 2010.

This note summarises the proposed overall approach to be applied for the spring 2013 NDM analysis.

Note: TWG and DESC are currently agreeing an approach to a wider analysis of EUC definitions. Any findings from this analysis could not be implemented until gas year 2014/15 at the earliest. In view of this wider analysis, there will be no repeat of the previous "break-point" analysis as part of this years modelling phase.

### Specific Points of Detail :

#### Model smoothing -

1. Year on year model smoothing will be used in the spring 2013 NDM analysis, in deriving the NDM proposals to be applied to gas year 2013/14.
2. In the absence of evidence of trends in the parameters of the year on year models, simple averaging will be applied to the NDM models feeding into model smoothing.
3. The NDM models for three years will be used for model smoothing. The three years will be 2010/11, 2011/12 and 2012/13. For all three analysis years, all data sets cover a twelve month period (mid-March to mid-March or April to March). In all three analysis years the April to March periods include at least one Easter weekend. Note that the mid-March to mid-March data sets of 12 months duration, which are applied to modelling EUCs below 293 MWh pa always include at least one Easter weekend in every year. Also note that for 2011/12 and 2012/13 the data sets for all EUCs (including EUCs below 293 MWh pa) are from April to March.
4. In applying smoothing, models from equivalent WAR bands in the three separate years will be averaged although WAR band limits change from year to year. This is the approach adopted for each NDM analysis since spring 1999 (i.e. all previous NDM analyses in which model smoothing was applied), and there is no real alternative to this. As a subsidiary point there is also a strong stability incentive to retain the current period (December to March) in the definition of the WAR values and therefore the existing definition will be retained for the spring 2013 analysis.
5. The approach to model smoothing will be at the level of the underlying demand models, as was the case in the previous analyses. Further details are attached in Appendix 1 to this note.
6. In line with previous commitments to bi-annual assessment, the approach to model smoothing will be reviewed in full again by DESC during the autumn of 2013, following finalisation of the NDM algorithms for 2013/14.

#### Model Re-runs :

1. To assist in any investigation of trends, all three years (i.e. 2009/10, 2010/11 and 2011/12) used in the spring 2012 implementation of model smoothing will be re-run to correctly take into account any changes in holiday periods applicable to the spring 2013 NDM analysis.
2. Only the re-runs from the 2010/11 and 2011/12 data sets will be used (along with the new data sets for 2012/13) in model smoothing, making up the three years of data applied in the spring 2013 analysis.
3. For EUCs in consumption ranges above 293 MWh pa, the data sets will cover the 12 month period April to March in 2009/10, 2010/11 and 2011/12.

4. For EUCs for the consumption ranges 0-73.2 MWh pa and 73.2-293 MWh pa, the analyses will in the case of all three years be done on data sets covering 12 months. The data sets for 2009/10 and 2010/11 run from mid-March to mid-March in each analysis year. The data set for 2011/12 runs from April to March. All these contain at least one Easter holiday weekend.
5. The holiday codes that apply to the Christmas/New Year period are the latest that were agreed following discussion at DESC on 8th November 2011. There are no planned special bank holidays at present for the 2013/14 period. Therefore the holiday code rules that apply (including treatment of recent special bank holidays) will be unchanged from the spring 2012 analysis. As in the spring 2012 analysis, the holiday codes that apply to the Diamond Jubilee holiday week in June 2012 will be those that normally apply to the second bank holiday week in May, with the days from Sunday 3rd June 2012 to the Diamond Jubilee holiday on Tuesday 5th June 2012 inclusive and Saturday 9th June 2012 assigned the holiday code that normally applies to the second bank holiday in May and the preceding Sunday and following Saturday. The set of holiday days applied to the analyses will be the union of the holidays applying to England and Wales on the one hand and Scotland on the other. This approach has been used since the adoption of model smoothing in spring 1999 and continues to be appropriate because EUC sample data from geographically adjacent LDZs are usually aggregated to allow some EUCs to be modelled. Both population and sample disposition are such that this aggregation of data is essential to enable modelling of all EUCs in all LDZs. No judgemental alterations will be made to the disposition or derived values of the ensuing holiday codes when they are applied to deriving EUC profiles for the target gas year (2013/14). Following evidence presented at the 10th November 2010 DESC meeting about the inconsistent holiday factors that would arise if holidays were to be excluded from the regression models, and there being no widespread support among DESC members for a change to this practice, holidays will not be excluded from the regression models for "01B" EUCs.

### Modelling Details

1. The general modelling approach to be adopted for the spring 2013 analysis will be the same as that applied in spring 2012. This approach is detailed in the flowcharts on pages 30 and 31 of the July 2012 NDM Report. A broad outline of the approach is reproduced below :
  - a. Exclude warm weather data and summer data (i.e. June to September) and fit a line to the remaining data. Any flat models are detected and re-run with all the data.
  - b. Warm weather data (for exclusion) is defined in this context as the warmest 2<sup>o</sup> of data (i.e. that for which the CWV is greater than Max. CWV - 2<sup>o</sup>).
  - c. Assess the excluded summer data against the line fitted in step (a) to establish whether a summer reduction is required. The current condition of a 5% bar before any summer reduction is considered to apply to each individual year model will be retained.
  - d. Reintroduce the summer data into the data set (after inflating by any summer reduction identified in step c; if no summer reduction is identified then there would be no inflation). Fit a line to the augmented data set, excluding the warmest 2<sup>o</sup>, to establish whether a cut-off is appropriate, considering potential cut-offs in the range 0.5 to 4 degrees below the maximum value of the composite weather variable. The criterion applied from spring 2001 onwards, of a 20% improvement in the mean square residual over that obtained by using the straight line alone, will be retained in assessing whether or not there should be a cut-off applied to each individual year model.

Note: During spring 2012 additional analysis was performed using a 10% and 30% improvement and the results were shared with TWG on 23<sup>rd</sup> May 2012. TWG decided to add this area to the work plan as a low priority item for investigation at a later date.

  - e. If a cut-off is not required, then reintroduce the warmest 2<sup>o</sup> of data and fit a line to the entire data set.
  - f. Model smoothing considers three years' models and the application of summer reductions or not to the smoothed model is dependent on all of the years contributing to the smoothed model. Thus it is possible that the smoothed model will not incorporate a summer reduction, in spite of a summer reduction being identified for one (or more) of the individual years. To cover this eventuality it is necessary in each year's modelling to produce models with and without summer reductions. The model without summer reductions will be produced by including summer data (except for the warmest 2<sup>o</sup>) in the regression in step a above, and fitting a cut-off if necessary, as in steps d and e above.
2. As previously agreed and implemented from the spring 2002 NDM analysis onwards, weekend effects for the "01B" EUCs will be modelled using the same "variable weather sensitivity" form of model used for all other EUCs. (This form of the model is set out in Appendix 3, on page 22 of the spring 2012 NDM Report.)
3. The data applicable to the analysis year 2012/13 will not have been analysed previously, and so, investigation of the most appropriate data aggregations, determination of WAR band limits, etc., will be undertaken with respect to this data set. This will be done in conjunction with the Technical Work Group (a decision point described in Appendix 2 below )
4. The models for all EUCs will allow the possibility of summer cut-offs and summer reductions being applied. Note however that cut-offs will not be applied to the models derived for consumption bands up to 293 MWh pa (i.e. the "01B" and "02B" EUCs), for the spring 2013 analysis. This amended approach was agreed by DESC in December 2003, with

a view to mitigating summer scaling factor instability and was also applied to all previous NDM analyses from spring 2004 onwards.

5. In any single LDZ, the same definition of CWV will be used for all runs (i.e. for all EUCs in that LDZ and for all years of data).
6. Weekend, holiday and summer reductions will be calculated (where appropriate) as the average of the percentage reductions estimated for the three individual years' models; where applicable the CWV cut-off (at which models cease to be weather sensitive) will be the simple average of the three separate estimates. (If for one or two of the three years there is no CWV cut-off, the maximum value of the CWV will be substituted as the cut-off for those years.) Further details are provided in the attached Appendix 1.
7. As set out in Appendix 1, the key aspect of averaging the models will be to average the ratio of the slope to the constant term, from each year's model. These ratios are equivalent to the reciprocals of the CWV intercepts.
8. Prior to the averaging, any models giving non-negative slopes on initial analysis (excluding the warmest weather from the regression), will be re-fitted to the entire data set. Any positive slopes remaining will be set to zero. This has become established practice.
9. A single EUC will be applied in each LDZ for the consumption range 0-73.2 MWh pa. Domestic only data sets will be applied to modelling this consumption range. This is in line with the approach taken in spring 2012. There has been various analysis investigating the appropriateness of this approach which is described in the paragraph below:

Following a detailed investigation (reported to DESC on 8th November 2007) of the modelling of this consumption range as two sub bands split at 20 MWh pa and at 30 MWh pa, with and without non-domestic supply points included in the upper sub-band, it was clearly shown that given the available sample strength no statistical improvement in the representation of the consumption range was obtained by either sub-bands or the inclusion of non-domestic supply points. Furthermore, a follow-up investigation (reported to DESC on 11th November 2008) of assessing potential breakpoints other than 73.2 MWh pa for dividing the range 0-293 MWh pa, showed clearly that breakpoints lower than 73.2 MWh pa at 30 MWh pa and 60 MWh pa gave no statistical improvement over the currently applied 73.2 MWh pa. The results of a further analysis of three sub-bands of the consumption range 0 to 73.2 MWh pa (split at 10 MWh pa and 20 MWh pa) was presented to DESC on February 1st 2012 which concluded that there was no compelling evidence for dividing the 0-73.2 MWh pa consumption band into three sub bands.

10. The following approach will be taken in spring 2013 with respect to non-statistically significant (at the 95% confidence level) weekend effects:

For 01B EUCs, a purely domestic sample will be used and all positive non-significant weekend effects will be retained at their original values.

For all of the remaining EUCs, all negative non-significant weekend effects will be retained at their original values.

11. For large NDM (i.e. above 2196 MWh pa), the consumption band break points by which large NDM EUCs are defined will remain in line with current practice. However, if sample numbers prove to be insufficient in the most recent year's data sets, it has been agreed with DESC that the samples applicable to consumption ranges 14650 - 29300 MWh pa and 29300 - 58600 MWh pa (EUC bands 07 and 08, respectively) may be combined to obtain samples of adequate strength for more robust demand modelling.

The data may be combined in this way for either the consumption band EUCs or for the WAR band EUCs or for both, depending on whether sample deficiencies require it. Even if data is combined in this way, separate EUCs will be defined for consumption band and WAR band EUCs in the consumption ranges 14650 - 29300 MWh pa and 29300 - 58600 MWh pa.

However, if data has been combined, the underlying demand models applicable to the most recent year of data will be the same for some of these EUCs. For the avoidance of doubt, previous years' data sets for these EUCs, included in deriving the final smoothed model, will be at the level of aggregation that applied at the time (i.e. bands 07 and 08 are separately modelled). Thus, despite any aggregation of data in the most recent year's data sets, the derived factors (i.e. ALPs, DAFs and load factors) will in general be different for each of these EUCs.

One issue with combining data sets for bands 07 and 08 for WAR bands analyses was revealed during the spring 2009 analysis using the then most recent 2008/09 data sets. The models for corresponding WAR bands for bands 07 and 08 were distinctly different. For example, they had markedly different indicative load factors. This pattern was again observed in the spring 2010, 2011 and 2012 analyses using the then most recent data sets. Therefore, combining these data sets may not be the most appropriate approach to take. The WAR band models based on combined data sets may be inappropriate for both bands. It may therefore be more sensible to accept the models based on smaller data sets.

### Exploratory Analyses -

In line with spring 2012, the exploratory NDM analyses will focus on confirming the most appropriate levels of aggregation to apply to the data sets for the various EUC analyses within the existing EUC boundaries.

In line with previous practice, WAR band EUCs over the consumption range 293-2196 MWh pa will be based on the overall range, which should then enable analysis by individual LDZ instead of LDZ groupings.

#### Derived Factors -

1. The DAFs for gas year 2013/14 will continue to be computed based on aggregate NDM demand.

For the NDM proposals for 2013/14, the historical aggregate NDM demand modelling approach will be retained (in line with recent practice since spring 2009). From spring 2009 to spring 2011 (inclusive) the aggregate NDM demand model was created for three separate sub-aggregations within the NDM sector. This introduced an inaccuracy whereby weekend and holiday effects within the aggregate model did not correctly cancel out, and therefore such effects were also present in the DAF shape.

From spring 2012 onwards the aggregate NDM demand model has been re-built to work with aggregate NDM LDZ demand in total. This ensures that weekend and holidays are more accurately represented. This approach was approved by TWG on 23<sup>rd</sup> May 2012 and will be retained for spring 2013.

The aggregate NDM models used will be models obtained from the average of three previous gas years aggregate NDM data modelled against weather (in this instance gas years: 2009/10, 2010/11 and 2011/12). The ensuing averaged historical model would be applied to the day of the week and holiday pattern of the target gas year but no forecast element would pertain to the model. With respect to a possible fallback position that may arise one year later in spring 2014, the same historical model will be applied to the day of the week and holiday pattern of the gas year 2014/15 to obtain a model appropriate for use in 2014/15 in case the fallback position has to be implemented.

2. Load factor computations for each EUC will be based on the relevant smoothed model. This is the same approach as adopted for all NDM analyses since spring 1999.
3. In calculating DAF values in the case where the smoothed model has a cut-off, the reduction in the magnitude of weather sensitivity will be phased in as described on page 68 of the spring 2012 NDM Report. This approach has been in place since its introduction at the time of the spring 1997 NDM analysis.
4. In the context of the non-application of cut-offs to EUC models in consumption range 0-293 MWh pa, and as agreed by DESC in December 2003, the values of ALPs for EUCs in this consumption range will be constrained to be never less than 1% of their maximum values. Note that this is a safeguard against a theoretical possibility of negative ALPs arising (in the profiles computed for all gas years since 2004/05 it has never been necessary to invoke this constraint).

#### Fallback Position –

For clarification, it should be noted that if DESC determine that the final NDM proposals made for gas year 2013/14 should not be based upon EUC definitions and demand models proposed from the spring 2013 analysis then the fallback position that would apply is that EUC definitions and derived factors (ALPs, DAFs and load factors) applied to gas year 2013/14 would be based on the underlying EUC demand models from the spring 2012 NDM analysis and the historical aggregate NDM demand models for 2013/14 computed in spring 2012. For the avoidance of doubt, the fallback proposals will use the holiday definition from the spring 2012 analysis but the actual weekend and holiday dates for gas year 2013/14.

#### Reporting -

The parameters for the smoothed models will be published, in an Appendix to the spring 2013 NDM Report.

As usual, all model parameters (for each of the three years feeding into model smoothing) will be provided in electronic form.

For all final smoothed EUC models, information (i.e. values of factors and flags where these apply to each model) pertaining to: summer cut-off, summer reduction, non-holiday weekend effects, and holiday effects will be provided in electronic form.

As in the spring 2012 NDM Report, all CWV intercepts (for each year's models and for the smoothed model) will be included in the report.

The performance evaluation appendix of the spring 2013 NDM Report will continue to have the now customary three strands of information (WCFs & SFs, RVs and NDM sample analysis) and as agreed by DESC at the 7<sup>th</sup> November 2012 meeting this will be a repeat of the gas year analysis published in the autumn / winter period. The analysis will not be updated prior to inclusion in the NDM report.

Appendix 11 of the NDM Report customarily contains a comparison of the proposed EUC load factors with the corresponding EUC load factors that applied in the previous gas year (in this instance 2012/13). This approach will be adopted in the spring 2013 NDM Report, as the seasonal normal basis has not changed between the spring 2012 and spring 2013 NDM Reports.

## Appendix 1 - EUC Model Smoothing

The key stages of the end user category (EUC) model smoothing process are explained below. This is unchanged from previous practice.

Produce models for the EUC based on the data for each of the last three years. In the case that summer reductions have been applied in an individual year, two versions of the EUC model for that year exist, one with summer reductions and one without summer reductions. Where summer reductions are applied, the magnitude of these reductions is expressed in terms of a summer multiplier applied to the fitted daily demands over the non holiday days from the spring bank holiday period to the last weekend in September. For example, a summer multiplier of 0.870 means that fitted demands are reduced by 13% over this period. If no summer reductions are applied, the summer multiplier takes a value of 1.

Decide whether to apply summer reductions to the final smoothed model. The criterion applied in making this decision is as follows. The summer multipliers for the three individual year models for the EUC are averaged. If this average summer multiplier is less than the critical value of 0.9 (a 10% reduction), summer reductions are applied in the smoothed model; the summer multiplier for the smoothed model is this average value. If the average summer multiplier is greater than or equal to the critical value, summer reductions are not applied to the smoothed model.

For example, for an EUC with summer multipliers of 1.000 (i.e. no summer reductions), 0.820, and 0.840 in the individual years, the average summer multiplier is 0.887. This is less than the critical value of 0.9, so a summer reduction is applied to the smoothed model.

This decision process allows a unique EUC model to be selected for each individual year. If summer reductions are to be applied in the smoothed model, the version of each individual year's model with summer reductions (if such a version exists) is selected. Otherwise, the version without summer reductions is selected for each individual year.

At this stage, the decision as to whether to set weekend effects to zero is taken.

The selected individual year models for the EUC are standardised, by dividing through by the constant for that individual year. This gives a model for each year (yr) of the form:

$$Dt(yr) = 1 + C2(yr)*CWVt + C3(yr)*Fri + C4(yr)*Sat + C5(yr)*Sun$$

This standardisation ensures that all three individual year models give the same normalised daily demand value (i.e. 1.0) for a non-holiday Monday to Thursday at 0° CWV. This ensures that equal weight is given to each individual year in the smoothing process.

Each individual parameter of the initial smoothed model for the EUC is calculated by averaging the values of the parameter over the three individual years.

For example,  $C2(\text{smoothed}) = \{C2(\text{yr. 1}) + C2(\text{yr. 2}) + C2(\text{yr. 3})\}/3$

The constant (which is 1 in the standardised model) and the slope of the smoothed model are then multiplied by the constant term of the original (unstandardised) model for the most recent year. Note that this step has no effect on the NDM profiling or capacity estimation parameters, but it gives model parameters of the same scale as that of the model for the most recent individual year.

The multiplicative day of week/holiday factors (Pt as described in Appendix 3 of the spring 2012 NDM Report) are calculated for the smoothed model for the EUC. These are calculated for each day as averages of the corresponding values in the three individual years' models.

A decision is made as to whether to apply a composite weather variable cut-off to the smoothed model for the EUC. Application of a CWV cut-off has the effect of causing the fitted demand to level off for values of CWV above the cut-off. The criterion used in making the decision is as follows. The value of the CWV cut off is estimated for each year's model. If no cut-off is required, the cut-off value for that year is set to the maximum CWV for the LDZ. The three individual years' CWV cut-offs are then averaged. If this average value is less than the maximum CWV for that LDZ, a CWV cut-off is set at this value in the smoothed model. Otherwise no CWV cut-off is applied to the smoothed model. Note however that cut-offs will not be applied to the models derived for consumption bands up to 293 MWh pa (i.e. the "01B" and "02B" EUCs), for the spring 2013 analysis. This amended approach was agreed by DESC in December 2003, with a view to mitigating summer scaling factor instability and has been applied to all NDM analyses since spring 2004.

The ensuing form of model is used in the calculation of NDM profiling parameters and capacity estimation parameters.

A form of the smoothed model is also produced with additive weekend effects. The averaged standardised parameters for each day from Friday to Sunday are multiplied by the constant term of the original unstandardised model for the most recent year, to give additive weekend effects for the smoothed model. This gives a smoothed model of the form:

$$Dt = C1 + C2*CWVt + C3*Fri + C4*Sat + C5*Sun$$

C1 has the same value as the constant term of the EUC model for the most recent year. This is a simple form of the smoothed model because it does not embody such features as holiday effects, summer cut-offs and summer reductions. The parameter values for this form of model will be shown in the spring 2013 NDM Report, for consistency with previous years' reports.

Appendix 2: Interaction and / or Decision Points			
Phase	Approx Dates	Interaction / Decisions	Made by
Approach to modelling	Winter 12/13	Agree the approach to be taken to modelling for the 2013/14 NDM profiles allowing back runs to be completed and new year modelling.	Technical Workgroup and DESC
Sample data validation	22/04/13 to 26/04/13	Agree modelling runs based on collected data aggregations and WAR band definitions	Technical Workgroup
Single year modelling	29/04/13 to 10/05/13	Possible that any issues with the regression analysis need to be reviewed promptly with consensus decisions made quickly	Technical Workgroup
Single year modelling	20/05/13 to 24/05/13	Review of all single year modelling results. Decisions likely to be required on which models are best for certain EUC/LDZ combinations. Choice of models will be offered that the group shall be required to select	Technical Workgroup
Draft NDM profiles	10/06/13 to 28/06/13	Review will be required of draft NDM proposals for all EUCs such as Annual Load Profiles and Daily Adjustment Factors. Consensus will be required on any comments raised and agreement of key messages to be taken forward to DESC	Technical Workgroup
Draft NDM profiles	08/07/13 to 12/07/13	Recommendations from TWG for draft NDM proposals to be reviewed seeking approval for informing wider industry	DESC
Final NDM profiles	29/07/13 to 02/08/13	Industry representations to be reviewed along with an agreed response before finalising the NDM proposals	DESC