Autumn 2014 Composite Weather Variable (CWV) Review - Proposed Approach

Background:

This document describes the proposed approach for reviewing and revising the parameters of the Composite Weather Variable (CWV). Following changes to Section H of the Uniform Network Code the obligation to oversee and sign off this work now lies with the Demand Estimation Sub Committee (DESC) – see below:

The Uniform Network Code (Section H, Paragraph 1.4.2) requires:

> "The relevant Sub-committee will, at appropriate frequencies determined by it, after consultation with the Uniform Network Code Committee or any other relevant Subcommittee, review and where appropriate revise (with effect from the start of a Gas Year) the formula by which the Composite Weather Variable for an LDZ will be determined. "

The last such CWV review was completed in autumn 2009 and implemented on 1st October 2010. The next review will be concluded in autumn 2014 for implementation on 1st October 2015 and the revised CWVs will be used in the spring 2015 NDM analysis. This note describes in outline the proposed approach for this CWV review. The proposed approach is essentially the same as applied in the previous review undertaken in autumn 2009 with the addition of another 5 gas years of aggregate NDM demand and weather data being available to the analysis.

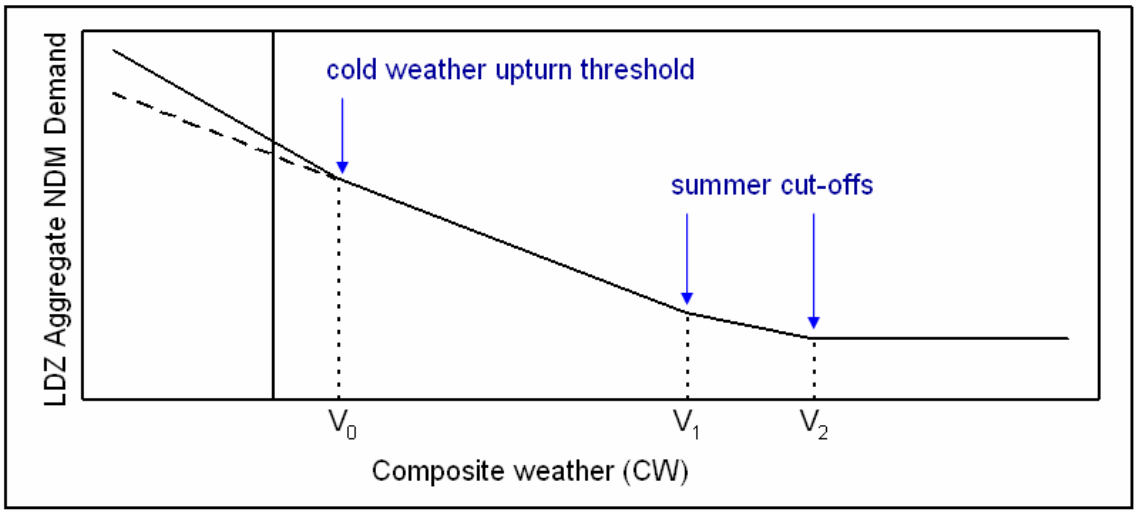
DESC agreed at a meeting on 12th February 2014 that its Technical Work group (TWG) shall preside over the detailed analysis and provide recommendations back to DESC later in the year when it has a set of proposed revisions to the CWV parameters. The TWG will therefore be required to interact with and provide guidance and support to Xoserve as it works through the analysis.

Definition of Composite Weather Variable:

The Composite Weather Variable (CWV) is a single measure of daily weather in each LDZ and is a function of actual temperature, wind speed, effective temperature and seasonal normal effective temperature. The definition of CWV includes provision for summer cut-offs and provision for cold weather upturn during low temperature extremes, defined such that a linear relationship applies between daily demand in the LDZ and the composite weather variable.

The current definitions of each CWV implemented on 1st October 2010, include a pseudo seasonal normal effective temperature (SNET) profile based on aggregate NDM demand as well as weather. This is a specific feature of the current (and previous) CWV definitions intended to beneficially alter the underlying shape of the CWV profile throughout the year and thereby help mitigate seasonal modelling bias.

The figure set out below shows schematically the component parts of the definition of the CWV:



Scope of Review:

The scope of the analysis will focus on a fresh optimisation of the parameters used within the existing CWV formula. Despite the ongoing discussions relating to the gas day and its timings potentially changing, this review will assume the current timeslots for recording Temperature and Wind Speed observations, which feed into the daily temperature and wind speed calculations, will remain unchanged. Depending on whether appropriate demand data is available it may be possible to consider including a review of the weightings associated with the existing individual timeslots. This review cannot consider fundamental changes, such as introducing a new weather variable or additional terms within the formula, however Xoserve is aware of the aspiration within the industry to enhance the CWV and/or replace it but this will need to be a consideration for DESC post UK Link replacement.

Outline of Approach:

In the proposed approach, there are a number of stages involved in revising the CWV definition for a particular LDZ that use demand and weather data from a number of gas years. At each stage the values for one or more CWV parameter is estimated. For most of these stages, a range of possible values for the parameter(s) is investigated. Regression models are derived for each gas year relating daily demand to CWV (on some or all non-holiday days) for each of the possible CWV parameter values. The value(s) of the parameter(s) that produces the best fit of CWV to demand on average over the modelled gas years is chosen as the parameter estimate(s). If a particular gas year contains suspect demand or weather data, the demand model for that year may be excluded when selecting the best value(s) for the parameter estimate(s).

Due to the nature of the data used in the analysis and the industry timetable that needs to be adhered to, the analysis needs to be performed over 2 separate phases. In this document these phases shall be referred to as the Trial phase and the Production phase, an explanation of each is given below:

Trial Phase

The objective of the trial phase is to establish key principles and approaches for how the main CWV optimisation analysis will be carried out during the Production phase. The work involved in revising all of the parameters for each LDZ is substantial, as it involves many iterations of analysis in order to find the optimum set of values which have proven themselves over a number of gas years. Therefore, during this investigative type work only a selection of the 13 LDZs will be chosen for analysis and the results from these LDZs will be used to support the final agreements on how the calculations for all LDZs will be performed during the Production phase.

It is expected that the Trial phase analysis will be completed during Q1/Q2 of 2014

Production Phase

The objective of the production phase is to revise the CWV parameters for all LDZs following the agreements reached at the end of the Trial phase. This phase, carried out during Q4 of 2014 – once the last gas day of 2013/14 has 'closed out', will involve a significant amount of analysis with the output providing a key component of the calculations for the new Seasonal Normal Composite Weather Variable (SNCWV). The SNCWV will also need to be derived during Q4 and so it is therefore not feasible to include another TWG 'review cycle' of the CWV parameters within this phase. The CWV parameters output during this phase will have been derived following the earlier agreement, hence the importance of the analysis performed during the Trial phase.

In order to perform CWV optimisation the main data requirement is 2 hourly temperature, 4 hourly wind speed observations and daily demand data. The next section describes these data requirements in more detail

Source Data - Weather History to be used in the investigation:

The Weather Station Substitution Methodology (WSSM) has delivered a new weather dataset for temperature, wind speed and several other variables. Those two named variables will be used in the 2014 CWV optimisation review.

The weather stations that will be used for the optimisation will be the existing gas industry weather stations with the following exceptions:

> Winterbourne 2 will be used as the source for Temperature data for LDZ WM with Edgbaston providing the historical observations upto the point of its closure.
>
> Rostherne No2 (unadjusted) will become the new source station for Temperature and Wind Speed measurements used in deriving the parameters for LDZs NW and WN.

For completeness the remaining list of stations to be used are as follows:

> Glasgow Bishopton – to be used for LDZ SC
> Albermarle Barracks – to be used for LDZ NO
> Nottingham Watnall – to be used for LDZs NE and EM
> London Heathrow – to be used for LDZs EA, NT and SE
> Coleshill (wind speed only) – to be used for LDZ WM
> St Athan – to be used for LDZ WS
> Southampton Oceanographic Institute – to be used for LDZ SO
> Filton – to be used for LDZ SW

The WSSM data is a set of hourly measurements starting at midnight on 1st January 1960 and ending at midnight on 30th September 2012. There are some gaps within this dataset which will need to be filled prior to its use in the Production Phase, however there are workarounds which can be applied during the Trial Phase, this is explained later in the document.

Post 30th September 2012 the 2 hourly temperatures and 4 hourly wind speeds received into UK Link to calculate the CWV shall be used to complete the required data series.

For the majority of the stations this will provide a complete weather data series upto 30th September 2014 which ultimately is needed to complete the full analysis in the Production Phase, however Winterbourne 2 and Rostherne No.2 are slightly different cases and require a combination of data sets – see below:

Winterbourne 2 Weather data series:

WSSM History from Edgbaston 1st Jan 1960 to 30th September 2012
UK Link History from Edgbaston 1st October 2012 to 28th November 2012
UK Link History from Winterbourne 2 29th November 2012 to 30th September 2014

Rostherne No.2 Weather data series:

WSSM History from Rostherne No.2 1st Jan 1960 to 30th September 2012
*Missing data 1st October 2012 to 31st October 2012 **
Investigation data from Rostherne No.2 1st November 2012 to 15th July 2013
*Missing data 16th July 2013 to 27th October 2013 **
UK Link History from Rostherne No.2 (with bias 'backed out') 28th October 2013 to 30th September 2014

* The *Missing data* highlighted above will need to be resolved for Rostherne No.2 prior to the Production phase.

Source Data - Demand History to be used in the investigation:

As explained the objective of the CWV formula is to ensure a linear relationship to aggregate NDM demand in the LDZ is achieved. To perform the CWV optimisation analysis aggregate NDM demand is therefore required as a data input.

This aggregate NDM demand data is the equivalent of the 'top-down' values seen in Gemini (i.e. LDZ Measurement – DM Measurements – Shrinkage). The concept of aggregate NDM demand started in 1996 and this data is available upto the current day.

All of this daily aggregate NDM demand data for each LDZ will be used in the analysis, with the following conditions:

In recent years DESC have requested that significant measurement errors be taken into account in the Aggregate NDM Modelling undertaken as part of the Daily Adjustment Factor (DAF) calculation which is required as part of the annual NDM proposals work. On 12th February 2014 TWG confirmed that where adjustments have been necessary (since the change in DAF approach) these will also be considered for optimisation.

Demand data that appears suspect or unusual for particular days, perhaps as a result of an incorrect DM or LDZ measurement which ultimately affects the NDM position, will be removed from the analysis. Where this happens the removed days will be recorded.

To complement the aggregate NDM demand data we can also use Maximum Potential Demand (MPD) which is an additional source of LDZ demand data prior to the introduction of aggregate NDM demand in 1996. This data is available for most LDZs for gas years 1981/82 to 1995/96. On 12th February 2014 TWG confirmed this data could also be used in optimisation as it includes the winter of 1981/82 which was particularly cold and will be useful for the cold weather upturn parameter.

Trial Phase Approach:

On 12th February 2014 TWG agreed to the following approach for the Trial Phase:

i) 4 LDZs will be analysed and these are: SC, NE, WM and SW.

ii) The date ranges of the analysis for seeking revised parameters will be:

Run 1: Extend existing approach by additional 5 years available since last CWV review – during trial phase this will be 4 years (Gas Years 1996/97 to 2012/13) as the last year 2013/14 will not be complete until the Production phase.

Run 2: Retain current basis of using the latest 13 years – during trial phase this will be 12 years (Gas Years 2001/02 to 2012/13) as the last year 2013/14 will not be complete until the Production phase

iii) For the selected 4 LDZs the WSSM data has less days impacted by missing data and so for the trial phase only TWG agreed these days could be filled in with the daily temperature (or wind speed) values from the current gas industry data series.

iv) The CWV optimisation results provided will be in line with the last CWV review performed in 2009.

Production Phase Approach:

The Production Phase is the full optimisation and is scheduled for October 2014 so that it can include the latest complete gas year ending on 30th September 2014.

The date range and number of years agreed in the Trial phase will be used to determine the optimised CWV parameters for all LDZs.

In preparation for this phase a complete WSSM data series for all weather stations will be needed, along with a complete data series for the post WSSM period, namely 1st October 2012 to 30th September 2014.

It should be noted that running the full optimisation in October 2014 will mean the CWVs will be published with little or no review time to adhere to the timetable of making the CWV available for AQ calculation. The proposed approach has the benefit of allowing for a trial calculation using the available additional four years of data, to reach a decision before the final year is finished. This then permits a quicker turnaround after the end of the fifth year, to support the need for new definitions to support the 2015 AQ process.

The following section describes the stages involved in revising the various CWV parameters. The values in square brackets are not fixed and are pending a final decision by DESC, in this example however it assumes the final selection for deriving the CWV parameters is based on 18 years upto the end of GY 2013/14.

Stages involved in revising the CWV definition

The stages involved in revising the CWV definition for a particular LDZ are described below:

1 Derive a pseudo SNET (an alternative seasonal profile) from aggregate NDM demand data using 3-frequency Fourier series. The pseudo SNET values are used in place of SNET values in the CWV formula. The parameters of the pseudo SNET are calculated from [18] years (1996/97 to 2013/14) autoregressive models of the form:

$$D = a - \sum_{i=1}^{3} bi \sin\left(\frac{2id\pi}{365}\right) - \sum_{i=1}^{3} ci \cos\left(\frac{2id\pi}{365}\right) + d\mathrm{ET} + e\mathrm{WC} + f\mathrm{FRI} + g\mathrm{SAT} + h\mathrm{SUN} + \mu$$

using non-holiday days (excluding 29th February) with $ET_{min}<ET<ET_{max}$ where

D=daily aggregate NDM demand,

ET=daily effective temperature,

WC=daily wind chill,

d= day number (day 1=1st January etc.),

FRI/SAT/SUN=1 if day is a Friday/Saturday/Sunday and 0 otherwise,

μ= autoregressive error such that $\mu(t) = A*\mu(t-1)+\varepsilon(t)$,

A=autoregressive parameter.

For each year's model, scale the bi and ci parameters by dividing by the sum of the Fourier series parameters (b1+b2+b3+c1+c2+c3). Take the mean of these 8 sets of scaled parameters to produce an average Fourier series. A "pseudo SNET" is derived from this average Fourier series by adding the mean ET and scaling the averaged parameters so that the pseudo SNET has a similar range and mean to the mean daily ET profile over the [18] years. The value for 29th February is derived from the average of the 28th February and March 1st values.

Note that the limits ET_{min} and ET_{max} are integers that vary by LDZ and are chosen to select most of the non-holiday days that do not fall within the cold weather upturn or warm weather flattening off periods. Initial estimates of these limits are obtained from inspection of graphs of demand against composite weather (CW). Example initial estimates for ET_{min} and ET_{max} are 3 and 14 respectively.

2 Derive l_1 and l_2 parameter estimates using aggregate NDM demand data, pseudo SNET, ET and WC data from [1996/97 to 2013/14 (all non-holiday days with $ET_{min}<ET<ET_{max}$).

3 Derive initial estimates of cold weather parameters (V_0 and l_3) using demand and weather data from [1981/82 onwards] (all non-holiday days with $ET<ET_{max}$). The demand data comprises maximum potential demand (MPD) data for gas years [1981/82 to 1995/96] and aggregate NDM data from [1996/97 to 2013/14].

4 Derive warm weather parameters (V_1, V_2 and q) using aggregate NDM demand data and weather data from [1996/97 to 2013/14] (Monday to Thursday non-holiday days).

5 Derive final estimates of cold weather parameters (V_0 and I_3) using demand and weather data from [1981/82] onwards (all non-holiday days). The demand data comprises MPD data for gas years [1981/82 to 1995/96] and aggregate NDM data from [1996/97 to 2013/14].

6 Derive the 1 in 20 peak CWV from all available weather data (54 gas years from 01/10/1960 to 30/09/2014) and estimate indicative 1 in 20 peak demands for each gas year from Monday to Thursday demand model parameters. Compare the fit and indicative peak demands for the revised CWV with the existing CWV.

7 Repeat stages 1 to 6 using different values for ET_{min} and ET_{max} on either side of the initial estimates. Select the combination of ET_{min} and ET_{max} limits and associated pseudo SNET and CWV parameters that give the best fit of CWV to aggregate NDM demand on average over the [18] gas years. If two sets of pseudo SNET and CWV parameters give very similar fits, chose the set that results in the minimum change to the indicative 1 in 20 peak demand estimates. The revised CWV definition for the LDZ comprises the selected pseudo SNET and set of CWV parameters.

Appendices

Appendix 1: Interaction and / or Decision Points

Phase	Approx Dates	Interaction / Decisions	Made by
Approach to Optimisation	Mid to Late Feb 2014	Draft the proposed approach to be undertaken for Optimisation	Xoserve
Approach to Optimisation	12/02/2014	DESC to be asked to delegate review of CWV Optimisation to TWG	DESC
Approach to Optimisation	Q1 2014	Review the proposed approach to be taken for Optimisation	TWG
Approach to Optimisation	Q1 2014	Approve the approach to Optimisation	TWG
Optimisation - Trial Phase	Q1 / Q2 2014	Based on approved approach: Prepare data (weather / demands) as necessary Undertake initial analysis on agreed LDZs and parameters	Xoserve
Optimisation - Trial Phase	Q1 / Q2 2014	Review the outputs from the initial analysis and provide recommendation to DESC	TWG
Optimisation - Trial Phase	Q1 / Q2 2014	DESC to agree preferred options for full optimisation	DESC
Full Optimisation - Production Phase	Q4 2014	Complete analysis of 13 LDZs per DESC and TWG agreed performed options	Xoserve
Full Optimisation - Production Phase	Q4 2014	Publish final revised CWV Parameters	Xoserve