Average Cold Spell Methodology

Introduction

This document is being written under Special Condition 4L.12 (Financial incentives on EMR) of National Grid Electricity Transmission plc's Electricity Transmission Licence: "The Weather Correction Methodology must be published by the licensee at the same time as the Electricity Capacity Report that uses that Peak National Demand Forecast."[1]

The weather correction methodology used, as stated in the Licence, is the Average Cold Spell (ACS) Methodology for both forecast and outturn demand. This approach is used as is takes into consideration the variability in weather due to people's changing behaviour e.g. more heating demand when it is colder and the variability in weather dependent distributed generation e.g. wind generation. These two elements combine to have a significant effect on peak electricity demand. Further to these elements the methodology uses the Daily Demand Forecasting models used by National Grid's operational Energy Forecasting team. The core of the process is a Monte Carlo simulation to capture the variability of demand and weather.

Due this methodology using third party data (weather information) and running simulations a worked example is not possible. We have included flow diagrams to aid the understating of this process. We welcome any questions or comments on this methodology; please contact Russell Fowler Russell.Fowler@nationalgrid.com

ACS Forecast Methodology

1. At beginning of August before coming GMT period unrestricted[2] national demand[2] forecast for daily peak (DP) is built. It is modelled on historical demand data and meteorological data as required by Grid Code OC1. Currently three years' worth is used, but this alters depending on how rapidly demand patterns alter.
2. During the Triad[3] period, unrestricted demand is demand that would have been observed had there been no Triad avoidance. The amount of Triad avoidance is estimated by assessing the (current) value of the lowest Triad, the most recent demand forecast, and the shape of the historical load curve on a similar day on which there was no triad avoidance.
3. To model, unrestricted National Demand is split into five components:
   - Basic Demand level, reflecting amount of demand unaffected by day-to-day variations
   - Temporal effects (e.g. day of week, time of year)
   - Weather effect, reflecting human behaviour response to meteorological weather
   - Effect of unmetered wind variable generation (
   - Unexplained residual random fluctuations
4. Symbolically:

$$Demand = basic\ demand + temporal\ effect + weather\ effect - unmetered\ generation + residual$$

[1] 4L.11 states that "The Weather Correction Methodology used for calculating Peak National Demand will be the Weather Correction Methodology in place at the time each Peak National Demand Forecast was produced."

[2] National Grid, *The Grid Code*, http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/The-Grid-code/

[3] National Grid, *Triad Data,* http://www2.nationalgrid.com/UK/Industry-information/System-charges/Electricity-transmission/Transmission-Network-Use-of-System-Charges/Transmission-Charges-Triad-Data/

5. Basic demand reflects underlying demand level on transmission system independent of day of week, weather, unmetered generation etc.
6. The demand forecast model for daily peak requires unrestricted national demand, so a daily estimate of triad avoidance is made for every day in the triad season.
7. Determine an underlying basic demand level for the coming winter, this is based on assessment of economic factors, technological factors, and intelligence on forecast new build of non-metered distributed generation
8. Demand forecast model together with up to 10 years' of historic demand data is used to forecast a time series of daily basic demand levels at DP throughout coming winter
9. Perform Monte Carlo simulation (20000 replicates currently used to obtain convergence).
    - Variables treated probabilistically in Monte Carlo simulation (i.e. that vary from replicate to replicate):
        - Weather that is input into demand models
        - Unmetered wind load factor
        - Residual demand fluctuation
    - Variables that are treated as (deterministic) parameters:
        - Forecast average level of underlying basic demand
        - Forecast unmetered wind capacity
10. For each Monte Carlo replicate:
    - Sample winter's worth of weather at DP from 30 year history
        - 30 years is chosen as this is the period recommended by the World Meteorological Organisation[4] for the length of a "weather normal" – the period that is long enough not to be affected by interannual variation, but short enough to be able to ignore climate trends
    - Sample winter's worth of unmetered wind load factors
        - This is currently sampled from a database of unmetered wind generation estimates from 2011, since before this time unmetered wind generation was not sufficiently geographically dispersed to represent the current geographical distribution
    - Multiply by monthly forecast unmetered wind capacities to produce sample of winter's worth of unmetered wind generation at daily peak
    - Simulate winter's worth of demand residual using observed distribution of residuals from demand forecast model
    - Use demand forecast model to calculate a simulated winter of daily peak demands
    - Replicate to obtain 20000 simulated winters
11. Calculate maximum demand for each simulated winter
12. Take median of this sample as the Forecast Average Cold Spell demand

ACS Outturn Methodology

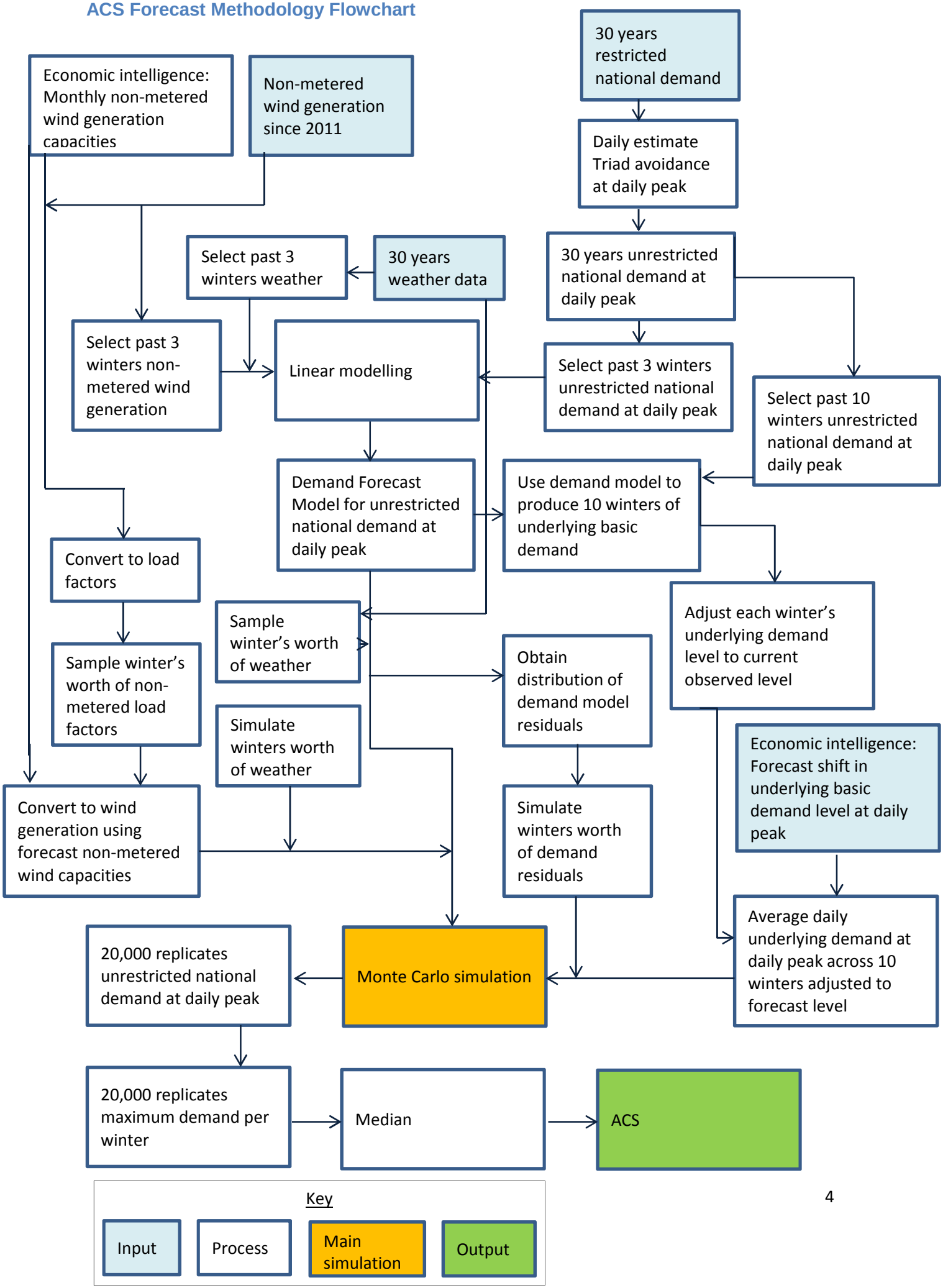
13. ACS outturn is calculated after GMT period has finished, and once it is possible to validate operational demand metering against settlement demand metering. This is usually at the end of April
14. Calculate observed average underlying basic demand level for previous winter, using demand forecast model employed in ACS forecast
15. Use daily underlying adjusted basic demands from forecasting process, and adjust these to observed basic demand level
16. Perform Monte Carlo simulation (20000 replicates). For each replicate:
    - Sample winter's worth of weather at daily peak from same data as used in forecast process
    - Sample winter's worth of unmetered wind load factors same data as used in forecast process

[4] World Meteorological Organization, *Climate Data and Data Related Products,* http://www.wmo.int/pages/themes/climate/climate_data_and_products.php

- Multiply by monthly forecast unmetered wind capacities to produce sample of winter's worth of unmetered wind generation at daily peak
- Simulate winter's worth of demand residual using observed distribution of residuals from demand forecast model
- Use demand forecast model to calculate a simulated winter of DP demands
- Replicate to obtain 20000 simulated winters

17. Calculate maximum demand for each simulated winter
18. Take median of this sample as the Outturn Average Cold Spell demand

ACS Forecast Methodology Flowchart



ACS Outturn Methodology Flowchart