TOP-DOWN AND BOTTOM-UP FORECASTS RECONCILIATION

27th of February 2019

1 PROBLEM AND OBJECTIVE

CitiPower & Powercor (CPPAL) forecasts maximum demand (MD) on its network with two different approaches.

- The 'top-down' approach provides a forecast at the Terminal Station (TS) level. It relies on high level econometrics such as gross state product, energy efficiency, demographic evolution, etc. and performs some post-model adjustments to account for new technologies.
- The 'bottom-up' approach provides more granular predictions at Zone Substation (ZSS) and feeder levels. It takes into account macroeconomic trends, demographic evolution and local uptake data such as rooftop PV, electric vehicles and residential storage uptakes, block loads and transfers at the feeder level.

In the context of the Regulatory Information Notice (RIN), CPPAL needs to provide a consistent forecast for the 2019-2025 period at TS and ZSS levels. To meet this objective, the bottom-up forecast has been leveraged and aligned to the top-down forecast. This document presents in detail how the reconciliation between the two forecasts was performed.

2 METHODOLOGY

The reconciliation of the two forecasts was carried out in four steps:

1. Aggregation of ZSSs' MD at TS level, to construct a bottom-up TS level forecast comparable with the top-down TS level forecast;
2. Identification of closest bottom-up scenario, to select for the reconciliation;
3. Troubleshooting, to ensure that the compared values at TS level were consistent and to solve discrepancies;
4. Reconciliation.

Each step is detailed in the sections below.

2.1 Aggregation of ZSSs' MD at TS level

The bottom-up forecast at ZSS level was aggregated at TS level, taking into account diversification factors. This enabled translating non-coincident MD into coincident MD at ZSS level and eventually to compare both forecasts at TS level.

The diversification factor of an asset (DF) is defined as the ratio between its load at the time of its parent MD and its own MD.

For ZSS connecting large-scale wind generation, this traditional approach does not work (very negative DF). As a result the DF was capped at a minimum of 0, and large-scale wind generation managed separately (see §2.3.2).

For a ZSS connected to a TS, DF is given by the following formula:

$$DF_{ZSS-TS} = \max\left(0, \frac{\text{Load}_{ZSS}(\text{time of TS MD})}{MD_{ZSS}}\right)$$

For each ZSS, the DF used to perform the alignment was the average of the historical DF values for this ZSS over the 2015-2018 period.

As no bottom-up forecast was available for customer-owned ZSS, their MD over the 2019-2025 period was considered constant and equal to their historical MD as provided by CPPAL. A conservative diversity factor of 95% was used for these ZSS.

For ZSS connected to several TS simultaneously (shared loops), the proportion of its load served by each of its parent TS was provided by CPPAL. This ratio ($noted\ w_{ZSS-TS}$) was accounted for in the aggregation of the bottom-up forecast from the ZSS to the TS using the formula:

$$MD_{TS,bottom-up} = \sum_{ZSS\ in\ TS} DF_{ZSS-TS} * w_{ZSS-TS} * MD_{ZSS}$$

2.2 Identification of closest bottom-up scenario

The bottom-up forecast is available under three scenarios (weak, neutral and strong). These scenarios consider different uptake rates of new technologies and different macro-economic trends.

The three bottom-up forecasts aggregated at TS level ($MD_{TS,bottom-up}$, see §2.1) were compared to the top-down forecast for the same TS. The scenario resulting in an aggregated bottom-up forecast "closest" to the top-down forecast was then selected for further processing (the selection was done manually for each TS).

In addition, the selection was considered acceptable if the identified bottom-up forecast was within 10% of the top-down forecast for every year of the 2019-2025 period. This criterion was set to ensure that both forecasts were based on the same data and assumptions (e.g. connections between ZSS and TS, large block loads, etc). When the criterion was not met, further investigation was undertaken to identify the cause of the discrepancies and remedy them (see 2.3 Troubleshooting).

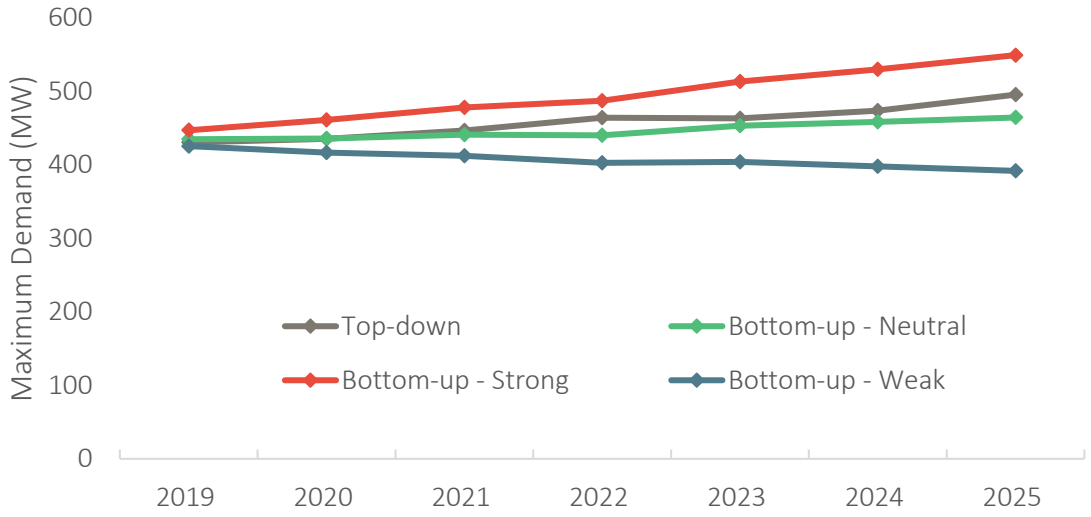

Figure 1 - Top-down and bottom-up forecasts for GTS66

Figure 1 shows the comparison between the three aggregated bottom-up forecasts with the top-down forecast for one Terminal Station, GTS66. In this case, the Neutral scenario was selected for reconciliation.

2.3 Troubleshooting

When none of the bottom-up forecast scenarios matched the top-down forecast (within 10% difference), further investigations were undertaken to understand the source of the difference. Two mechanisms (detailed below) were used to harmonise the two forecasts and allowed to identify a bottom-up forecast matching the top-down forecast within 10% (i.e. ready for the Reconciliation step).

2.3.1 Transfers and shared loops

When TS share transmission loops or when ZSS bulk loads are transferred from one TS to another, comparing both forecasts for one standalone TS can be challenging. In order to reconciliate both forecasts, TS that have shared load in a recent past or will share some in a near future were grouped together.

Below are the three groups that were formed as part of this reconciliation exercise, along with the reasons behind the grouping:

- ATS West, KTS East, KTS West and DPTS were grouped together. As DPTS was only recently built, the ZSS now connected to it were recently connected to the other three mentioned TS.
- BTS66, RTS22, RTS66 bus 3-4, WMTS22 and WMTS66 were grouped together for two reasons.
  - As BTS66 was only recently built, the ZSS now connected to it were recently connected to RTS66 bus 3-4 and WMTS66.
  - MP will be transferred from RTS66 bus 3-4 to BTS66, RP will be transferred from RTS22 to RTS66 bus 3-4 and DA from WMTS22 to WMTS66 in a near future.
- RCTS66 and WETS are grouped together to cater for past and future transfers between these two TS.

2.3.2 Large-scale wind and solar generation

In the top-down forecast, large scale generation is integrated as a block load.

Since wind generation was in effect excluded from the aggregated bottom-up forecast due to the aggregation method used (see §2.1), similar negative block loads were added to the bottom-up forecast for wind generation to enable the alignment of the two forecasts as post-adjustment:

- 40MW of wind generation on TGTS
- 20 MW of wind generation on HOTS

The top-down forecast also considers an increase of large-scale solar generation of 5MW on KGTS66 from 2019 onwards which was not accounted for in the bottom-up forecast and was thus added back to the latter.

2.4 Reconciliation

To perform the forecast reconciliation, the bottom-up forecast for each ZSS was scaled by the ratio between the top-down and the bottom-up forecasts at TS level for each year of the forecast period. The result of the alignment for one ZSS is shown in Figure 2 as an example.

$$MD_{ZSS,aligned}(year) = MD_{ZSS}(year) * \frac{MD_{TS,top-down}(year)}{MD_{TS,bottom-up}(year)}$$

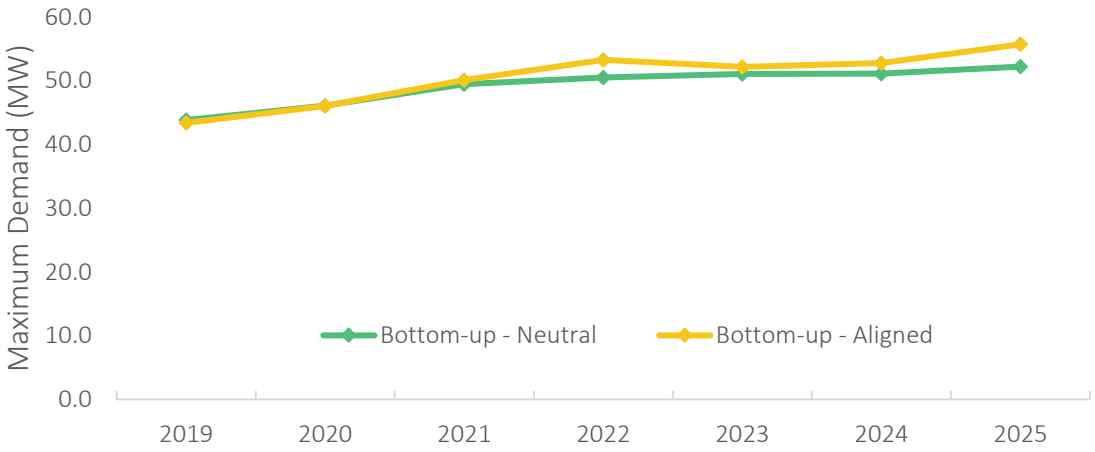

Figure 2 - Bottom-up forecast before and after alignment for FNS, a ZSS connected to GTS66 TS