



PUBLIC

## WESM Manual

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# LOAD FORECASTING METHODOLOGY

## Issue 0.0

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Abstract	This document covers the methodology and procedures involved in preparing load forecasts for WESM.
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## 1.0 Introduction

### 1.1 About this Manual

This document focuses on methodologies to be employed in providing load forecast to be used for the Philippine Wholesale Electricity Spot Market (WESM). Where there is a discrepancy between the requirements in this document and the “WESM Rules”, the “WESM Rules” shall prevail. Standards and policies appended to, or referenced in, these procedures shall provide a supporting framework. This document at present shall work on the platform of dynamism and would be further developed or amended as the WESM and industry consultation progresses and the WESM Rules revised or finalized.

### 1.2 Purpose

Provide the general methods and requirements in determining demand forecasts for market projections and real-time calculation of prices and dispatch schedules.

### 1.3 Scope

This document covers the provision of load forecasts for the Week-Ahead, Day-Ahead and Real-Time Dispatch processes for the WESM.

### 1.4 Intended Audience

This document is intended for use by the WESM participants.

### 1.5 Conventions

The standard conventions to be followed in this *manuals* are as follows:

- The word 'shall' denotes a mandatory requirement;
- Terms and acronyms used in this *market manual* including all Parts thereto that are italicized have the meanings ascribed thereto in “WESM Rules” and/or “PGC”;
- Double quotation marks are used to indicate titles of publications, legislation, forms and other documents.
- Any procedure-specific convention(s) shall be identified within the specific document itself.

### 1.6 Background

The provision of load demand is necessary to provide for the calculation of nodal prices and dispatch. It is an integral requirement of the market dispatch optimization model. The WESM Rules provide for the calculation of market projections and real-time schedules which require accurate load demand forecast information.



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In the WESM Rules, the Market Operator (MO) has been tasked to provide net load forecasts for each market trading node wherein load is expected to occur. Each *net load forecast* shall be prepared in such a way as to represent the *net load* to be met by *scheduled generation*, including losses occurring outside the system represented by the *market network model*, but excluding any *scheduled load*, and less:

- (a) *Non-scheduled generation*, and
- (b) Generation from *NRE generating units with intermittent energy resource*.

Further, amendments to the Rules (as per DOE Circular No. 2004-07-008, Rule 3.5.4.1) stipulates that “each customer may submit a forecast in respect of each trading interval for each of its registered load facilities for each trading day of the week in accordance with the timetable. The forecast submitted by the customer shall be used by the Market Operator in preparation of net load forecast. If the Customer fails to submit a forecast of his load facilities in accordance with the timetable, the forecast prepared by the Market Operator at the node where the customer is located shall be used.”

The market net load forecasts shall be used for the Week-Ahead, Day-Ahead and Real-Time Dispatch of the WESM.

## 2.0 Definition of Terms

- 2.1 **Load Demand** – The active and/or reactive power at a given instant or averaged over a specified interval of time, that is actually delivered or is expected to be delivered by an electrical equipment or supply system. It is expressed in watts (W) and/or vars (VAR) and multiple thereof. It is the amount of energy consumed in a defined period via a node.
- 2.2 **System** – Refers to the Grid or Distribution System or any user system. Also a group of components connected or associated in a fixed configuration to perform a specified function.
- 2.3 **Net Load Forecast** - A forecast, prepared in accordance with the procedures to be developed under clause 3.5.4, of the *load*, net of any non-scheduled generation, to be matched, along with any *scheduled load*, by generation from *scheduled generation facilities*.
- 2.4 **System Forecast** – Load demand projections pertaining to the energy to be consumed in a power system in a particular *Forecast Area*.
- 2.5 **Forecast Area** – pertains to the Power System or Grid where Forecast will be applied.



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- 2.6 **Load Predictor** – MMS functionality used to provide system energy demands for the next real-time interval, where forecasted load is used for the *Real-Time Dispatch* (RTD).
- 2.7 **Similar Day Load Forecast** – MMS functionality that provides load forecast for each forecast area. Forecasted loads are hourly area loads for the current day and future seven days.
- 2.8 **Load Profile** – Time series representation of load demand. Also known as load pattern.
- 2.9 **Short-Term Forecasting** – Load forecast pertaining to the future one hour up to seven days and shall be applied to the calculation of market projections and real-time dispatch.

All other terms used in this document shall conform to the definition of terms under the WESM Rules and the Philippine Grid Code.

## 3.0 Responsibilities

- 3.1 The Market Operator shall prepare the *net load forecasts* for each *market trading node* at which *load* can be expected to occur in accord with the methodology provided in this document.
- 3.2 The System Operator shall provide necessary information for the MO to carry out its responsibilities in this document and perform SO procedures accordingly.
- 3.3 Trading Participants shall provide the necessary information for the MO to carry out its responsibilities in this document and perform allied procedures accordingly.
- 3.4 The PEM Board shall be responsible for the approval of this document and any other approvals as maybe deemed necessary for any subsequent revisions and issuances.

## 4.0 Load Forecasting Considerations

### 4.1 Weather Data

Historical and forecast weather data shall be made available to the MMS database on a regular interval and in accordance with the WESM timetable and shall be obtained from a reliable source recommended by the SO and agreed upon by all WESM Participants. The weather data shall be based on the major load center (Annex 1) located in the forecast area. Weather parameters shall include, but not limited to:

- Temperature
- Humidity
- Wind direction
- Wind speed



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- Sky cover (0 = clear, 10 = maximum overcast)
- Precipitation

WESM may consider two forecasting seasons. These shall include 1) Dry Season and 2) Wet Season. Definition and season duration for each forecast area shall be based on the information provided by Philippine Atmospheric Geophysical and Astronomical Agency (PAGASA).

The weather data may be obtained from PAGASA or any other sources of information deemed reliable by the MO.

## 4.2 Load Demand

### 4.2.1 Telemetry Data

Demand and generation telemetry data shall be obtained via the Network Service Providers' SCADA system and incorporated in the data provided by SO EMS to MMS. Telemetered data shall form part of the system load forecast and the net load forecast prepared by MO for the Real-time dispatch.

In the absence or failure of a telemetry point to provide reliable information, the MO shall utilize the latest information provided by the SO-EMS. Telemetered data shall be provided to the MMS by the EMS every 5 minutes.

### 4.2.2 Historical Meter Data

Historical hourly load demand information shall be used by the MO in providing historical load profile for the Day ahead and Week ahead dispatch.

### 4.2.3 Trading Participant Demand

Customers shall have the option to provide their own hourly demand forecast at their MTN to be used in the determination of market projections and real time dispatch in accordance with WESM timetable.

- 4.2.3.1 Customer forecasting methodology - In preparing the load forecast, the customers may select the methodology that they believe is most appropriate for each individual market trading node.
- 4.2.3.2 Customer demand forecast not at MTN – If the customer opt to provide forecast other than at the relevant market trading node, corresponding load



forecast adjustment shall be made to reflect the demand at the relevant market trading node.

- 4.2.3.3 Customer load forecast adjustment - Load adjustment factors shall be established by the Customer and his Meter Service Provider and shall be approved by the MO. The adjustment factors shall consider site-specific losses and other factors deemed necessary to reflect accurate customer load forecast at his market trading node.
- 4.2.3.4 Customer load forecast not available until submission cut-off time – If the time period for uploading customer forecast for the relevant timeframe has expired, the MO shall consider the Customer as relying on the MO to provide the necessary forecast.
- 4.2.3.5 Application of Customer forecast tolerance range – to maintain system security and reliability and provide a fair and level playing field for all trading participants, the MO shall consider tolerance criteria in considering the Customer forecast for the market projections and real-time dispatch. If the customer forecast is not within the tolerance range, then the MO prepared market projections and real-time dispatch forecasts shall be considered as binding.
- 4.2.3.6 Customer forecast tolerance range – the WESM shall initially consider the tolerance range to be +/-3.4% (based on SO peak-period dispatch tolerance) of the MMS Similar Day Load Forecast and Load Predictor values. This tolerance range, shall be subject to final determination during market trials and prior to WESM commercial operation and subject to annual review and revision and approved by PEMC.

## 4.3 Power System Condition

The MO shall consider the forecasted power system condition in the preparation of net load forecast. These shall include programmed transmission, subtransmission and generation maintenance, large customer maintenance schedules and other programmed activities, including generator testing and commissioning, that may impact on the preparation of market projections and real-time dispatch. The SO shall ensure that all relevant information is provide to the MO in accordance with the WESM timetable.

**Comment:** TI outages, generator testing.

For un-programmed power system condition, the SO shall ensure that all relevant information is timely provided to the MMS via the EMS or other means of communication to the MO. In this regard, all Trading



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Participants shall also ensure that information regarding any unprogrammed activity or condition is timely provided to the SO.

## 4.4 Load Profile

For similar day load forecasts, the MO may utilize static profiling, proxy day profiling and estimated or deemed profiling or a combination thereof. The MO shall endeavor to provide the most appropriate load profile in determining system forecast and net load forecast for each market trading node.

### 4.4.1 Static Profile

The MO may consider typical day representations for any day of the week and season combination. Static profiling shall consider day of the week profile, holidays and special events profile. The MO should note that static profiles do not reflect operating conditions of the day being estimated

### 4.4.2 Proxy Day Profile

The MO may consider selecting a day in history that most closely matches the day being estimated. The proxy day can be chosen based on either on weather forecast and/or system load. Actual data from the sample for the selected proxy day shall then used to create the profile. Proxy day profiling shall consider day of the week profile, holidays and special events profile

### 4.4.3 Deemed Profile

The MO may obtain engineering estimates, if and when necessary, for very predictable loads such as street lighting or residential area from Trading Participants.

## 4.5 Load Distribution Factor

In determining net load forecast for each market trading node the MO shall apply load distribution factors. Each customer market trading node shall be provided by relevant Trading Participants connected to that market trading node with load profiles as each relevant Trading Participant is in the best position to determine the individual connection point characteristics. The MO shall validate the submitted load profile based on registration data and historical metering information for each Trading Participant.



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## 4.6 Load Growth

The MO shall consider the projected growth of load demand on a system wide basis in the preparation of net load forecasts. In determining the load growth values, the MO shall consider information obtained from the operation of WESM, Network Service Providers, Trading Participants and relevant government agencies.

## 5.0 Load Forecasting for Market Projections and Real-time dispatch

### 5.1 Similar Day Load Forecasting

The *Similar Day Load Forecast (SDLF)* produces forecasted nodal hourly loads for each forecast area. The forecast period covers the current day and future seven days. The load forecast values are used in pre-dispatch processes performed by *Security-Constrained Economic Dispatch (SCED)* particularly for the Day-Ahead and Week-Ahead dispatch.

Using daily forecasted weather data, SDLF calculates forecasted load based on historical load and weather data. The load profile consist of the values of actual *Hourly Average Loads*, type of day (normal day and/or holiday) and actual weather data for the day, which has been previously saved in the MMS database. SDLF extracts from the historical data the best curve candidate and then applies customer provided factors to produce the load forecast.

### 5.2 Load Predictor

*Load Predictor (LDP)* forecasts total system load for next two hours at five-minutes intervals. The forecasted total system loads are used for the calculation of real-time nodal prices and dispatch schedules. The LDP utilizes the latest historical load profile and telemetering data provided by the Energy Management System (EMS) of SO to the Market Management System (MMS) every 5 minutes (system snapshot) for the estimation of loads.

## 6.0 SDLF Methodology

- 6.1 Execute Similar Day Load Forecast (SDLF) functionality of the MMS to identify days meeting the screening criteria.
  - 6.1.1 The MO shall prepare day ahead and week ahead forecasts based on the following: a) similar day load profile pattern (Sun, Mon, Tue-Wed-Thurs, Fri, Sat, and holiday), b) special events, (e.g. boxing event), c) temperature, d) humidity, e) other weather conditions, f) other factors as deemed appropriate by the MO.

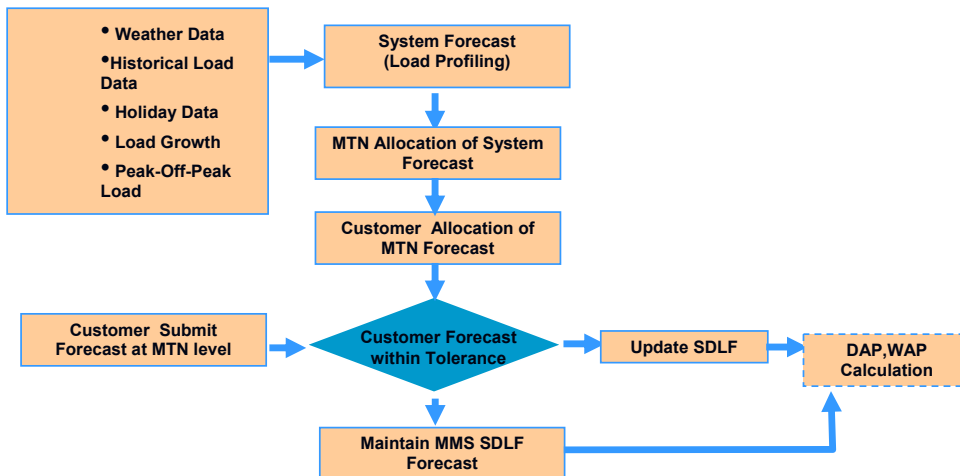


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- 6.2 Adjust the equivalent system load forecast based on the screening criteria to reflect the most appropriate condition for the similar days.
- 6.3 Provide adjustments to the similar days considering load growth and all time peak load value.
- 6.4 Allocate system demand to each Market Trading Node and Customer based on load distribution factor submitted by Customers and validated by MO.
- 6.5 Compare Customer forecast demand to the MO demand forecast, if demand forecast is within the tolerance level, then the customer demand shall be considered by the MO.
- 6.6 The MO shall then finalize net load forecast and perform necessary re-aggregation to system level.
- 6.7 Publish the load forecasts once a day in accordance with the WESM timetable.

Figure 1. SDLF Methodology



## 7.0 Load Predictor Methodology

- 7.1 The MO shall derived the target loads for the forecast horizon from resource current load and the load shape of the respective day type.
- 7.2 The MO shall then compute the deviations between the target load and the actual load of current time.
- 7.3 Based on the target load error derived from last step, predict the target load error for rest of time-points of the forecast horizon.
- 7.4 For each load forecast time point, adjust the target load by the predicted error. This becomes the system forecast load.

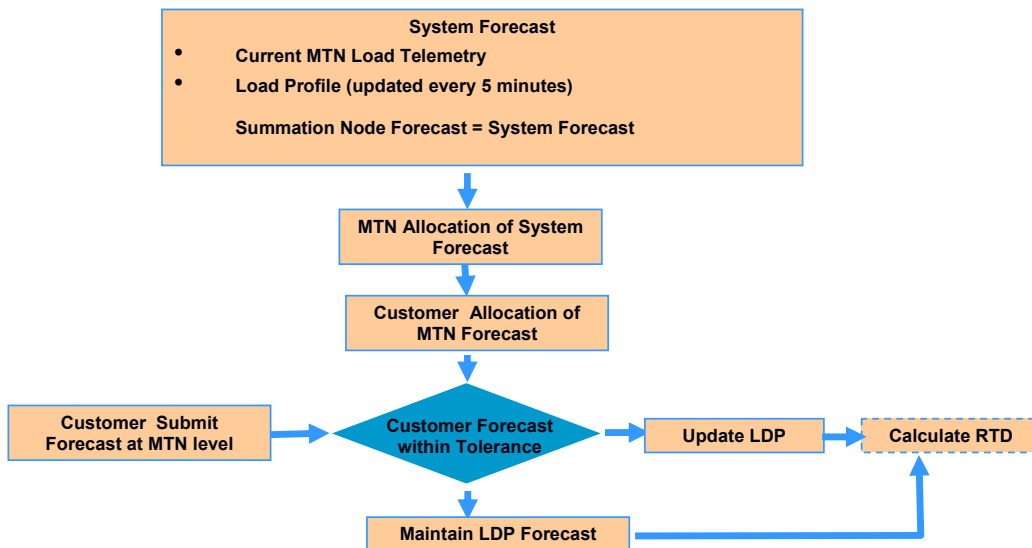


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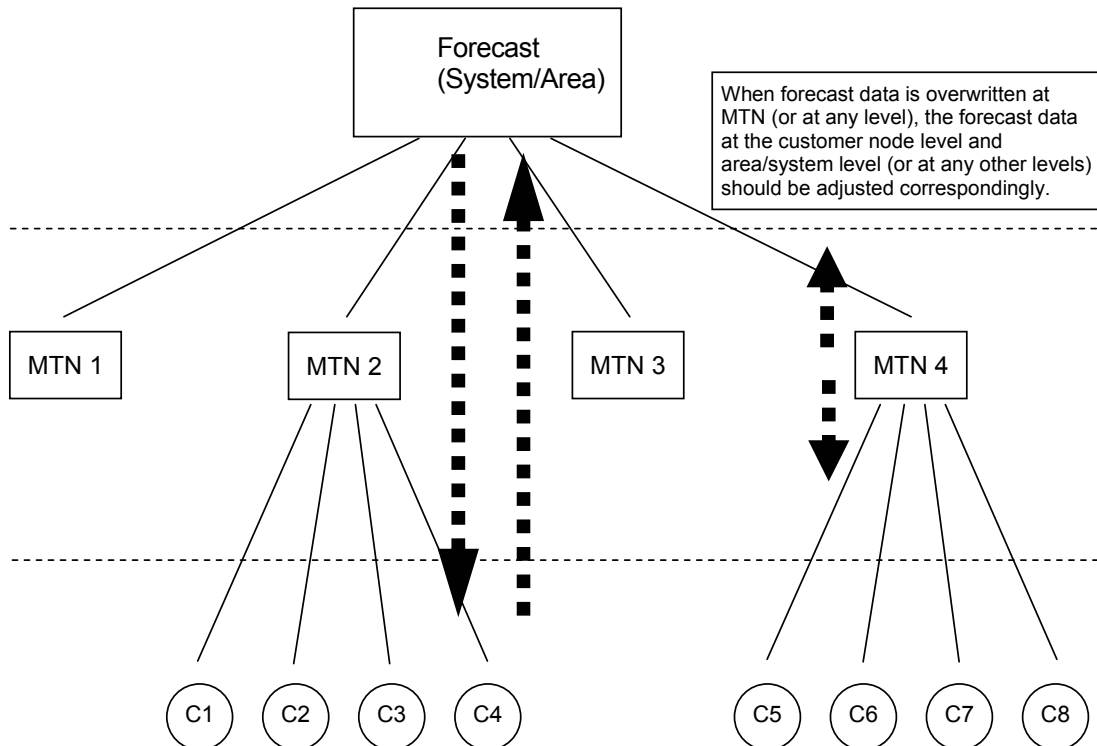
- 7.5 Once system load forecast is derived, the forecast will be allocated to each Market Trading Node based on telemetering information.
- 7.6 Compare Customer forecast demand to the MO demand forecast reflected to the MTN, if demand forecast is within the tolerance level, then the customer demand shall be considered by the MO.
- 7.7 The MO shall then finalize net load forecast and perform necessary re-aggregation to system level.

Figure 2. Load Predictor





## 8.0 Customer Forecast Aggregation



### 8.1 Case 1: No load forecast data is received from customers

When no forecast data is received from customers, the output of LDP and SDLF shall be used.

### 8.2 Case 2: All Customers connected at MTN (C1, C2, C3 and C4) submit forecast data

When all customers connected at a single MTN submit forecast data, the forecast data at the MTN shall be based on the forecast data provided by the customers subject to validation procedure. The forecast at the MTN level should be the aggregate of the load data at



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customer level adjusted to losses. The aggregation formula is presented below:

$$Forecast_{MTN} = DF_1 \times DLF_1 + DF_2 \times DLF_2 + DF_3 \times DLF_3 + DF_4 \times DLF_4$$

$$Forecast_{MTN} = \sum DF_N \times DLF_N \text{ at MTN}$$

where:

$DF_N$  – demand forecast data submitted by the customers

$DLF_N$  – Distribution loss factor to reflect losses from customer node to MTN

The forecast data above the MTN level (area level, system level) shall be adjusted to reflect the changes made at the customer and MTN level.

### 8.3 Case 3: A number of customers (but not all) connected at MTN submit forecast data (Example: At MTN<sub>2</sub>, C1 and C2 submitted forecast data)

The forecast data submitted by the customers, subject to validation procedure, at nodal level shall replace the forecast data allocated by the LDP and SDLF. The change in the customer node level shall be reflected at the MTN by aggregating the forecast at customer node level. The aggregation formula is presented below.

$$Forecast_{MTN} = DF_1 \times DLF_1 + DF_2 \times DLF_2 + DF_{FOR-3} + DF_{FOR-4}$$

$$Forecast_{MTN} = \sum (DF_N \times DLF_N + DF_{FOR-N}) \text{ at MTN}$$

where:

$DF_N$  – demand forecast data submitted by the customers

$DF_{FOR-N}$  – demand forecast data allocated by SDLF and LDP

$DLF_N$  – Distribution loss factor to reflect losses from customer node to MTN



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## 9.0 Customer Forecast Submission

- 9.1 Each customer that intends to participate in the optional customer forecasting shall officially notify the MO for accounting and validation purposes.
- 9.2 Each Customer that submits forecast for the day ahead, week ahead and real-time dispatch shall upload the relevant forecast in accordance with the WESM timetable. The Customer forecast shall represent the estimated aggregate demand at the Market Trading Node.
- 9.3 Customer forecast for the market projections and real-time dispatch shall be in real-power quantities (MW) and shall be financially binding.

## 10.0 Submission of Trading Participant Load Information

To provide for the determination of demand at the Market Trading Node level for each customer for the market projections and real-time dispatch, Customers shall provide the following information to the Market Operator.

- 10.1 Load profile representing the characteristics of the load connected to the associated market trading node.
- 10.2 Load distribution factor including losses determined in accordance with agreed procedures between MO, SO, MSP and Trading Participants.
- 10.3 Un-metered loads and or house loads.

## 11.0 Forecast Area

Three forecast areas shall be considered for the WESM. These are the Luzon, Visayas and Mindanao forecast areas.

## 12.0 Load Forecast Audit and Performance Measure

- 12.1 The MO shall provide for the logging of all transactions performed for the determination of net load forecast including the uploading of the optional Customer's load demand forecast.
- 12.2 The MO shall provide for the monitoring of actual and forecasted load demand for each relevant market trading node.
- 12.3 The MO shall determine appropriate statistical measures and provide monthly reports to PEMC pertaining to average forecast errors and deviation standards.



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## **Annex 1**

### **Major Load Center For Each Forecast Area**

**Luzon – Metro Manila**

**Visayas – Cebu**

**Mindanao - Davao**