Republic of the Philippines
DEPARTMENT OF ENERGY

DEPARTMENT CIRCULAR NO. _DC2018-04-0008_

ADOPTING FURTHER AMENDMENTS TO THE WHOLESALE ELECTRICITY SPOT MARKET (WESM) MARKET MANUALS ON BILLING AND SETTLEMENT AND LOAD FORECASTING METHODOLOGY FOR THE IMPLEMENTATION OF ENHANCEMENTS TO WESM DESIGN AND OPERATIONS

WHEREAS, Sections 30 and 37(f) of the Electric Power Industry Reform Act (EPIRA) provides that the DOE, jointly with the electric power industry participants, shall establish the Wholesale Electricity Spot Market (WESM) and formulate the detailed rules governing the operations thereof;

WHEREAS, on 28 June 2002, the DOE, with the endorsement of the electric power industry participants, promulgated the WESM Rules through Department Circular No. DC2002-06-003;

WHEREAS, any changes, amendments, and modifications to the WESM Rules including its Market Manuals shall be undertaken in accordance with the provisions of Chapter 8 thereof;

WHEREAS, on 07 December 2016, the Philippine Electricity Market Corporation (PEMC) submitted and presented to the Rules Change Committee (RCC) the Proposed Amendments to the WESM Market Manuals on Billing and Settlement (BS) and Load Forecasting Methodology (LFM) for the implementation of enhancements to WESM design and operations;

WHEREAS, the PEMC's proposed amendments to the said Market Manuals aim to facilitate the implementation of the new market features as provided under the DOE policies on enhancements to market design and operations and the amended WESM Rules for the New Market Management System (NMMS) through Department Circulars No. DC2015-10-0015 and No. DC2016-10-0014, respectively;

WHEREAS, on 16 December 2016, the RCC approved the publication of the said PEMC's proposal in the WESM website to solicit comments from market participants and other interested parties;

WHEREAS, on 03 and 17 March 2017, the RCC during its 126th and 127th RCC Meetings respectively, deliberated on the said proposal giving due course to the comments received from market participants and the DOE;

WHEREAS, on 11 April 2017, the RCC during its 128th RCC Meeting, further deliberated on the proposal taking into consideration the DOE Department Circular No. DC2017-03-0002 dated 20 March 2017 concerning implementation of Must

Dispatch and Priority Dispatch Generating Units in the WESM, and it finalized and approved the proposal for endorsement to the PEM Board;

WHEREAS, on 18 September 2017, after due evaluation and deliberation, the PEM Board during its 127th PEM Board Meeting approved for endorsement to the DOE the above stated RCC proposal;

WHEREAS, on 02 October 2017, the PEM Board-approved amendments to the WESM Market Manuals on BS and LFM were submitted to the DOE for final approval, in compliance with Chapter 8 of the WESM Rules;

WHEREAS, the DOE reviewed the said PEM Board-approved proposal, made minor revisions for consistency and deemed it consistent with the objectives of the WESM and the DOE policies on the enhancements of WESM design and operations;

NOW THEREFORE, pursuant to its authority under the EPIRA and the WESM Rules, the DOE hereby adopts, issues, and promulgates the following amendments to the WESM Market Manuals for the implementation of enhancements to WESM design and operations:

Section 1. Amendments to the WESM Market Manual on Billing and Settlement. The following provisions in the Billing and Settlement Manual are hereby amended:

(a) Section 1.1 under Introduction is amended to read as -

"1.1 Background

This Market Manual provides the procedures on the preparation of settlement statements as basis for the settlement of transactions of Trading Participants in the Wholesale Electricity Spot Market (WESM)."

(b) Section 1.2 under Introduction is amended to read as -

"1.2 Purpose

This Market Manual implements relevant provisions from WESM Rules Clauses 3.14 and 3.15. It describes the procedures which the Market Operator and Trading Participants must follow in relation to the settlement process and compliance with the prudential requirements."

(c) Section 1.3 and its subsections under Introduction are amended to read as -

"1.3 Scope

1.3.1 This Market Manual covers the following procedures:

a) Section 4 - Issuance of Settlement Statements in accordance with WESM Rules Clauses 3.14.4, 3.14.5, 3.14.8, and 3.14.9;

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b) Section 5- Collection and Payment of Settlement Amounts in accordance with WESM Rules Clauses 3.14.2, 3.14.3, 3.14.6, 3.14.7, and 3.14.10;

c) Section 6 - Payment Default in accordance with WESM Rules Clauses 3.14.11 and 3.14.12;

d) Section 7 - Prudential Requirement in accordance with WESM Rules Clause 3.15; and

e) Section 8 - Suspension and Revocation of Suspension in accordance with WESM Rules Clauses 3.14.11.2(b) and 3.15.8.

f) Section 9 - Bilateral contract declaration for energy and reserves in accordance with WESM Rules Clauses 3.13.1 and 3.13.2; and

g) Section 10 - Filing of additional compensation in accordance with Section 8.3 of the Price Determination Methodology.

1.3.2 This Market Manual does not cover the following processes, which are all provided under the Price Determination Methodology Manual:

a) Calculation of administered prices;
b) Settlement amounts calculation;
c) Net settlement surplus; and
d) Must-run unit calculation."

(d) Section 2.1 and its subsections under Definitions, References and Interpretation are amended to read as -

"2.1 Definitions

2.1.1 Unless otherwise defined or the context implies otherwise, the italicized terms used in this Market Manual shall bear the same meaning as defined in the WESM Rules and other Market Manuals.

2.1.2 The following words and phrases as used in this Market Manual shall have the following meaning:

a) Average Actual Market Price. This refers to the ratio of the total spot market payment of a WESM Member, which may include spot market energy and reserve transactions to the total metered quantities net of bilateral contract quantities for each billing month.

b) Credit Support Provider. Banks, or insurance companies.

c) FIT-All Administrator. The National Transmission Corporation as administrator of the FIT-All Fund, as designated in Resolution No. 15, Series of 2012, amending the FIT Rules.

d) Marginal cost of congestion. Congestion component of the locational marginal price as defined under Section 4.10.1 of the Price Determination Methodology.

e) Marginal cost of losses. Losses component of the locational marginal price as defined under Section 4.10.1 of the Price Determination Methodology.

f) Preliminary Statement. A statement issued by the Market Operator under WESM Rules Clause 3.14.4.

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g) Settlement. The activity of producing bills and credit notes for WESM members in accordance with WESM Rules Clause 3.13, and with the processes defined in WESM Rules Clause 3.14.

h) Settlement Statements. Statements issued by the Market Operator that contains the settlement transactions of a WESM Member. It can either be a preliminary, final or revised statements."

(e) New Section 2.2 under Definitions, References and Interpretation is added to read as -

"2.2 References

This Market Manual shall be read in association with the WESM Rules and other relevant Market Manuals."

(f) New Sections 2.3, 2.31 and 2.3.2 under Definitions, References and Interpretation are added to read as -

"2.3 Interpretation

2.3.1 Any reference to a clause in any section of this Market Manual shall refer to the particular clause of the same section in which the reference is made, unless otherwise specified or the context provides otherwise.

2.3.2 Standards and policies appended to, or referenced in, this Market Manual shall provide a supporting framework."

(g) Section 3.1.1 under Market Operator is amended to read as -

"3.1.1 The Market Operator shall be responsible for complying with the requirements set forth in this Market Manual and in the WESM Rules, as follows:

xxx   xxx   xxx"

(h) Section 3.2 under Responsibilities is amended to read as -

"3.2 Trading Participants

The Trading Participants shall be responsible for complying with the requirements set forth in this Market Manual and in the WESM Rules, as follows:

a) Retrieve and review settlement statement files and supporting data issued by the Market Operator. The Trading Participants shall notify the Market Operator if files are not accessible or received within the timetable and if there are discrepancies or errors;

xxx   xxx   xxx"

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(i) Section 4.1.1 under Contents of Settlement Statements and Data is amended to read as -

"4.1.1 Settlement Quantity and Amounts

a) The settlement quantity billed to each Trading Participant is in accordance to WESM Rules Clauses 3.13.5 and 3.13.6.
b) The trading amount billed to each Trading Participant is in accordance to WESM Rules Clauses 3.13.17 and 3.13.18.
c) The reserve cost recovery charge billed to each Trading Participant is in accordance to WESM Rules Clause 3.13.9.
d) The transmission rights trading amount billed to each Trading Participant is in accordance to WESM Rules Clause 3.13.10.
e) The aggregate trading amount for a Trading Participant for a settlement interval equals the sum of:

   i. The energy trading amounts for each market trading node for which the Trading Participants is responsible calculated in accordance with WESM Rules Clause 3.13.7 (which will typically be positive for a Generation Company and negative for a Customer); plus
   ii. The reserve trading amounts for each reserve region into which that Trading Participant contributes reserve calculated in accordance with WESM Rules Clause 3.13.8 (which will always be positive for both Generation Companies and Customers); plus
   iii. The transmission right trading amounts for each transmission right held by the WESM Participant calculated in accordance with WESM Rules Clause 3.13.10 (which will always be positive for both Generation Companies and Customers) plus
   iv. The reserve cost recovery charge determined for that Trading Participant with respect to any reserve cost recovery zone within which it has any facility connected calculated in accordance with the procedures developed under WESM Rules Clause 3.3.5 (which will be positive for any Trading Participant); and
   v. Any other ancillary service cost recovery charges determined for that Trading Participant in accordance with the procedures developed under WESM Rules Clause 3.3.5.

f) For each billing period, the Market Operator shall determine the settlement amount for each Trading Participant as the sum of the aggregate trading amounts for the settlement intervals in that billing period, determined in accordance with WESM Rules 3.13.11.2 plus:

   i. Any amount payable by the Market Operator to that Trading Participant in respect of that billing period and not accounted for in WESM Rules 3.13.11.2, including payment for any ancillary services purchased on behalf of the System operator, less the sum of
   ii. Any market fees which that Trading Participant is required to pay in respect of that billing period as determined in accordance with WESM Rules 2.10; plus

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iii. Any other amounts payable by that Trading Participant to the Market Operator in respect of that billing period, including any reserves recovery charges."

(j) Section 4.1.2 under Contents of Settlement Statements and Data is amended to read as -

" 4.1.2 Net Settlement Surplus. If the transactions indicated in Section 4.1.1, in aggregate, results in a surplus or deficit remaining, this will be known as the net settlement surplus. This may be retained by the Market Operator, to fund deficit as a result of transactions required in WESM Rules Clause 3.13.11 or may be flowed back to the Market Participants in accordance with the procedures to be developed under WESM Rules Clause 3.13.12.3 or may be used by the Market Operator to establish and support the market for Financial Transmission Rights subject to the approval of the PEM Board."

(k) Original Section 4.1.3 (Price Substitution Adjustments) under Contents of Settlement Statements and Data is hereby deleted.

(l) Original Section 4.1.4 (Must-Run Adjustment) under Contents of Settlement Statements and Data is renumbered and amended to read as -

"4.1.3 Must-Run Adjustment. In a particular billing period where a must-run generating unit was implemented for a dispatch interval, the settlement for the Trading Participant of the generating unit for the affected dispatch interval shall be in accordance to the relevant market price under the Price Determination Methodology Manual and Section10 of this Market Manual."

(m) Original Section 4.1.5 under Contents of Settlement Statements and Data is renumbered and amended to read as -

"4.1.4 The settlement data that are being transmitted to the Trading Participants along with the preliminary and final statements including the market fee statements which includes the energy trading amounts, final nodal energy dispatch prices, energy settlement quantity, line rental trading amount of participants with bilateral contract quantity and each of the participants' bilateral contract quantity, reserve trading amount, reserve recovery amount, net settlement surplus rebated, and line loss and congestion charges. These set of information are being transmitted to the Trading Participants via email and CD copy mailed along with the Participant's Statements."

(n) New Section 9 (Bilateral Contract Declaration) and its subsections are hereby added to read as -

"9 Bilateral Contract Declaration

9.1 Declaration for Energy Transactions

9.1.1 Trading Participants who will sell electricity pursuant to bilateral contracts during a dispatch interval and wish those bilateral contracts to be

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accounted for in settlements may declare to the Market Operator bilateral contract data up to the end of the following trading day.

9.1.2 To be valid, bilateral contract declarations submitted by a Trading Participant shall include:

a. market trading node from the identified market trading nodes during the enrolment of the supply contract designated as the source of the supply from the selling Trading Participant;
b. the Trading Participant who will buy the declared volume pursuant to their bilateral contract;
c. market trading node from the identified market trading nodes during the enrolment of the supply contract and whose final nodal energy dispatch price will be used as reference during settlements; and
d. bilateral contract quantity in MWh for each dispatch interval for that trading day.

9.1.3 Bilateral contract declarations may include the market trading node from the identified market trading nodes during the enrolment of the supply contract designated as the withdrawal point of the buying Trading Participant.

9.1.4 Bilateral contract declarations submitted by a Trading Participant should be covered by a supply contract enrolled by the Trading Participant to the Market Operator in accordance with the relevant Market Manual.

9.1.5 The Market Operator shall immediately send to each Trading Participant with whom it has received a valid bilateral contract declaration an electronic confirmation of receipt of that bilateral contract declaration.

9.1.6 If the enrollment of the supply contract covering the bilateral contract declaration requires confirmation from the buying Trading Participant, the valid bilateral contract declaration shall be accounted for during settlements only upon confirmation by the buying Trading Participant in accordance with Section 9.2.

9.1.7 If the enrollment of the supply contract covering the bilateral contract declaration does not require confirmation from the buying Trading Participant, the valid bilateral contract declaration shall be accounted for during settlements unless nullified by the buying Trading Participant in accordance with Section 9.2.

9.1.8 If the bilateral contract declaration is invalid, the Market Operator shall promptly inform the Trading Participant and such bilateral contract declaration shall not be accounted for in settlements.

9.2 Confirmation and Nullification for Energy Transactions

9.2.1 In order to be accounted for during settlements, valid bilateral contract declarations covered by supply contracts enrolled to require confirmation submitted by a Trading Participant should be confirmed by the buying Trading

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Participant to the Market Operator one day after each trading day.

9.2.2 If the enrollment of the supply contract does not require confirmation from the buying Trading Participant, the valid bilateral contract declarations submitted by a Trading Participant shall be accounted for during settlements unless the buying Trading Participant submits to the Market Operator a notice of nullification one day after each trading day.

9.2.3 The Market Operator shall immediately send to each buying Trading Participant with whom it has received a confirmation or notice of nullification an electronic confirmation of receipt of that confirmation or notice of nullification.

9.2.4 Upon receipt of a confirmation or notice of nullification, the Market Operator shall immediately notify the relevant selling Trading Participant to the supply contract that the valid bilateral contract declaration has been confirmed or nullified.

9.2.5 At the end of each trading day, the Market Operator shall notify all buying and selling Trading Participants, whose supply contract was enrolled to require confirmation and whose valid bilateral contract declarations was not confirmed, that their bilateral contract declarations shall not be accounted for during settlements.

9.2.6 At the end of each trading day, the Market Operator shall notify all buying and selling Trading Participants, whose supply contract was enrolled to not require confirmation and whose valid bilateral contract declarations was not nullified, that their bilateral contract declarations shall be accounted for during settlements.

9.3. Line Rental Calculation for Energy Transactions

9.3.1 WESM Rules Clause 3.13.7.2 provides that the Market Operator shall calculate line rental trading amounts for each bilateral contract quantity declaration, for informational purposes.

9.3.2 For the purpose of calculating line rental trading amounts, bilateral contract quantities declared for buying trading participants shall be:

a. if available, assigned to each of its market trading nodes as identified in Section 9.1.3; or
b. pro-rated to each of its market trading node based on metered quantities.

9.3.3 For a selling Trading Participant, the line rental trading amount associated with a bilateral contract declaration shall be equal to the bilateral contract quantity multiplied by the difference of the final energy dispatch price at the market trading node identified under Section 9.1.2(a) and the final energy dispatch price at the market trading node identified under Section 9.1.2(c).

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9.3.4 For a buying Trading Participant, the line rental trading amount associated with a bilateral contract declaration shall be equal to the sum of the line rental trading amounts calculated for each of its market trading nodes. The line rental trading amount for each market trading node of a buying Trading Participant is equal to the bilateral contract quantity or, if applicable, the pro-rated bilateral contract quantity calculated under Section 9.4.3 of the market trading nodes multiplied by the difference of the final energy dispatch price at the market trading node of the buying Trading Participant and the final energy dispatch price at the market trading node identified under Section 9.1.2(c).

9.3.5 The line rental trading amount associated with each bilateral contract declaration of a Trading Participant may be segregated into:

a. the line rental trading amount attributable to losses calculated by applying the same formula in Sections 10.1.3 and 10.1.4 but only using the marginal cost of losses component of the final energy dispatch prices in place of the final energy dispatch prices; and

b. the line rental trading amount attributable to congestion calculated by applying the same formula in Section 10.1.3 and 10.1.4 but only using the marginal cost of congestion component of the final energy dispatch prices in place of the final energy dispatch prices.

9.3.6 Line rental trading amounts segregated into the amounts attributable to the cost of losses and of congestion shall be calculated by the Market Operator and included in the settlement statements of Trading Participants. Additional information to validate segregated line rental trading amounts may be provided by the Market Operator subject to the pertinent provisions of the WESM Rules and the relevant Market Manual.

9.4 Declaration for Reserve Transactions

9.4.1 The System Operator shall submit to the Market Operator the following information on bilateral contracts for reserves up to the end of the following trading day:

a. Trading Participant who provides the ancillary service;
b. Reserve bilateral contract quantity; and
c. Reserve category.

9.4.2 The Market Operator shall confirm the receipt of reserve bilateral contract quantity declaration."

(o) New Section 10 (Filing of Claims for Additional Compensation) and its Sub-sections are hereby added to read as -

"10 Filing of Claims for Additional Compensation

10.1. Criteria for Additional Compensation

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In accordance with Section 8.3.3 of the Price Determination Methodology Manual, Trading Participants may be entitled to additional compensation when the cost incurred in complying with the dispatch instruction are not sufficiently covered by the trading amounts related to settlement intervals with dispatch intervals under any of the following conditions:

a. Market suspension or Market intervention; or
b. When a trading participant is designated as must-run unit or constrain-on generating unit.

10.2. Filing of Claims

10.2.1 Trading Participants shall submit the written claim for additional compensation within the allowable timeframe, as follows:

a. Market suspension or market intervention – fourteen (14) working days after the resumption of the market; and
b. Must-run unit or constrain-on generating unit – within one (1) year after the trading participant was designated as MRU or constrain-on generating unit.

Any claims not filed within such period shall be deemed waived.

10.2.2 Trading Participants shall submit sufficient proof regarding the costs incurred, which are limited to fuel cost and variable operating and maintenance costs, which may include start-up and shut down cost. Below is the non-exhaustive list of requirement documents in filing claims for additional compensation:

a. Certified correct Fuel Consumption and Inventory Report;
b. Purchase Invoices, Official Receipts and other supporting documents; and
c. ERC approved rate or List of Variable Operation and Maintenance Costs supported by photocopies of invoices/receipts.

10.2.3 The Market Operator shall determine validity of the costs incurred based on the aforementioned supporting documents.

10.2.4 The Market Operator shall inform the requesting Trading Participant of the approval or disapproval of the claim within fourteen (14) working days from receipt of the complete documents from the Trading Participant. Any claim not decided within fourteen (14) working days shall be deemed approved and shall be allocated and billed immediately in the succeeding billing period.'

(p) Original Section 9 (Amendments, Publication and Effectivity) and its subsections are renumbered accordingly to read as –

"11 Amendments, Publication and Effectivity

11.1 Amendments

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11.2 Publication and Effectivity

xxx   xxx   xxx"

(q) New Appendix "A" is hereby added to read as –

PROCEDURES	TIMETABLE
Declaration of Bilateral Contract Quantities for Energy and Reserves	Within one (1) day following the trading day
Filing of Claims for Additional Compensation	a. Market suspension or market intervention – fourteen (14) working days two billing periods after the resumption of the market; and b. Must-run unit or constrain-on generating unit – within one (1) year after the trading participant was designated as MRU or constrain-on generating unit

Section 2. Amendments to the WESM Market Manual on Load Forecasting Methodology. The WESM Market Manual on Load Forecasting Methodology Issue No. 3.0 and presented as Annex A to this Circular is hereby approved and adopted.

For this purpose, the Philippine Electricity Market Corporation (PEMC), as the Market Operator, shall expedite the development of the procedures in connection with the preparation of load distribution factor as required under Section 6.2.3 of the Load Forecasting Methodology Manual. Such procedures to be developed and approved in accordance with the WESM Rules shall form part of the said Market Manual for consistency and transparency.

Section 3. Transitory Provisions. These amended Market Manuals shall be initially used for the development of the WESM's New Market Management System (NMMS) and provide guidance for the stakeholders and WESM participants on the implementation of the enhancements to WESM design and operations. For clarity, the current WESM Rules and its Market Manuals shall remain valid and effective for the commercial operation of the integrated WESM and Retail Market using the present MMS.

Section 4. Separability Clause. If for any reason, any section or provision of this Circular is declared unconstitutional or invalid, such parts not affected shall remain valid and subsisting.

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Section 5. Effectivity. This Circular shall take effect upon its publication in at least two (2) newspapers of general circulation and shall remain in effect until otherwise revoked.

Issued this _____ February 2018 at the DOE, Energy Center, Rizal Drive, Bonifacio Global City, Taguig City, Metro Manila.

ALFONSO G. CUSI
Secretary

MAR 28 2018

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PUBLIC

WESM Market Manual

Load Forecasting Methodology Issue No. 03

Abstract	This Market Manual sets out the procedures for determining load forecast used in the relevant market runs in the Philippine Wholesale Electricity Spot Market

Document Change History

Issue No.	Proponent	Date of Effectivity	Reason for Amendment
0.0	MO Sub-com	2004-08-09	New Document
0.1	MO Sub-com	2004-08-17	Sub-com members comment incorporated
2.0	PEMC	2014-04-17	Entire document revised in accordance with recommendations made in the report on the operational audit of the market operator systems and processes.
3.0	PEMC		Revised to incorporate changes to forecasting methodologies and definition of nodal load distribution factors in accordance with the enhancements to WESM operations under DOE DC 2015-10-0015

Document Approval

Issue No.	RCC Approval	RCC Resolution No.	PEM Board Approval	PEM Board Resolution No.	DOE Approval	DOE Department Circular
0/1	07 Sep 2004 (TWG)	2004-04	09 Sep 2004		n/a	n/a
2	08 Jan 2014	2014-02	05 Feb 2014	2014-04	n/a	n/a
3	11 Apr 2017	2017-05				

Reference Documents

Document ID.	Document Title
	WESM Rules
	Philippine Grid Code
WESM-DP	Dispatch Protocol
	PA Consulting Group. *Philippine Electricity Market Corporation. 2012 Independent Audit Summary Report* (12 December 2012).

Wholesale Electricity Spot Market

Load Forecasting Methodology   WESM-LFM-03

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SECTION 1 INTRODUCTION

1.1. Background

1.1.1. *Load forecasts* are necessary inputs to the optimization runs in the *Wholesale Electricity Spot Market* (WESM), particularly the *week-ahead projection*, *day-ahead projection*, *hour-ahead projection*, and the *real time dispatch market runs*. The responsibility to prepare *load forecasts* rests in the *Market Operator* although *Customers* are also permitted to perform their own customer forecasts under certain conditions.

1.1.2. The *WESM Rules* provide for the responsibilities of the *Market Operator* in performing its *load forecasts*:

    a.   *WESM Rules* Clause 3.7.4.1 (c) requires that each *market projection* shall take into account the forecast demand information prepared by the *Market Operator* in accordance with *WESM Rules* Clause 3.5.4.

    b.   *WESM Rules* Clause 3.7.4.2 further requires that prior to the preparation of each set of *market projections*, the *Market Operator* shall, in consultation with the *System Operator*, prepare an expected unrestrained *net load forecast* in accordance with the procedures developed under Clause 3.5.4, and such number of other load scenarios as may be determined in consultation with *WESM Participants* and approved by the *PEM Board*.

    c.   For the *real-time dispatch market runs*, *WESM Rules* Clause 3.8.1 (b) and (c) directs that at the beginning of each interval, the *Market Operator* shall prepare a forecast of the *unrestrained net load* expected at each market trading node for the end of that trading interval, and adjust that *unrestrained net load forecast* to account for *load shedding*, if required, in accordance with *WESM Rules* clause 3.9.5.

    d.   Furthermore, *WESM Rules* Clause 3.5.4.2 states that each net *load forecast* shall be prepared in such a way as to represent the net *load* to be met by *generation* from *scheduled generating units*, *must-dispatch generating units*, *priority dispatch generating units*, and *non-scheduled generating units* including losses occurring outside the system represented by the *market network model*, but excluding any *scheduled load*.

e.　　WESM Rules Clause 3.5.4.3 states that the *unrestrained net load forecast* shall be prepared so as to represent the *net load* as it would be, or would have been, in the absence of *load shedding*.

f.　　WESM Rules Clause 3.5.4.4 states that if *load shedding* is expected to occur in any *dispatch interval*, a *restrained net load forecast* for that *dispatch interval* shall be prepared on the same basis, but accounting for *load shedding* to the extent that it is expected to occur.

1.1.3.　*Customers* are permitted under WESM Rules Clause 3.5.4.1 to submit their own *load forecast* that shall be used by the *Market Operator* in the preparation of *net load forecast* subject to certain conditions.

a.　　Each *Customer* may submit a forecast in respect of each *dispatch interval* for each of its registered *load* facilities for each trading day of week in accordance with the WESM *timetable*. The *timetable* is set out in Section 4 of the WESM Dispatch Protocol.

b.　　The forecasted load shall be used by the *Market Operator* in the preparation of the *net load forecast*.

c.　　If the *Customer fails* to submit a forecast for his *load* facility in accordance with the WESM *timetable*, then the forecast prepared by the *Market Operator* at the relevant *node* shall be used.

1.2.　Purpose

This *Market Manual* establishes the following:

1.2.1.　The requirements in determining the *load forecasts* for the following *market runs* in the WESM:

a.　　*Market Projections*
　　i.　　*Week-Ahead Projection* (WAP)
　　ii.　　*Day-Ahead Projection* (DAP)
　　iii.　　*Hour-Ahead Projection* (HAP)
b.　　*Real-time Dispatch*

1.2.2.　The forecast methodology to be employed by the *Market Operator* for preparing load forecasts.

1.3. Scope

The systems, processes and procedures set out in this *Market Manual* shall be used in the preparation of *load forecasts* to be used for the *week-ahead projections* (WAP), *day-ahead projections* (DAP), *hour-ahead projections* (HAP), and *real-time dispatch market runs* in the *WESM*.

SECTION 2 DEFINITIONS, REFERENCES, AND INTERPRETATION

2.1. Definitions

2.1.1. Unless otherwise defined in this section or the context implies otherwise, the italicized terms used in this *Market Manual* shall bear the same meaning as defined in the *WESM Rules*.

2.1.2. In addition, the following words and phrases as used in this *Market Manual* shall have the following meaning -

a. **Demand.** Total power consumed in a *power system* or *grid* inclusive of the relevant losses produced during the delivery of power. It is also the total power generated in the *grid*.

b. **Demand Forecast.** *Demand* projection for a particular *forecast area*.

c. **Final Demand Forecast.** Sum of the *net load forecasts* plus the losses in a *forecast area*.

d. **Forecast Area.** A *grid* in the Philippine *power system* where *demand forecast* will be applied. Currently, each *grid* in the Philippines is designated as a *forecast area*, namely the Luzon, the Visayas, and the Mindanao *grids*.

e. **Input Demand Forecast.** Initially assumed *demand forecast* that shall be used as the off-take for determining the *unrestrained net load forecast*.

f. **Load Distribution Factor (LDF).** Factor used in allocating the total projected *load* to individual *loads* in the *market network model*.

g. **Market Management System (MMS).** Infrastructure that supports the operations of the *WESM* and which includes functionalities that support the processes set out in this *Market Manual.*

h. **Real-time Dispatch.** Otherwise known as RTD. It is the *dispatch schedule* which determines the target loading of facilities at the end of the *dispatch interval.* The RTD calculates the ex-ante *nodal energy dispatch prices.*

i. **Short-Term Load Forecast.** Hourly *demand forecasts* starting at the next hour up to seven days ahead. It shall be applied to the calculation of the *week-ahead projection* and *day-ahead projection.*

j. **Unrestrained net load forecast.** Also refers to *unrestrained load.*

k. **Very Short-Term Load Forecast.** *Demand forecasts* for each *dispatch interval* starting at the next *dispatch interval* up to the next two hours. It shall be applied to the calculation of the *hour-ahead projection* and *real-time dispatch.*

l. **Weather Area.** A specific location where there is available weather data.

2.2. References

This *Market Manual* shall be read in association with the *WESM Rules* and other relevant *Market Manuals.*

2.3. Interpretation

2.3.1. Any reference to a clause in any section of this *Market Manual* shall refer to the particular clause of the same section in which the reference is made, unless otherwise specified or the context provides otherwise.

2.3.2. Where there is a discrepancy or conflict between this *Market Manual* and the *WESM Rules*, the *WESM Rules* shall prevail.

2.3.3. Standards and policies appended to, or referenced in, this *Market Manual* shall provide a supporting framework.

SECTION 3   RESPONSIBILITIES

3.1.   Market Operator

3.1.1.   The *Market Operator* shall prepare *net load forecasts* for each *customer market trading node* in accordance with the methodology set out in this *Market Manual*.

3.1.2.   The *Market Operator* shall be primarily responsible for the development and review of the *load forecasting* methodology documented in this *Market Manual*.

3.2.   System Operator

3.2.1.   The *System Operator* shall provide the information required by the *Market Operator* in accordance with this *Market Manual*, and ensure such information's accuracy.

3.2.2.   The *System Operator* shall assist the *Market Operator* in improving the *load forecasting* methodology set out in this *Market Manual*.

3.3.   Trading Participants

3.3.1.   The *Trading Participants* shall carry out the responsibilities provided for in this *Market Manual*.

3.3.2.   *Customer Trading Participants* that opted to provide *net load forecasts* for their respective facilities shall be responsible for the timely submission and accuracy of their forecast information.

SECTION 4   SHORT-TERM LOAD FORECAST

4.1.   Background

4.1.1.   Hourly *demand forecasts* for each *forecast area* from the current day to the next seven (7) days shall be determined by the *Market Operator* using the *Market Management System's* **Short**-*Term Load Forecast (STLF)* application.

4.1.2. The aforementioned hourly *demand forecasts* shall be used as *input demand forecasts* to obtain the hourly *unrestrained net load forecasts* for the *week-ahead projection* (WAP) and the *day-ahead projection* (DAP).

4.1.3. The summation of the *net load forecast* plus the losses computed for a *forecast area* after the optimization process in the relevant *market run* (i.e., WAP or DAP) constitutes the *final demand forecast* for that *forecast area*.

4.1.4. The procedures for obtaining the *net load forecasts* from the *demand forecasts* using *load distribution factors* (LDF) are discussed further in Section 6 of this *Market Manual*.

4.2. Determination of Hourly Demand Forecasts

4.2.1. The process of determining hourly *demand forecasts* involve various input data such as historical *demand*, historical weather measurements, and weather forecast data.

4.2.2. Each *forecast area* is mapped to a *Weather Area*, which has its own distinct historical weather and forecasted weather information.

4.2.3. Hourly *demand forecasts* are determined using the MMS' STLF application's weather adaptive, similar day, and pattern matching algorithms as shown in the illustration below. The methodology behind these forecasting algorithms are further discussed in Section 11.

Figure 1. Process Overview for Determining Hourly Demand Forecasts via MMS-STLF

4.2.4. The *Market Operator* may use other forecasting algorithms to determine hourly *demand forecasts* for each *forecast area*.

4.2.5. The *demand forecast* determined by the *Market Operator* outside of the MMS' forecasting algorithm shall be treated as an external *demand forecast*.

4.2.6. If an external *demand forecast* is provided by the *Market Operator* in a relevant hourly interval, then the external *demand forecast* shall be considered as the *input demand forecast* regardless of any existing *demand forecast* determined by the MMS. These hourly *demand forecasts* shall be included in the MO's performance standards.

4.2.7. Pursuant to *WESM Rules* Clauses 3.7.4.2 and 3.7.4.3, the *Market Operator* shall prepare a *market projection* corresponding to each *load* scenario as may be determined in consultation with *WESM Participants* and approved by the *PEM Board*.

4.2.8. Load scenarios shall be provided for each *day-ahead projection* using the following sensitivities (increments/decrements) with respect to the *input demand forecast* provided:

Table 1. DAP Load Scenarios

DAP Load Scenario	Increment (+) / Decrement (-), %
Load Scenario 1	– 5 %
Load Scenario 2	– 3 %
Load Scenario 3	+ 3 %
Load Scenario 4	+ 5 %

SECTION 5 VERY SHORT-TERM LOAD FORECAST

5.1. Background

5.1.1. *Demand forecasts* for each 5-minute interval in the next two (2) hours in each *forecast area* shall be determined by the *Market Operator* using the *Market Management System's Very Short-Term Load Forecast* (VSTLF) application.

5.1.2. The *demand forecasts* for each 5-minute interval in the next two (2) hours shall be used as *input demand forecasts* to obtain the *unrestrained net load forecasts* for the *hour-ahead projection* (HAP) and the *real-time dispatch* (RTD).

5.1.3. The summation of the *net load forecast* plus the losses computed for a *forecast area* after the optimization process in the relevant HAP or RTD run constitutes the *final demand forecast* for that *forecast area*.

5.2. Determination of *Demand Forecasts* for Each Dispatch Interval

5.2.1. The VSTLF uses historical *demand* data and shall be represented in a time-series.

5.2.2. From the *demand* time-series data, *demand forecast* shall be determined using the Cubic-Spline Interpolation Method, which details are discussed in Appendix D.

SECTION 6   NET LOAD FORECASTS

6.1. Scope

Pursuant to *WESM Rules* Clause 3.5.4.1, this section provides the *Market Operator's* preparation of *net load forecasts*, which are either *unrestrained* or *restrained*, for *market projections* and *real-time dispatch market runs*.

6.2. Unrestrained Net Load Forecast

6.2.1. The *unrestrained net load forecast* is prepared by the *Market Operator* by allocating the *input demand forecast* net of an initial loss percentage with respect to the *Load Distribution Factors* (LDF) set for each *customer market trading node*.

6.2.2. LDFs are defined for each *customer market trading node* that belongs to a specific *forecast area*, for each day and hour.

6.2.3. The *Market Operator* shall develop relevant procedures in the preparation of the LDFs.

6.2.4. The following figure shows the process of how *unrestrained net load forecasts* are determined from *input demand forecasts* using LDFs.

Figure 2. Determination of Unrestrained Net Load Forecasts for each Customer Market Trading Node

6.2.5. The total *unrestrained net load forecast* can be interpreted in the following equation:

$$\text{Total UNLF} = \textit{Demand Forecast} \times \left(1 - \text{Initial Loss Percentage}_{FA}\right)$$

Where:

UNLF refers to unrestrained net load forecast

Initial Loss Percentage$_{FA}$ refers to initial loss percentage in FA

FA refers to forecast area

6.2.6. The *unrestrained net load forecast* of each *customer market trading node* shall be obtained by pro-rating the total *unrestrained net load forecast* to the actual load of each *customer market trading node* based on the latest actual *system snapshot* from the *System Operator*. This is provided in the following equation:

$$\text{UNLF}_b = \frac{\text{Total UNLF}}{\text{Total LDF}_{h, FA}} \times \text{LDF}_{b, h, FA}$$

Where:

UNLF$_b$ refers to *unrestrained net load forecast* of *customer market trading node b*

| Total LDF Load$_{h, FA}$ | refers to the sum of *load distribution factors* for hour *h* in a *forecast area FA* where *customer market trading node b* belongs |
| LDF$_{b, h, FA}$ | refers to the *load distribution factor* of *customer market trading node b* for hour *h* in *forecast area FA* |

6.2.7. A *Trading Participant* may submit his own *unrestrained net load forecast*. Further details on customer forecasts are available in SECTION 7.

6.3. RESTRAINED NET LOAD FORECAST

6.3.1. The *Restrained Net Load Forecast* of each Customer Market Trading Node is achieved after the optimization process of the Market Dispatch Optimization Model (MDOM).

6.3.2. A Customer Market Trading Node's projected load will be shed should its price reach the level of the Nodal VoLL price.

6.3.3. The *Restrained Net Load Forecast* shall then be obtained after the MDOM determines a solution reflective of load shedding. The following equation shows the value of the *Restrained Net Load Forecast*.

$$RNLF_b = UNLF_b - \text{Load Shed}_b$$

Where:

RNLF$_b$	refers to the *Restrained Net Load Forecast* of Customer Market Trading Node b
UNLF$_b$	refers to the *Unrestrained Net Load Forecast* of Customer Market Trading Node b
Load Shed$_b$	refers to the amount of load to be shed at Customer Market Trading Node b

6.4. INITIAL LOSS PERCENTAGE

6.4.1. The Initial Loss Percentage is the percentage of the *Demand Forecast* initially assumed to be the loss. It shall be netted out of the *Demand Forecast* in order to achieve the Total *Unrestrained Net Load Forecast*, which shall then be used to obtain the *Unrestrained Net Load Forecast* of each *customer market trading node*.

6.4.2. Each *Forecast Area* has its own Initial Loss Percentage, and it shall be reviewed on an annual basis by the *Market Operator*. The Initial Loss Percentage per *Forecast Area* shall be published by the *Market Operator* in the *Market Information Website*[1].

SECTION 7 CUSTOMER FORECASTS

7.1. CUSTOMER FORECAST SUBMISSION

7.1.1. Each qualified *Customer*, except those that are required by the *Market Operator* based on Section 7.1.6, may at its option, submit forecasts for its respective *market trading node* for each hourly or *dispatch interval*.

7.1.2. A *Customer* may only submit a *load forecast* for a *market trading node* that is solely registered to them.

7.1.3. Each *Customer* that submits *load forecasts* for the *market projections* and the *real-time dispatch* shall upload the relevant forecast in accordance with the *WESM timetable*.

7.1.4. The *Customer* forecast shall represent the estimated aggregate *demand* at the *market trading node* and shall be in real-power quantities (MW).

7.1.5. *Customer* forecasts submitted by *Trading Participants* shall replace the *Unrestrained Net Load Forecast* determined in Section 6.2 of this *Market Manual*.

7.1.6. Should a *customer market trading node* have a definite MW loading that can materially affect *WESM's* pricing and scheduling, then the *Market Operator* shall require the relevant *Trading Participant* to submit *Customer* forecasts for the identified *market trading node* for each interval in accordance with the *WESM timetable*.

7.1.7. Submission of *Customer* Forecasts in the *WESM* shall be made via *the Market Management System's* Market Participant Interface (MPI).

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[1] http://www.wesm.ph

7.2. CUSTOMER LOAD FORECAST CONSIDERATIONS

Trading Participants submitting customer load forecasts shall consider the following when determining Net Load Forecasts for their relevant market trading nodes.

1. **Customer Forecast Methodology.** In preparing the load forecast, the customers may select the methodology that they believe is most appropriate for each individual market trading node.

2. **Customer Load Forecast Adjustment.** Load adjustment factors shall be established by the Customer and his Meter Service Provider. The adjustment factors shall consider site-specific losses and other factors deemed necessary to reflect accurate customer load forecast at his market trading node.

3. **Customer Forecast Timeline.** Customers may be able to provide their own load forecast based on the Open Market Window defined in the WESM Dispatch Protocol.

SECTION 8 LOAD FORECASTING PARAMETERS

8.1. WEATHER DATA

8.1.1. Historical and forecast weather data shall be made available to the Market Management System's database on a regular interval in accordance with the WESM timetable. The weather data shall be based on the major load center located in the forecast area. Weather parameters shall include, but not limited to the following.
   - Temperature
   - Humidity

8.1.2. Such weather information shall be obtained from a reliable source deemed appropriate by the Market Operator. Prospective weather data providers are listed in Appendix E.

8.1.3. The Market Operator shall maintain a repository of the historical weather-related information.

8.2. DEMAND

8.2.1. *Demand* shall be obtained from the *Network Service Providers'* SCADA system, and it shall be incorporated in the data provided by the *System Operator* to the *Market Operator*.

8.2.2. Real-time information at the nodal levels shall also be retrieved by the *Market Operator* from the *System Operator*. Such information shall be used by the *Market Operator* in preparing the *Demand Forecast* and the *Net Load Forecast*.

8.2.3. In the absence or failure to provide reliable real-time information, the *Market Operator* shall utilize the latest information provided.

8.2.4. *Demand* obtained over time shall form part of the historical hourly load information that shall be used by the *Market Operator* as inputs to the load forecasting algorithms used for *market projections* and *real-time dispatch*.

8.2.5. Customer Demand Forecasts shall be based on the provisions under Section 7.

8.3. POWER SYSTEM CONDITION

8.3.1. The *Market Operator* shall consider the forecasted *power system* condition in the preparation of *net load forecast*. These shall include planned maintenance (transmission, sub-transmission, and generation), large *customer* maintenance schedules, and other activities, including generator testing and commissioning that may have an impact on the preparation of *market projections* and *real-time dispatch*.

8.3.2. The *System Operator* shall ensure that all relevant information is provided to the *Market Operator* in accordance with the *WESM timetable*.

8.3.3. For unplanned power system conditions, the *System Operator* shall ensure that all relevant information is timely provided to the *Market Management System* through the Energy Management System or other means of communication to the *Market Operator*.

8.3.4. All *Trading Participants* shall also ensure that information regarding any unplanned activity or condition is timely provided to the *System Operator*.

8.4. LOAD PROFILE

8.4.1. For similar day load forecasts, the *Market Operator* may utilize static profiling, proxy day profiling, and estimated or deemed profiling or a combination thereof. The *Market Operator* shall use all reasonable endeavors to provide the most appropriate load profile in determining *demand* and *net load forecasts*.

8.4.2. The *Market Operator* 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 *Market Operator* should note that static profiles do not reflect operating conditions of the day being estimated.

8.4.3. The *Market Operator* 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 be used to create the profile. Proxy day profiling shall consider day of the week profile, holidays and special events profile.

8.4.4. The *Market Operator* may obtain *Demand Forecasts* using engineering estimates, if and when necessary, for very predictable loads such as street lighting or residential area from *Trading Participants*.

8.5. LOAD GROWTH

8.5.1. The *Market Operator* shall consider the projected growth of load demand for each *Forecast Area* in the preparation of *Net Load Forecasts*. For consistency, the *Market Operator* shall consider information from the *Department of Energy* (DOE) for the load growth values.

SECTION 9 LOAD FORECAST AUDIT AND PERFORMANCE MEASURES

9.1. The *Market Operator* shall log all transactions performed for the determination of *net load forecast* including the uploading of the optional *Customer's* load demand forecast.

9.2. The *Market Operator* shall monitor the actual and forecasted nodal load for each relevant *market trading node*.

9.3. The *Market Operator* shall evaluate the *Net Load Forecast* Performance.

9.4. The *Market Operator* shall evaluate the *Demand Forecast* Performance pursuant to the performance standards that shall be maintained pursuant to *WESM Rules* Clause 10.4.10.2.

SECTION 10   AMENDMENTS, PUBLICATION AND EFFECTIVITY

10.1. Review and Update

10.1.1. Pursuant to *WESM Rules* Clause 3.5.4.6, the *Market Operator* shall periodically review the methodologies for performing *nodal load forecasts* and update this *Market Manual* as necessary.

10.1.2. Any amendments or revision to this *Market Manual* shall be approved in accordance with Chapter 8 of the *WESM Rules* and corresponding *Market Manual* on rules change process.

10.2. Publication and Effectivity

The publication and effectivity of this *Market Manual* shall be in accordance with Chapter 8 of the *WESM Rules* and corresponding *Market Manual* on rules change process.

SECTION 11 APPENDIX

Appendix A. Weather Adaptive Algorithm for Short-Term Load Forecast

1. INPUT DATA SPECIFICATION

The following input data are necessary to calculate the *load forecast* for this methodology:

a. Current load data.
b. Current weather data.
c. Weather forecast data provided by weather services companies.
d. Preselected day types for forecasting period.
e. The prediction error of the last forecast.
f. Estimated parameter values which quantify the causal relationship among historical load data, historical weather data and day type data.

2. WEATHER ADAPTIVE USING MULTIPLE REGRESSION METHOD

The Weather Adaptive Algorithm uses multiple regression analysis to create a statistical relationship between demand and weather conditions, including day types. In this methodology, the regression coefficients are estimated using equally or exponentially weighted minimum mean square error (MMSE) estimation criteria.

The regression analysis is performed with up to 3rd degree polynomial functions. The polynomial degree is adjusted for each weather influencing variable by parameter.

Regression analysis filters the different weather-dependent parts of the load for a given time, for example, time interval 8.00-9.00 a.m., as well as the influence of day type. The result of this filtering process is a set of regression coefficients (polynomial-coefficients).

To detect non-typical historical data, an adjustable data check is implemented. If load or influencing variables violate an adjustable bandwidth, they are excluded from the data analysis.

The result of the analysis is a decomposition of the time-dependent total load $Y(t)$ into:

$$Y(t) = B(t) + a_T T(t) + a_L L(t) + \left[\sum a_W W(t) \right] + D(t) + model\_error(t)$$

Where:

B(t) refers to weather insensitive load component

a_L, L(t) refers to weather-sensitive load components

a_T, T(t) refers to temperature-dependent load

a_L L(t) refers to humidity-dependent load

a_W W(t) refers to other weather-dependent load

D(t) refers to day type-specific load component

model_error (t) refers to the minimized weighted least squares estimation

The model error, is minimized using a weighted least squares technique, and this allows the user to get the forecast results in the form of an analytical expression.

Generally the regression analysis, which involves regression coefficient estimation, is activated periodically together with a subsequent forecast calculation.

3. MODEL ANALYSIS

Model analysis is the process used to find a new set of parameters that reduces the forecast errors for the weather adaptive algorithm. This requires using a particular set of historical load and weather history. Multiple simulations are run which imitate what the Weather Adaptive forecasting calculations would have been for that particular set of data starting at a user defined day and moving through the remaining data one day at a time. Each simulation has a different set of weather adaptive parameters. Results are summarized and may be compared, and therefore help to in analysing points that need further improvement.

4. DETERMINATION OF THE WEATHER FORECAST DATA

In order to get good forecast results the best available weather forecast data are necessary.

For the forecast calculation, the STLF program requires time series in the adjusted time step of each weather variable over the whole forecast period. These values are calculated automatically from the preceding inputs that are listed.

For the temperature influence, the program tracks a standardized curve through the day-specific values of minimum and maximum temperature. This standardized temperature curve is determined from the historical data at each run of the analysis program. The time points of the extreme forecast temperature are extracted from the historical data.

5. DETERMINATION OF THE LOAD FORECAST

The *load forecast* is calculated for each adjusted time step of the forecast period using the regression coefficients and the weather variables forecast as well as type of day.

The forecast program is activated through the following different means
- Periodically at defined time steps
- After each run of the analysis program
- On user request

Appendix B. Similar Day Algorithm for Short-Term Load Forecast

Use the similar day forecast to produce a *Demand Forecast* for a day or a range of days in the forecast period.

The similar day forecast is based on recalculated *Demand* patterns. There are *Demand* increment patterns for each:

- Forecast Area *Demand*
- Month
- Hour/minute
- Day type
- Normal/average weather conditions

The similar day profiles where calculated initially using historical *Demand* data and recalculation is going to be done once a day during midnight processing. Subsequently, they can be reviewed and edited using the STLF User Interface.

Historical load profile (similar day load) has been calculated for each month, hour and day type:

$$LoadProfile_{i,j,k} = \frac{1}{n} \cdot \sum_{l=1}^{n} HistoricalLoad_{i,j,k}$$

And standard deviation for each calculated load profile has been calculated by:

$$StandardDeviation_{i,j,k} = \sqrt{\frac{\sum(HistoricalLoad_{i,j,k} - LoadProfile_{i,j,k})^2}{n}}$$

Where:

i = 1, 2, 3,....12	- month
j = 1, 2, 3,....24	- hour
k = 1, 2, 3,....8	- day type
l = 1, 2, 3,....n	- number of historical days

Forecasting applications supporting the following day types:

Day Type No.	Day Type
1	FRI
2	MON
3	SAT
4	SUN
5	WKD

Day Type No.	Day Type
6	TUE
7	WED
8	THU

The *Demand* similar day patterns are non-weather sensitive, and they provide the average *Demand* in case for normal weather condition for that time of year (defined by month, hour and day type).

The weather increment patterns defined by standard deviation are expected to change under "Hot"/"Cold" weather conditions. Positive increments indicate that load increases in hotter weather conditions than in normal weather conditions. Negative increments indicate the reverse. Under cold weather conditions, the increments are subtracted rather than added to the non-weather sensitive load pattern values.

Appendix C. Pattern Matching Algorithm for Short-Term Load Forecast

The pattern matching algorithm uses a process to filter days that can be used to determine *Demand Forecasts*. The filtering of days is based on a pre-defined set of parameters, namely the type of day and historical weather data.

Based on the values defined in the filter, such as the type of day and the high and low values of temperature, it will select days and then provide an index for its difference. From there, it will assign a weight to be applied to the *Demand* for that day.

Using the weights along with the actual *Demand* for that day, a *Demand Forecast* shall be determined.

Appendix D. Cubic-Spline Interpolation Algorithm for Very Short-Term Load Forecast

1. CUBIC-SPLINE INTERPOLATION PROCESS

The 5-minute *Demand Forecast* executes for a time-horizon of 2 hours, or for 24 5-minutes intervals.

The 5-minute forecast-area load forecast makes use of a Cubic Spline Fitting algorithm in conjunction with the load-tracking methodology.

The inputs to the calculation are the hourly *Demand Forecast* as well as the 5-minute historical loads as shown in the figure below.
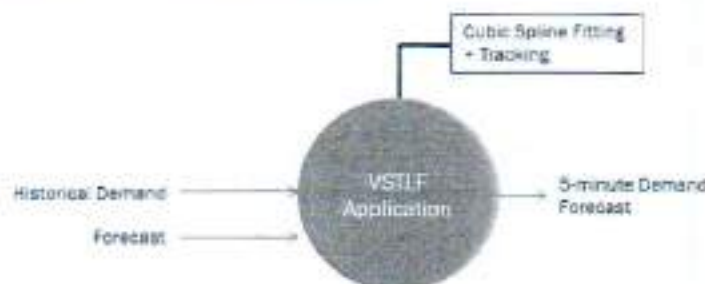

Figure 3. Cubic Spline Process Overview

The Tracking algorithm calculates correction term to the forecast for several 5-minute forecasting period. A curve fitting algorithm is used along with actual *Demand* to calculate the 5 minute forecast.

2. 5-MINUTE TRACKING LOAD FORECAST FUNCTION VIA CUBIC SPLINE

The tracking forecast is based on deviations between the five minute *Demand Forecasts* and the actual *Demand* every five minutes over the last hour. An average error term is used for the tracking forecast calculation. This average error term is calculated by adapting the relative errors for each time step so that values reflect the recent error trend.

$$\varepsilon_i = \frac{\left[5MinuteLoad_i - 5MinuteLoad_i\right]}{5MinuteLoad_i}$$

$$A_t = A_{t-1} + \alpha[\varepsilon_t - A_{t-1}]$$

Where:

$5MinuteLoad'_t$	- 5 minute forecast load at time t
$5MinuteLoad_t$	- 5 minute measured load at time t
ε_t	- Relative error at time t
A_t	- Average (or adapted) error at time t
α_t	- Adaptive parameter ($0 < \alpha_t < 1$)

The correction terms for future time steps are then be calculated as follows:

$$Y_{t+1} = (-1)5MinuteLoad'_{t+1}[\beta(\varepsilon_t - A_t) + A_t]$$

$$Y_{t+n} = (-1)5MinuteLoad'_{t+n}A_t$$

Where:

Y_t	- Forecast correction term for time t
β	- Weighting factor for the first future time step
n	- The number of the forecasting time steps (n>1)

The adaptive parameter is selected so that the error from the previous time step does not receive too much weight. The weighting factor is introduced so that the effect of the error for the previous time step may receive additional weight in determining the correction for the next time step.

Wholesale Electricity Spot Market

Appendix E. List of Prospective Weather Data Providers

1. Department of Science and Technology – Philippine Atmospheric, Geophysical, and Astronomical Services Administration (DOST-PAGASA)

2. Accuweather