



PUBLIC

WESM Manual

Market Network Model Development and Maintenance – Criteria and Procedures

Issue 8.0 | WESM-MNMCP

This document describes the processes involved in the development, approval, publication and revision of the WESM market network model.

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In case of inconsistency between this document and the DOE Circulars, the latter shall prevail.

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2.0	MOSubcom	11 August 2006	To clarify the audit provision in Section 9 stating the Grid Management Committee as the technical body to audit the MNM Incorporate provisions on aggregated/disaggregated representation of generators and loads in Section 7.0 Alteration and Revision to the MNM Revise provision on the approval process in Section 7.0
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4.0	PEMC	26 Jun 2021	Amendments related to metering point location
4.1	Technical Committee		Reflect amendments relevant to participation of battery energy storage systems and pumped-storage units in the WESM
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	PEMC		Revised formatting for the commencement of the enhanced WESM design and operations per DOE Department Circular No. DC2021-06-0015. Corrected Section 5.5.1 and 5.5.2 due to error in revising Issue 5.1 (Date of Change: 14-Oct-2021)
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Issue No.	Proponent	Date of Effectivity	Reason for Amendment
			MNM, and to provide details on the features of modelling generators.
8.0	MSC and CC	13 Feb 2024	Reflect amendments requiring Trading Participants to accurately reflect the available capacity of their generating units in their market offers.

**Previously tagged as Issue 4.2 by PEMC. Per DOE, this version is Issue 5.0.*

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Document Approval

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**Declaring the Commercial Operations of Enhanced WESM Design and Providing Further Policies*

Reference Documents

Document ID	Document Title
	WESM Rules
	Philippine Grid Code (PGC)
	Philippine Distribution Code (PDC)
WESM-PDM	Price Determination Methodology
WESM-RSDCP	WESM Market Manual on Registration, Suspension and De-Registration Criteria and Procedures
WESM-DRM	Dispute Resolution Market Manual
WESM-MSP	WESM Metering Market Manual
WESM-RCM	Market Manual of Procedures for Changes to the WESM Rules

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SECTION 1 INTRODUCTION

1.1 BACKGROUND

- 1.1.1 Pursuant to WESM Rules 3.2.1 and 3.2.2, this Market Manual consolidates the market procedures and associated forms, standards, and policies that define the Market Network Model (MNM) that shall be used in the operation of the Wholesale Electricity Spot Market (WESM). The documentation related to the MNM, which is published in the Market Information Website¹, provides more detailed descriptions of the requirements for the network model as specified in the WESM Rules. Where there is a discrepancy between the requirements in this document and the WESM Rules, the WESM Rules shall prevail. Standards and policies referenced or appended shall provide a supporting framework.

1.2 PURPOSE

The purpose of this Manual is to provide:

- 1.2.1 The methodology and criteria for the development, alteration and maintenance of the MNM that shall represent fairly, and in a manner that facilitate the consistent and reliable operation of the power system:
- a) The *transmission network* under the control of the *System Operator*, and
 - b) Such other aspects of the *power system* which, when *connected*, may be capable of materially affecting *dispatch of scheduled generating units* or pricing within the *spot market*.
- 1.2.2 Procedure for the approval and publication of the MNM.
- 1.2.3 The responsibilities of the Market Operator, the System Operator, Network Service Providers and the Trading Participants in the development, revision and maintenance of the MNM.

1.3 SCOPE

- 1.3.1 This WESM Manual implements the relevant provisions of Chapter 3 of the WESM Rules related to the Market Network Model.

1.4 APPROVAL OF THE MNM

- 1.4.1 Consistent with WESM Rules 3.2.1.5, any alteration recommended under Clause 3.2.1.4 shall be approved by the PEM Board.

¹ <http://www.wesm.ph>

- 1.4.2 Prior to the integration of a region in the commercial operations of the WESM, the development of the MNM incorporating the power system of such region shall be facilitated by the Market Operator in consultation with electric power industry participants prior to commencement of the spot market and shall be subject to approval by the Philippine Electricity Market Board (PEM Board).

SECTION 2 DEFINITIONS, REFERENCES AND INTERPRETATION

2.1 DEFINITIONS

- 2.1.1. **Generator Interconnection Lines** refers to the lines connecting generating plants to the transmission system.
- 2.1.2. **Load flow** refers to the process for calculating currents, voltages, and real and reactive power flows at every *node* in a given *power system* condition.
- 2.1.3. **Substation** refers to the physical representation of *nodes* in the *power system*. They may be composed of several *nodes* corresponding to the low voltage and high voltage busses.
- 2.1.4. **Sub-transmission Lines** refers to the *power system* lines directly under the control of power distributors and cooperatives.
- 2.1.5. **Market Resources** refers to the objects defined in the *Market Network Model* to represent *generators, battery energy storage systems, pumped-storage units, and loads*.

Other terms used in this document shall conform to the definition of terms under the WESM Rules and the Philippine Grid Code (PGC).

2.2 INTERPRETATION

This Market Manual is intended for use of the Market Operator, the System Operator, Network Service Providers, the Trading Participants and their representatives, and other parties as appropriate. The standard conventions to be followed in this Market Manual are as follows:

- 2.2.1. The word "shall" denotes a mandatory requirement;
- 2.2.2. Terms and acronyms used in this *Market Manual* including all Parts thereto that are italicized have the meanings ascribed thereto in *WESM Rules*;
- 2.2.3. Any procedure-specific convention(s) shall be identified within the specific document itself.

SECTION 3 RESPONSIBILITIES

3.1 MARKET OPERATOR

- 3.1.1. The *Market Operator* shall be responsible for the development, validation, maintenance, publication and revision of this document in coordination with *Trading Participants* and the *System Operator*.

3.2 SYSTEM OPERATOR AND TRADING PARTICIPANTS

- 3.2.1. The *System Operator* and the *Trading Participants* shall provide the *Market Operator* with necessary information *and references for subsequent revisions and validation* of this document.
- 3.2.2. The *System Operator* and the *Generation Companies* shall ensure that their facilities for real-time monitoring are available and that they accurately reflect the state of their generation (i.e., MW/MVAR output and generator circuit breaker *status*).
- 3.2.3. The *Market Operator* shall immediately inform the *System Operator* of any observed discrepancies in the real-time data.

3.3 NETWORK SERVICE PROVIDERS

- 3.3.1. Pursuant to *WESM Rules 3.5.2* and in accordance with the *Philippine Grid Code* and the *Philippine Distribution Code*, each *Network Service Provider* shall submit to the *System Operator* network data, and any revisions thereafter, under the *Network Service Provider's* control that is included in the MNM.
- 3.3.2. The *Network Service Provider* shall ensure that an equipment or facility is included in the *Market Network Model* prior to its issuance of approval to connect for energization.

SECTION 4 MARKET NETWORK MODEL DEVELOPMENT

4.1 DEFINITION

- 4.1.1. The MNM is a mathematical representation of the *power system* that shall be used for the purpose of determining *dispatch schedules* and *energy prices*, and preparing market projections. It contains the technical characteristics of the *transmission network*, particularly its connectivity, and the capacities of each network element. It also represents the *node* assignments and size of each generator and load. The *node* assignments indicate where each generator injects power to the transmission network, and where each load withdraws power from the *transmission network*.
- 4.1.2. The MNM also identifies the *Market Trading Node* on which the transactions for *Trading Participants* shall be referenced.
- 4.1.3. The components of the MNM interact with one another in accordance with *dispatch schedule* of the generating units, *battery energy storage systems*, *pumped-storage units*, customer demand and the physical laws that govern the operation of the network components. These interactions are complex by nature but should be balanced to maintain the reliable and secure operation of the *power system* by the *System Operator*, as well as for the generation of fair and economic market *dispatch schedules* and *nodal energy price*.

4.2 RESPONSIBILITIES IN MARKET NETWORK DEVELOPMENT

- 4.2.1. The *System Operator*, the *Network Service Providers*, and the *Trading Participants* shall provide the *Market Operator* with documents pertaining to *power system* changes that could trigger any change to the MNM topology and connectivity or parameter.
- 4.2.2. Specific responsibilities in the development of the MNM are highlighted in Section 4.5 of this document.

4.3 CRITERIA FOR THE MARKET NETWORK MODEL DEVELOPMENT

The following outlines the criteria necessary to develop the MNM as provided in the *WESM Rules*:

- 4.3.1. Representation of the physical *Transmission System* of the Luzon, Visayas, and Mindanao grids using an alternating current (AC) and direct current (DC) load flow network model
- 4.3.2. Network data that accurately reflects the conditions prevailing on the network, including losses, constraints and contingencies, at any *dispatch interval*.

- 4.3.3. Necessary simplifications based on the current best international industry practice
- 4.3.4. Pursuant to *WESM Rules* 3.2.1.2 (b), it shall include “other aspects of the *power system* which, when connected, may be capable of materially affecting dispatch of scheduled generating units or pricing within the spot market”.
- 4.3.5. The MNM shall have adequate detail to be able to capture the dynamism of the *power system* and shall be robust enough to reflect the dynamic behavior of the *power system* to determine the most optimal prices and schedules, and for the efficient and viable technical performance of the Market Management System (MMS) and the Energy Management System (EMS).

4.4 MNM COMPONENTS AND MODELING

The components of the MNM are as follows.

4.4.1. *Market Trading Nodes (MTN)*

These are *nodes* in the load flow model designated as the reckoning *node* for settlement of *energy* and reserves of *Trading Participants*. MTN shall be modeled as the trading point of a generating unit, *battery energy storage systems*, *pumped-storage unit* or a Load corresponding to its *connection point*. Where the MTN and the metering point are of different location, site-specific loss adjustment (SSLA) provided in the WESM Metering *Market Manual* shall apply. Further details on MTN can be viewed in Section 6 of this *Market Manual*.

4.4.2. Representations of Generator plant/unit *Market Resources*

These are numerical representations of *generating units* and its characteristics corresponding to power injection to the network. *Generating units* shall be modeled as the positive power injection with linear monotonically increasing cost function.

4.4.3. Representations of Load *Market Resources*

These are numerical representations of the *customer* demand corresponding to power withdrawal from the network. Loads shall be modeled as constant power withdrawal points.

4.4.4. Representations of *Battery Energy Storage System Market Resources*

This is the mathematical model of a *battery energy storage system* with its dual capability of injecting or withdrawing power through the network.

4.4.5. Representations of *Pumped-Storage Unit Market Resources*

This is the mathematical model of a *pumped-storage unit* with its dual capability of injecting or withdrawing power through the network.

4.4.6. Transmission and Sub-transmission lines

These are numerical representations of wires connecting different *nodes*.

Transmission lines shall be modeled as constant lumped impedance and shunt capacitance. Thermal and Contingency limits shall be based on the requirements of the *Philippine Grid Code* and *Philippine Distribution Code*.

4.4.7. Transshipment Node

A *node* in the network model that has neither a generator nor customer associated to it. A transshipment *node* connects at least two equipment together.

4.4.8. Power Transformer

Equipment used to transform the voltage from one level to another. Transformers shall be modeled as impedance. It shall also include if available, the no-load loss and nominal and off-nominal turns ratio including step-size. Two-winding transformers shall be modeled as two-winding transformers, while three-winding transformers shall be modeled as either a three-winding transformer or translated to three two-winding transformers.

4.4.9. Shunt and Series Devices

Network elements used to ensure the reliability and security of the *power system*. Shunt devices shall be modeled as MVAR injection to the *power system* and identified whether this is Fixed, Regulating or Static Var Compensator (SVC). Its nominal reactive power shall be indicated including upper limit and lower limit voltage control range. Series devices shall be modeled as series resistance.

4.4.10. Power Circuit Breakers and Disconnect Switches

Network switches that enable the *System Operator* to connect and disconnect network elements from each other.

Power circuit breakers are represented as switch points in the breaker oriented model or single line diagram.

4.4.11. Scheduling Points

These are *nodes* in the load flow model designated as the reckoning *node* for *Trading Participant* bids or offers. *Scheduling points* shall be modeled as the point of a Generator where the appropriate real-time monitoring facility can be associated. The

scheduling points of a *customer* shall be at its *connection points*; however, if the system of a *customer* is included in the *market network model*, the *scheduling points* of the *customer* shall be at the withdrawal points within its system.

4.4.12. Real-Time Data

The *System Operator* shall provide the following real-time data, each having its respective real-time data quality, to the *Market Operator*:

- a) Analog measurements (MW/MVAR) to represent gross generation output and generation net of the station use;
- b) Analog measurements (MW/MVAR) to represent consumption at least at the connection point;
- c) Analog measurements (MW/MVAR) measuring loading at the high-side and low-side of the transformer;
- d) Analog measurements (MW/MVAR) measuring the loading at both ends of an AC line or HVDC link;
- e) Breaker Status;
- f) Calculated MW Demand per region; and
- g) Power System Frequency per grid (Hz).

4.5 MNM DEVELOPMENT TIMETABLE

4.5.1. The following changes on the *power system* from the *System Operator* shall trigger a revision to the MNM:

- a) Addition of new generators, lines, transformers, and other equipment;
- b) Reconfiguration of substation;
- c) Changes in connection points of equipment;
- d) Change in impedance parameters of transformers and lines;
- e) Decommissioning of lines, transformer, generators, and feeders, and other equipment; and
- f) Change in equipment and station names

4.5.2. *Network Service Providers* shall also submit pertinent information relevant to Section 4.5.1 of this *Market Manual* to the *System Operator*, particularly the equipment that should be included, or those already included, in the MNM, considering the MNM Development Timetable in [Table 1](#) ~~Table 4~~ of this *Market Manual*. The *Market Operator* shall determine if the distribution network equipment should be included in the MNM based on the results of market impact study emanating from Section 4.6 - Market Impact Study of this *Market Manual*.

4.5.3. The official notification from the *System Operator* should contain the target date of energization, along with the details of the changes to the *transmission system*. The list of required information from the *System Operator* is described in Appendix A.

4.5.4. After the receipt of the official notification from the *System Operator*, the *Market Operator* shall start the preparations for the MNM update to facilitate the implementation of the notified change. Minor changes (such as but not limited to,

change in equipment/resources naming conventions, additional bays for future expansions) to the *transmission network* that has no impact to the market operations may be implemented at a later time.

4.5.5. The *Network Service Provider* shall only issue the approval to connect for the energization of a facility only when it has been included in the *market network model* and registered in the *WESM*.

4.5.6. The table below describes the timeline of activities involved in updating the MNM. The variable “D” stands for the target date of deployment of the MNM update. This date is set by the *Market Operator* upon its assessment and in consideration of the energization or commissioning date of a new or upgraded facility or equipment.

Table 1. MNM Development Timetable

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
1	Before D – 9	<i>Generator Trading Participants</i> should provide technical specifications of its facility to the <i>Market Operator</i>	At the very least, the technical requirements indicated in the WESM Market Manual on Registration, Suspension and De-Registration Criteria and Procedures for new <i>generators, battery energy storage systems, or pumped-storage</i> units should be provided. The same requirements are also required when requesting for the re-modelling of facilities (i.e. aggregation of disaggregation of resources).	<i>Generator Trading Participant</i>
2	Before D – 9	The <i>System Operator</i> should provide technical specifications to the <i>Market Operator</i> for new <i>load</i> facilities	The <i>System Operator</i> should provide the breaker-oriented single line diagram that reflects the connection of the new <i>load</i> facility.	<i>System Operator</i>
3	Before D – 8	<i>Network Service Providers</i> should provide notice of changes in the <i>Distribution Network</i>	Applicable only for <i>Network Service Providers</i> whose equipment should be included, or are already included, in the <i>Market Network Model</i>	<i>Network Service Providers</i>
4	D – 8	Register New <i>Market Resource</i> in the Central Registration and Settlement System (CRSS) and Market Management System (MMS)	Upon receiving the technical requirements for the registration of new <i>market resources</i> , the <i>Market Operator</i> shall register it in the CRSS and MMS at least eight (8) days prior to their target energization.	<i>Market Operator</i>

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
5	D – 7	Submit notice of changes to the <i>Grid</i>	<p>The <i>System Operator</i> shall submit a notice of changes to the <i>grid</i>, which includes the following:</p> <ul style="list-style-type: none"> • Breaker-oriented single line diagram that highlights the changes; • Real-time mapping definitions; and • Technical parameters affected by the change. 	<i>System Operator</i>
6	D – 6	Initiate Preparations for MNM Update	<p>The <i>Market Operator</i> shall make the necessary preparations concerning the MNM update, specifically for network changes that have a material effect to the system operations and market operations as appropriately assessed by the <i>Market Operator</i>. It shall involve the changes as notified by the <i>System Operator</i>, and changes recommended by the <i>Market Operator</i>, where appropriate, including simplifications and alterations to the <i>market network model</i> that maintains: (a) the relationship between the <i>market network model</i> and the <i>transmission network</i>; and (b) consistency with market requirements.</p>	<i>Market Operator</i>
7	Before D – 2	Market Model and Power System Model Update	<p>The <i>Market Operator</i> shall effect changes to the MNM through the updating of the market and power system models recognized by the MMS.</p> <p>The <i>Market Operator</i> may create different “MNM Update Tasks” for such MNM updates. An MNM update task represents a collection of changes in the MNM. Each MNM update task can be deployed separately for production use.</p>	<i>Market Operator</i>
8	Before D – 2	Testing of “MNM Update Task”	<p>The <i>Market Operator</i> shall perform functional and technical tests on the updated network model for each MNM task to ensure its consistency with the updated <i>power system</i>.</p>	<i>Market Operator</i>
9	Before D – 1	Confirm schedule of energization	<p>The <i>System Operator</i> shall inform the <i>Market Operator</i> of the final schedule of energization.</p>	<i>System Operator</i>
10	On or Before D	Notice of Planned Deployment to the <i>WESM Participants</i>	<p>The <i>Market Operator</i> shall inform the <i>WESM Participants</i> of the planned deployment date for the updating of the</p>	<i>Market Operator</i>

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
			MNM in the production system of the MMS	
11	D	Deployment of MNM Update Task	The <i>Market Operator</i> shall deploy the MNM Update Task in the production system. Should the MNM update task involve changes that are not yet energized, and the updated MNM's power system model is unable to dynamically adapt to its non-energization, then the <i>Market Operator</i> may defer the deployment of the MNM Update Task to a later date.	<i>Market Operator</i>
12	D	Notice of Post-Deployment to the <i>WESM Participants</i>	The <i>Market Operator</i> shall inform the <i>WESM Participants</i> of the successful deployment of MNM update in the production system of the MMS	<i>Market Operator</i>
13	D	Provide Updates on Market Model and Power System Model to the <i>System Operator</i>	The <i>Market Operator</i> shall provide the <i>System Operator</i> with relevant information to ensure reliable operation between the two entities. This primarily includes the updated mapping information between the MMS and EMS	<i>Market Operator</i>
14	D to D+7	Consistency monitoring of the updated MNM	The <i>Market Operator</i> shall continuously monitor the status of the recently updated MNM in the production system for the next seven days	<i>Market Operator</i>

4.5.7. The *Market Operator* shall prepare a monthly report containing all MNM updates deployed in the production system. This report shall be provided to the *DOE, ERC,* and the *PEM Board,* and shall be similarly published in the *market information website* ten (10) *working days* after the end of the *billing period.*

The *Market Operator* shall seek the approval of the *PEM Board* prior to integration of the new network, as described in *WESM Rules* Clauses 3.2.1.2 and 3.2.1.5, to the MNM. The result of functional and technical testing for such integration shall also be submitted to the *PEM Board.* within three (3) calendar days after completion.

- 4.5.8. Additional Considerations in the MNM Development are as follows:
- a) *Network Service Providers* shall ensure that they provide ample information regarding their planned activities to the *System Operator.*
 - b) All planned activities should involve proper coordination between the *Market Operator* and the *System Operator* (including affected *Trading Participants* if necessary).
 - c) The target date of deployment (Day 'D') by the *Market Operator* may be moved further depending on justifiable reasons from either the *Market Operator* or the *System Operator.* In such cases, the *Market Operator* in coordination with the *System Operator* should decide on the new target date of deployment.

- d) Should the target deployment of an MNM update be cancelled, and then other updates to the MNM were put into effect after its cancellation, the *System Operator* shall notify the *Market Operator* of its new scheduled energization date seven days prior.
- e) In cases where urgent updates to the MNM are necessary, the *Network Service Provider* or the *System Operator* shall provide the necessary technical requirements to update the MNM at least two (2) *working days* prior to the target energization. Urgent updates do not include new *market resources*.

4.6 MARKET IMPACT STUDY

- 4.6.1. The *Market Operator* shall conduct market impact studies relating to changes in the transmission and sub-transmission system that may materially affect the scheduling and pricing in the WESM.
- 4.6.2. *Network Service Providers* shall provide relevant network data for the conduct of a market impact study that intends to determine if such aspects of the power system may be capable of materially affecting the dispatch of scheduled generating units or pricing within the spot market.
- 4.6.3. The *Market Operator* shall submit the results of the market impact study to the DOE, ERC, and the *PEM Board*.

The *Market Operator* shall publish a public copy of the same in the *market information website*, if required by the DOE, ERC, or the PEM Board.

SECTION 5 UPDATING AND MAINTENANCE OF THE MARKET NETWORK MODEL

WESM Rules 3.2.1.4 state that “Where appropriate, the *Market Operator* or the *System operator* may recommend alterations to the *market network model*, so as to maintain: (a) the relationship between the *market network model* and the *transmission network*; and (b) consistency with market requirements”. Such alterations on the MNM shall be made by the *Market Operator* as a result of the following:

5.1 DYNAMISM OF MNM USING REAL-TIME DATA

- 5.1.1. The static power system model of the MNM shall be dynamically updated based on the inputs and data provided by the *System Operator*. This shall include, but may not be limited to, the following:
- a) Change in Transmission and Sub-transmission Network topology with reference to real-time status of breakers and disconnect switches; and
 - b) Scheduled outages of *power system* equipment (e.g. Lines, Power Transformers, HVDC Links, *Generators* and *Customer Loads* outage).

5.2 DEVELOPMENT OF UPDATES TO THE MNM

- 5.2.1. The *Market Operator* shall develop the *market network model* and *power system* model in view of any reconfiguration of any part of the transmission or sub-transmission system. This shall include the following:
- a) Installation of new lines and equipment
 - b) Line/network connectivity switching
 - c) Line upgrading
 - d) Transformer upgrading
 - e) Transformer relocation
 - f) Installation of new substation
 - g) Replacement network element parameter change
 - h) Substation/Switchyard re-configuration
 - i) Power circuit breaker relocation
- 5.2.2. Updates in the MNM as a result of the aggregation or disaggregation of *market resources* shall be made in accordance with the requirements set forth in Section 5.5 of this *Market Manual*.

5.3 SIMPLIFICATIONS ON THE MARKET NETWORK MODEL

- 5.3.1. *WESM Rules* Clause 3.2.1.3 state that the *market network model* may contain such simplifications, approximations, equivalencies or adaptations as may facilitate the dispatch, pricing, or settlement processes

- 5.3.2. The MNM may contain simplifications related to the representation of *market resources* upon request of a *Trading Participant*. It should be agreed upon by the *Trading Participant, Market Operator, System Operator*, and if necessary, the *Network Service Provider*. Such simplifications are listed, but not limited to the following conditions:
- a) Aggregated representation of multiple *generating units* (note: aggregated representation in the MNM may be applied to multiple *generating units* that are located in a single generating station);
 - b) Disaggregated representation of *customer* trading nodes;
 - c) Single Customer Trading Nodes representing an aggregate of multiple customers;
 - d) Representation of downstream *generating units* with limited real-time monitoring facilities such as in cases of *embedded generators* where there is limited availability of real-time monitoring facilities between the *transmission system's* main substation and the generator, in which case, the *Market Operator* shall determine nodal *load forecasts* for *loads* with no real-time information based on the different approaches listed in the WESM Manual on Load Forecasting (see *Appendix B*).
 - e) Representation of downstream *generating units* located in a *distribution network* that is not reflected in the *market network model*. The *Market Operator* may model the *generating unit* at the nearest MNM substation to which it is indirectly connected.
- 5.3.3. The *Market Operator*, in consultation with the *System Operator*, and if necessary, the *Network Service Provider*, may implement simplifications, approximations, equivalencies or adaptations of the transmission and sub-transmission system on the *market network model*.
- 5.3.4. The *Market Operator* shall ensure the consistency and accuracy of such simplifications, approximations, equivalencies or adaptations on the *market network model* while considering its impact on dispatch, pricing, and settlement processes.

5.4 MARKET NETWORK MODEL MAINTENANCE

- 5.4.1. The *Market Operator* shall prepare a document containing a summary of all the changes implemented in the MNM.
- 5.4.2. The *Market Operator* shall maintain an electronic copy of the following for all *market network model* updates:
- a) Bus-Oriented Single Line Diagram;
 - b) Breaker-Oriented Single Line Diagram; and
 - c) Technical Parameters

- 5.4.3. The *System Operator* shall regularly provide the *Market Operator* the following documents on a quarterly basis whether or not there are updates:
- a) Updated Single Line Diagram; and
 - b) PSS/E file of the transmission system
- 5.4.4. The *Market Operator* shall ensure that the MNM used in the MMS is the same as the ratified/approved MNM by the *PEM Board*.

5.5 REPORTING OF MNM UPDATES

- 5.5.1. Within two (2) *working days* from deployment, the *Market Operator* shall publish advisory on the MNM updates deployed in the production system.
- 5.5.2. Consistent with the provisions of Section 4.5.7 of this *Market Manual*, the *Market Operator* shall prepare a monthly report containing all MNM updates deployed in the production system. This report shall be provided to the *DOE, ERC*, and the *PEM Board*, and shall be similarly published in the *market information website* ten (10) *working days* after the end of the *billing period*. At the least, it shall contain the following:
- a) Summary of MNM Updates during the month
 - b) Latest Bus-Oriented Single Line Diagram
- 5.5.3. All publication by the *Market Operator* regarding the MNM shall be in an un-editable electronic format. The MNM documents shall be published to the general public through the *Market Information Website*.

5.6 INFORMATION DISCLOSURE

- 5.6.1. Disclosure of information concerning the MNM, shall be subject to the provisions in the *Information Disclosure and Confidentiality Market Manual*, consistent with Chapter 5 of the *WESM Rules*.

5.7 AUDITING OF MNM

- 5.7.1. In accordance with *WESM Rules* 1.5 and 5.2.6, the appropriateness of the *Market Network Model* as a representation of the transmission system shall be subject to the annual Market Operations Audit

5.8 REGULATORY COMPLIANCE

- 5.8.1. In compliance with the application of the *WESM Price Determination Methodology*, the MNM shall be submitted to the *Energy Regulatory Commission*, on a quarterly basis regardless of whether revisions or alterations have been introduced thereto.

5.9 DISPUTE RESOLUTION

- 5.9.1. Any dispute arising from the application of the MNM shall be submitted for resolution in accordance with the dispute resolution procedures set in the *WESM Rules* and applicable *WESM Market Manuals*.

5.10 CONTINUING OBLIGATIONS AND RESPONSIBILITIES

- 5.10.1. The *System Operator*, *Network Service Providers*, *Metering Service Provider* and *Trading Participants* shall continuously coordinate with the *Market Operator* with regard to maintenance, revision, publication and other necessary action regarding the MNM based on the *WESM Timetable*.
- 5.10.2. The *System Operator* and *Trading Participants*, in coordination with *Network Service Providers* shall continuously ensure the completeness, availability, and accuracy of the required *real-time data* in the *market network model*.
- 5.10.3. The *System Operator* shall report real-time monitoring facilities owned or managed by the *Trading Participants* or owned by the *System Operator* that have been persistently erroneous or non-updating for at least two (2) *business days* to the *Market Operator* and *Enforcement and Compliance Office*. The *Trading Participant* shall endeavor to resolve the issue within fifteen (15) calendar days from the time it was reported.
- 5.10.4. The *Market Operator* in coordination with the *System Operator* and *Trading Participant* shall be responsible for estimating *real-time data* that was reported to be erroneous or non-updating.
- 5.10.5. The *Market Operator* shall immediately inform the *System Operator* of any observed discrepancies in the *real-time data*.

SECTION 6 MODELLING OF MARKET RESOURCES

6.1 BACKGROUND

- 6.1.1. The *Market Trading Node* in the MNM, in physical terms, represents a power substation onto which *energy* is injected or withdrawn through power transformers or switching equipment. The transformers and switching equipment connect the transmission network operated by the *System Operator* and generating equipment, distribution network operated by *Network Service Provider* and load customers.
- 6.1.2. One *market resource* may be defined to represent both the *scheduling point* and the *market trading node*.

6.2 DEFINITION

- 6.2.1. Pursuant to the definition of *WESM Rules* Clause 3.2.2.1, "A market trading *node* is a designated point in the *market network model* where *energy* is bought or sold based on the schedules and prices determined by the *Market Dispatch Optimization Model*. A *market trading node* where *energy* is primarily sold into the WESM is referred to as the *generator node* while a *market trading node* where *energy* is primarily bought from the WESM is referred to as a *customer node*".
- 6.2.2. In addition to this, *WESM Rules* Clause 3.2.2.2 state that "Each market trading *node* shall:
- Be assigned to a *Trading Participant* that intends to buy or sell *energy* and is capable of complying with the *dispatch* and *settlement* requirements in the WESM;
 - Be associated with a revenue metering and *remote* telemetering facilities capable of measuring all relevant incoming and outgoing *energy* deliveries for the purpose of *dispatch* and *settlement* in the WESM; and
 - As much as possible, represent the *connection point* between the *Network Service Provider* and the *Trading Participant*

6.3 TYPES OF MARKET RESOURCES

- 6.3.1. Market Resources can be classified as:
- Generator resources – resources that represent a registered generating unit or generating system directly connected to a network operated by the *System Operator*. It is a resource where power is injected into the *transmission network*.
 - Customer resources – resources that represent where power is withdrawn by *Trading Participants* from the grid.
 - Battery Energy Storage System resources – resources that represent a registered *battery energy storage system* directly connected to a network

operated by the *System Operator*. It is a resource where power is injected or withdrawn through the *transmission network*.

- d) Pumped-Storage Unit resources – resources that represent a registered *pumped-storage unit* directly connected to a network operated by the *System Operator*. It is a resource where power is injected or withdrawn through the *transmission network*.

- 6.3.2. For *generating units* registered and modelled net of its station use, the *Trading Participant* shall have a generator and a customer resource registered in the *WESM* to accurately reflect the direction of power flow.

6.4 GUIDELINES FOR MODELLING A MARKET RESOURCE

The following are the general guidelines in modelling the different *market resources*:

- 6.4.1. Subject to Section 6.4.2 and Section 6.4.8, MTN and *scheduling points* shall be defined for each *node* in the MNM that lies at the boundary between a network operated by the *System Operator* and any apparatus, network or equipment used to generate, convey or control the conveyance of *energy* and operated by a person other than the *System Operator*.
- 6.4.2. *Scheduling points* shall also be defined for each *node* in the MNM that lies at the boundary between a network operated by the *Network Service Provider* that is included in the MNM, and any apparatus, network or equipment used to generate, convey or control the conveyance of *energy* and operated by a person other than the *System Operator*.
- 6.4.3. Each MTN shall be associated with at least one Trading Participant registered in the *WESM*.
- 6.4.4. MTN and *scheduling points* shall be defined in a manner that calculation of relevant power flows and locational marginal prices shall not result to cross-subsidization of the *Trading Participant*.

6.5 GENERATOR MARKET RESOURCE

- 6.5.1. During the registration of the generator resource, the *Trading Participant* shall specify if the *scheduling point* should represent the gross MW output of the generator or at the same location as the *market trading node*, which is at the connection point and net of its station use. The location of the *scheduling point* shall be the reference point for the *registered capacity*, submission of *generation offers* and self-scheduled nominations, scheduling, dispatch, and dispatch compliance monitoring.
- 6.5.2. The information that should be submitted by the generators in their *energy supply* and *reserve offers* are enumerated in Appendix A.1 of the *WESM Rules*.

- 6.5.3. During the registration of the generator resource, *Trading Participants* shall specify if its availability shall be based on the real-time status of its generator circuit breaker, or on the availability of its *market offers*.

6.6 CUSTOMER MARKET RESOURCE

- 6.6.1. Should there be limitations for a customer resource to be modelled at the *connection point* (e.g. availability of real-time monitoring facilities), the *Market Operator* may implement simplifications and approximations to its representation in the *market network model* while still ensuring its consistency and accuracy with its actual connection to the grid.
- 6.6.2. The information required from the customers during their submission of *demand bids* or *reserve offers* in the case of dispatchable loads are listed in Appendix A of the *WESM Rules*.

6.7 Battery Energy Storage System Market Resource

- 6.7.1. During the registration of the *battery energy storage system resource*, the *Trading Participant* shall specify if the *scheduling point* should represent the gross MW output of the generator or at the same location as the *market trading node*, which is at the connection point and net of its station use. The location of the *scheduling point* shall be the reference point for the *registered capacity*, submission of *generation offers* and self-scheduled nominations, scheduling, dispatch, and dispatch compliance monitoring.
- 6.7.2. The information that should be submitted by the generators in their energy supply and reserve *offers* are enumerated in Appendix A1.4 of the *WESM Rules*.
- 6.7.3. During the registration of the *battery energy storage system resource*, *Trading Participants* shall specify if its availability shall be based on the real-time status of its connecting breaker, or on the availability of its *market offers*.

6.8 PUMPED-STORAGE UNIT MARKET RESOURCE

- 6.8.1. During the registration of the *pumped- storage unit resource*, the *Trading Participant* shall specify if the *scheduling point* should represent the gross MW output of the generator or at the same location as the *market trading node* (i.e. at the *connection point*, which is at the connection point and net of its station use. The location of the *scheduling point* shall be the reference point for the *registered capacity*, submission of *generation offers* and self-scheduled nominations, scheduling, dispatch, and dispatch compliance monitoring.

- 6.8.2. The information that should be submitted by the generators in their energy supply and reserve *offers* are enumerated in Appendix A1.1 of the WESM Rules.
- 6.8.3. During the registration of the *pumped-storage unit resource*, *Trading Participants* shall specify if its availability shall be based on the real-time status of its connecting breaker, or on the availability of its *market offers*.

6.9 PROCEDURE FOR REGISTRATION OF MARKET RESOURCES

- 6.9.1. During registration process, *Trading Participants* shall submit data requirements specified by the *Market Operator* pursuant to the WESM *Market Manual* on Registration, Suspension, and De-Registration Criteria and Procedures.
- 6.9.2. The *Market Operator* and the *System Operator*, in coordination with the *Trading Participant*, shall *determine* the *market resource* model based on the guidelines of Section 6 of this document. The agreed *market resource* model shall be determined in accordance with the procedures under the *WESM Manual* on Registration, Suspension, and De-Registration Criteria and Procedures.

SECTION 7 AMENDMENTS, PUBLICATION, AND EFFECTIVITY

7.1 AMENDMENTS TO THIS MANUAL

Any amendment, or revision to this Manual shall be in accordance with the WESM Rules and relevant Market Manual.

7.2 PUBLICATION AND EFFECTIVITY

This *Market Manual* may be amended from time to time, shall be published in the *market information website* maintained by the *Market Operator*. Any amendments thereto shall become effective upon approval of the DOE in accordance with *WESM Rules* Clause 8.6.4 the date of effectivity shall be indicated in this document.

SECTION 8 APPENDICES

Appendix A. List of Required Transmission Network Parameters

The table below lists all parameters needed by *Market Operator* in order to completely define the MNM:

A. Topology of the Network²
1. Bus Voltage (in kilovolts)
2. Transmission Line Name and Circuit Number
3. Transmission Line Name
4. Transmission "From Bus"
5. Transmission Line "To bus"
6. Transformer Name (designated by NSP)
7. Transformer "From Bus"
8. Transformer "To bus"
9. Generator Station Identification
10. Generator Bus name
11. Generator Unit Number/Identification
12. Generator Interconnection Bus Name
13. Load Name
14. Load Unit Number
15. Load Interconnection Bus Name
16. Zone/Area Identification Name (Control Area)
17. Zone/Area ID Number (any number from 1-99000)
18. Switched Shunt (capacitor, reactor) Name
19. Switched Shunt (capacitor, reactor) associated Bus name
20. HVDC Link Circuit Number

B. Impedances, Thermal Limits, Loss Functions	Provision
1. Transmission Line Circuit Branch Resistance, R	Mandatory
2. Transmission Line Circuit Branch Reactance, X	Mandatory
3. Transmission Line Circuit Total Branch Susceptance, B	Mandatory
4. Transmission Line Circuit Thermal Limit under Normal Operation, MVA or MW	Mandatory
5. Transformer Voltage, kV	Mandatory
6. Transformer Resistance, R ³	As Available
7. Transformer reactance, X	Mandatory
8. Transformer Thermal limit under Normal Operation, MVA	Mandatory
9. Switched Shunt Capacitor, MVAR	Mandatory
10. Switched Shunt Reactor, MVAR	Mandatory
11. Core Loss, MW	As Available

² All are "Mandatory" requirements that shall be determined between the *Market Operator* and the *System Operator*

³ Shall be "Mandatory" for network or non-radial transformers

C. Limits on the voltage of the HVDC Equipment⁴

- | |
|-------------------------------|
| 1. HVDC Bus Voltage |
| 2. HVDC Power Transfer Rating |

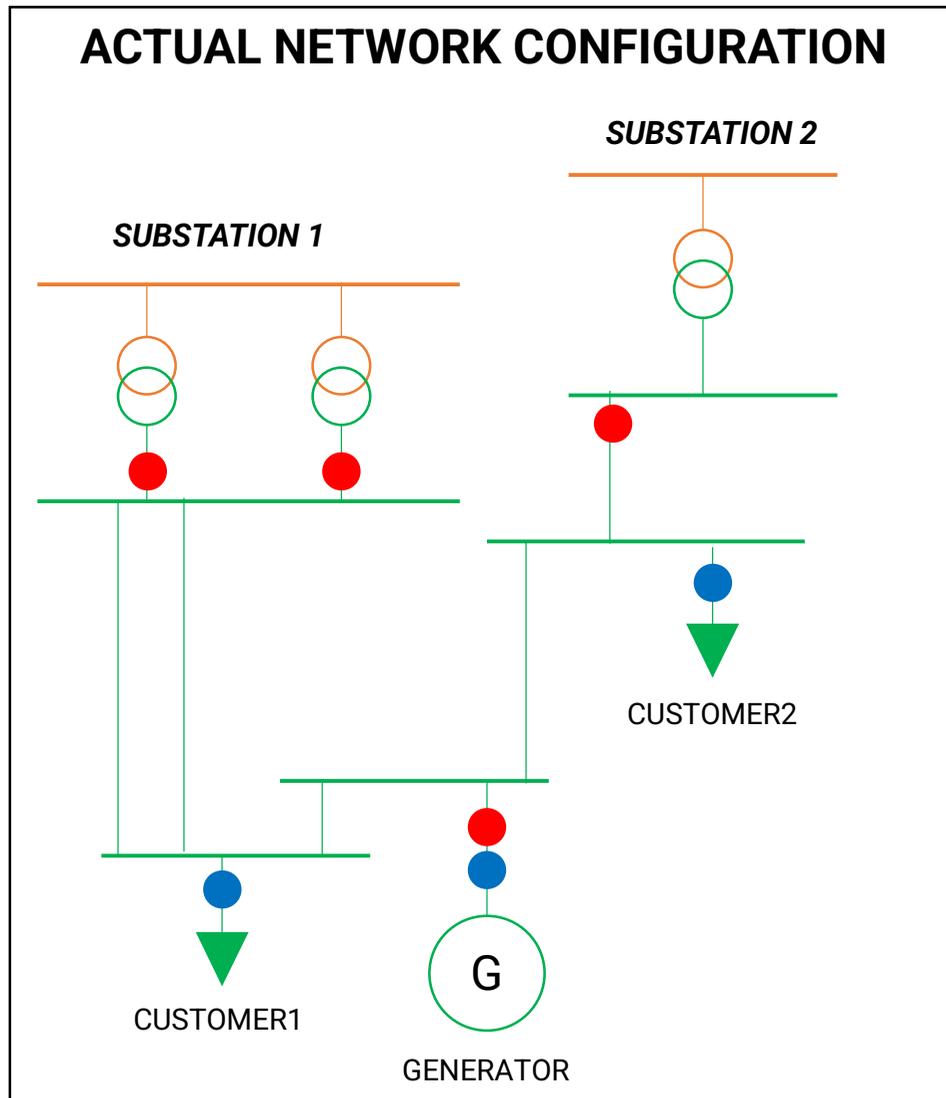
D. Generator parameters⁵
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- | |
|--|
| 1. Maximum generator Real Power Output MW |
| 2. Minimum generator Real Power Output, MW |
| 3. Generator Ramp Rates |

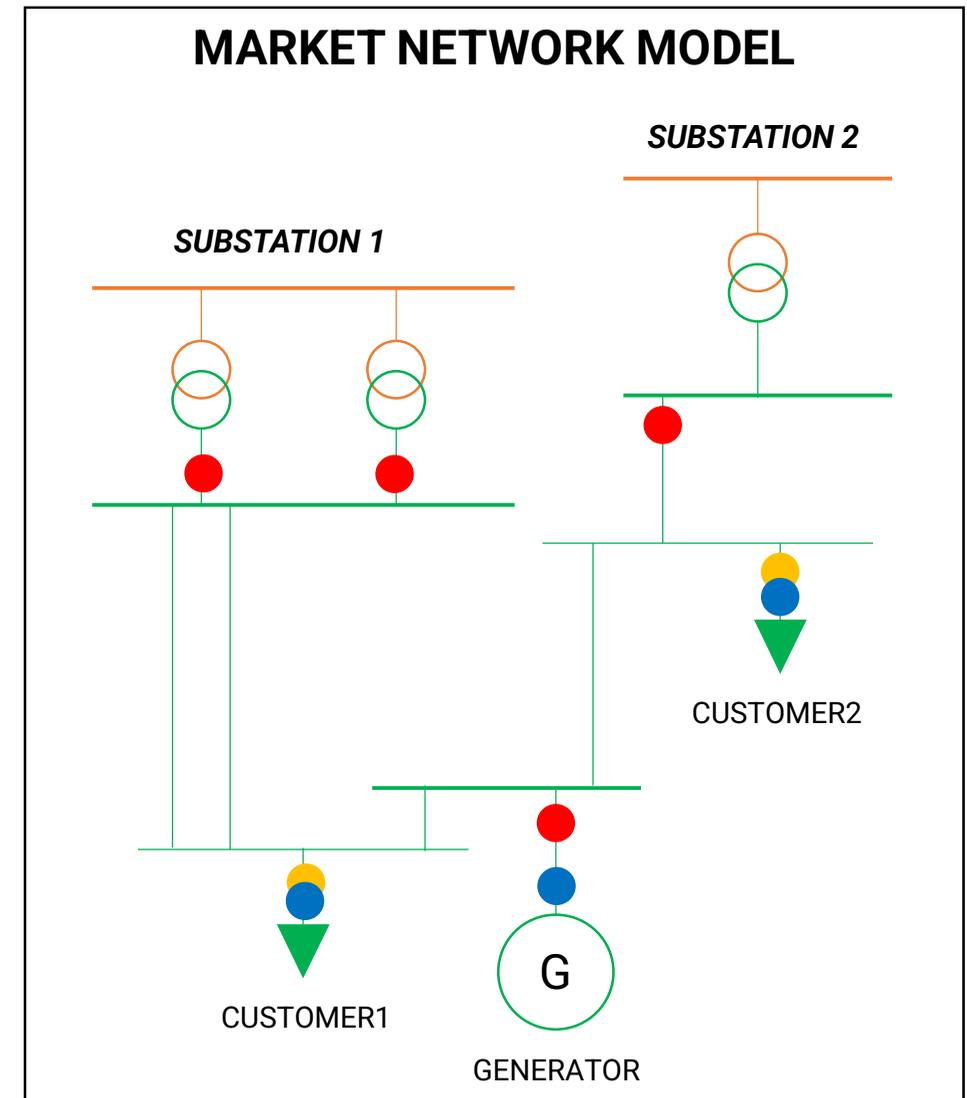
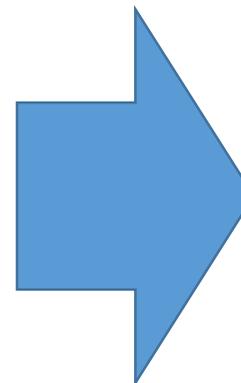
⁴ All are mandatory requirements

⁵ All are mandatory requirements

Appendix B. Illustration of Simplified Model for Embedded Generators



● REAL-TIME MONITORING ● REVENUE METER



● REAL-TIME MONITORING ● REVENUE METER
● ESTIMATED REAL-TIME DATA