

PUBLIC

WESM Manual

Market Network Model Development and Maintenance – Criteria and Procedures Issue 4.1

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

Document Identity: WESM-MNMCP-004.1
Issue: 4.1
Reason for Issue: Amendments related to participation of battery energy storage systems and pumped-storage units
Approval Date: 06 August 2018
Publication Date:
Effective Date: *Revisions to the WESM-MNMCP will be effective upon the commencement of the New Market Management System to be set by the DOE.*

Document Change History

Issue No.	Proponent	Date of Effectivity	Reason for Amendment
0.0	MOSubcom	21 May 2004	New Document New Draft Format
0.1	MOSubcom	08 June 2004	New Document Incorporating Subcom Comments
0.2	MOSubcom	16 June 2004	Revision Incorporating Initial TWG Comments
0.3	TWG	17 August 2004	As approved by the WESMTWG
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
3	PEMC	17 April 2014	Revised for consistency with the WESM Rules and compliance to the market operation audit findings.
4.0	PEMC		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

Document Approval

Issue No.	RCC Approval	RCC Resolution No.	PEM Board Approval	PEM Board Resolution No.	DOE Approval	DOE DC No.
1.0						
2.0						
3.0	08 January 2014	2014-03	05 February 2014	2014-05		
4.0	10 November 2017	2017-10	06 December 2017	2017-35	16 May 2018	2018-05-0015
4.1	04 May 2018	2018-04	30 May 2018	2018-27	06 August 2018	2018-08-0022

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-MSDM-MM	WESM Metering Market Manual
WESM-RCM	Market Manual of Procedures for Changes to the WESM Rules

Table of Contents

SECTION 1 INTRODUCTION	1
1.1 Background	1
1.2 Purpose	1
1.3 Scope	1
1.4 Approval of the MNM	2
SECTION 2 DEFINITIONS, REFERENCES AND INTERPRETATION	2
2.1 Definitions	2
2.2 Interpretation	2
SECTION 3 RESPONSIBILITIES	3
3.1 Market Operator	3
3.2 System Operator and Trading Participants	3
3.3 Network Service Providers	3
SECTION 4 MARKET NETWORK MODEL DEVELOPMENT	3
4.1 Definition	3
4.2 Responsibilities in Market Network Development	4
4.3 Criteria for the Market Network Model Development	4
4.4 MNM Components and Modeling	5
4.5 MNM Development Timetable	6
4.6 Market Impact Study	10
SECTION 5 ALTERATIONS TO THE MARKET NETWORK MODEL	11
5.1 Real-time MNM reconfiguration	11
5.2 Network Development	11
5.3 Simplifications on the Market Network Model	12
MARKET NETWORK MODEL MAINTENANCE AND PUBLICATION	12
5.4 Market Network Model Maintenance	12
5.5 Manner of Publication	13
5.6 information disclosure	13
5.7 Auditing of MNM	13
5.8 Regulatory Compliance	13
5.9 Dispute Resolution	14

5.10 Continuing Obligations and Responsibilities	14
SECTION 6 MARKET TRADING NODE	14
6.1 Background	14
6.2 Definition	14
6.3 Classification of Market Trading <i>Nodes</i>	15
6.4 Criteria for the Definition of MTN	15
6.5 Generator MTN	16
6.6 Customer MTN	16
6.7 Battery Energy Storage System MTN	16
6.8 Pumped-Storage Unit MTN	17
6.9 Procedure for MTN Identification	17
SECTION 7 AMENDMENTS, PUBLICATION, AND EFFECTIVITY	18
7.1 Amendments to this Manual	18
7.2 Publication and Effectivity	18
SECTION 8 APPENDICES	19

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 <http://www.wesm.ph>

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*.
- 1.4.2 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.

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.

3.3 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.

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 trading 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 Generator plant/unit representations

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 Load representations

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 *Battery Energy Storage System* representation

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 *Pumped-Storage Unit* representation

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 equipments 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.

4.5 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 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 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 initiate the approval process for the MNM uploading 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 table below describes the timeline of activities involved in updating the MNM. The variable “D” stands for the target date of uploading of the new MNM. This date is set by the *Market Operator* upon its assessment, and is based on energization date or commissioning date of a new or upgraded equipment.

Table 1. MNM Development Timetable

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
1	Before D – 8	Changes in the Distribution Network	-- For <i>Network Service Providers</i> whose equipment should be included, or are already included in the MNM	<i>Network Service Providers</i>
2	Before D – 9	Approval of Registration of	-- Required for changes involving new <i>Market Trading Nodes</i> ²	Trading Participant and

² For MNM updates that involve new *Market Trading Nodes* (new generator or load representation points from the grid)

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
		<i>WESM Trading Participant</i>	New WESM Trading Participants that will initiate new <i>Market Trading Nodes</i> (MTNs) need to have their registration approved at least nine (9) days prior to their energization	<i>Market Operator</i>
3	D – 8	Registration of <i>Market Trading Node</i> in the Market Management System (MMS)	-- Required for changes involving new <i>Market Trading Nodes</i> Upon approval of registration of new <i>Trading Participants</i> that initiated a new MTN, the <i>Market Operator</i> shall then register the MTN in the MMS at least eight (8) days prior to their energization	<i>Market Operator</i>
4	D – 7	Changes Initiated by either the <i>System Operator</i> or the <i>Market Operator</i>	Consistent with <i>WESM Rules 3.2.1.4</i> , “Where appropriate, the <i>Market Operator</i> or the <i>System Operator</i> may recommend alterations to the market network model, so as to maintain: (a) The relationship between the <i>market network model</i> and the <i>transmission network</i> ; and (b) Consistency with market requirements”. Should the changes come from the <i>System Operator</i> , it should include the network diagram, real-time monitoring points and the relevant network parameters affected by the change.	<i>System Operator or Market Operator</i>
5	D – 7	Initiate Approval Process for MNM Uploading	The <i>Market Operator</i> shall initiate the internal approval process on the MNM uploading for network changes that has a material effect to the system operations and market operations as appropriately assessed by the <i>Market Operator</i> .	<i>Market Operator</i>
6	Before D – 2	Updating of MNM	The <i>Market Operator</i> shall effect changes to the MNM through the updating of relevant data files recognized by the MMS.	<i>Market Operator</i>

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
7	Before D – 2	Confirm schedule of energization	The <i>System Operator</i> shall inform the <i>Market Operator</i> of the final schedule of energization.	<i>System Operator</i>
8	Before D – 1	Testing of Updated MNM	<p>The <i>Market Operator</i> shall perform functional and technical tests on the updated network model to ensure its consistency with the updated <i>power system</i>.</p> <p>Note: It shall involve the testing system of the <i>Market Operator</i></p>	<i>Market Operator</i>
9	Before D – 1	Provision of Relevant MNM Information to <i>System Operator</i>	The <i>Market Operator</i> shall provide the <i>System Operator</i> with relevant MNM information to ensure reliable operation between the two entities	<i>Market Operator</i>
10	Before D – 1	Notice to the DOE, ERC and Trading Participants	The <i>Market Operator</i> shall inform the <i>Department of Energy (DOE)</i> , <i>Energy Regulatory Commission (ERC)</i> , and <i>Trading Participants</i> of the planned date of uploading the updated MNM in the production system of the MMS	<i>Market Operator</i>
11	D	Uploading of the updated MNM in the production system	The <i>Market Operator</i> shall upload the updated MNM in the production system	<i>Market Operator</i>
12	D	Notice of uploading status of MNM in the production system	<p>The <i>Market Operator</i> shall immediately inform the DOE, the ERC, and the <i>Trading Participants</i> of the status (successful or failed) of the MNM uploading in the production system.</p> <p>Should the uploading fail, the <i>Market Operator</i> shall immediately revert back to the most recent issue of the MNM. The <i>Market Operator</i> shall then provide a notice containing the reason for such a failure</p>	<i>Market Operator</i>

ITEM	DAY	ACTIVITY	DESCRIPTION	RESPONSIBLE PARTY
13	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	Market Operator
14	D + 7 onwards	PEM Board ratification	After successful uploading and the completion of MNM consistency monitoring, PEMC shall seek ratification of the PEM Board for the MNM.	Market Operator

4.5.6 All MNM revisions uploaded to the production system should be ratified by the *PEM Board*. Ratification of the said network model shall be done upon completion of the seven-day consistency monitoring.

4.5.7 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 uploading (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 uploading.
- d) Should the target uploading of a new MNM issue be cancelled, and then other changes 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.

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 publish the results of the market impact study as may be required by the *PEM Board*.

SECTION 5 ALTERATIONS TO 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 REAL-TIME MNM RECONFIGURATION

- 5.1.1 Real time reconfiguration refers to any changes in the MNM reconfiguration of any part of the transmission system that may affect the dispatch within any trading interval. These revisions shall be made automatically to the MNM based on the inputs and data provided by the *System Operator* through the EMS. This shall include, but may not be limited to, the following:
- a) Change in Transmission and Sub-transmission Network topology;
 - b) Line, Generator and Customer Load outage; and
 - c) Reconfiguration as initiated by the *System Operator* or the *Network Service Providers* to maintain system security and reliability.

5.2 NETWORK DEVELOPMENT

- 5.2.1 Network development is any reconfiguration of any part of the transmission or sub-transmission system. The Market Operator should be notified as the network development may affect the dispatch and are permanent in nature. 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 Changes in the MNM configuration as a result of network development or aggregation or disaggregation of Trading Nodes shall be published in accordance with MNM publication requirements set forth in Section 6.0 of this document.

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 Generation and Customer Trading Nodes upon request of a *Trading Participant* and approved by the *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;
 - b) Aggregated representation in the MNM may be applied to multiple generating units that are located in a single generating station;
 - c) Disaggregated representation of customer trading nodes; and
 - d) Single Customer Trading Nodes representing an aggregate of multiple customers maybe disaggregated into several Customer Trading Nodes corresponding to the customers represented in that Trading Node. It is provided, however, that such disaggregation shall be allowed only in cases where there are appropriate real-time monitoring points that can account for the real-time withdrawal of *energy* in each disaggregated individual customer trading node.
- 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.

MARKET NETWORK MODEL MAINTENANCE AND PUBLICATION

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 revisions:
- a) Bus Oriented Single Line Diagram; and
 - b) Breaker Oriented Single Line Diagram
 - c) Network 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:
- Updated Single Line Diagram; and
 - 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 MANNER OF PUBLICATION

- 5.5.1 Any changes or revision initiated by the *Market Operator* or *System Operator* shall trigger the publication of the revised and approved MNM.
- 5.5.2 The *Market Operator* shall regularly publish the relevant updated MNM documents within seven days after the completion of the MNM consistency monitoring in the MMS' production system. Every revision of the MNM shall have the following associated documents published in the Market Information Website:
- MNM Revisions Manual;
 - Bus-Oriented Single Line Diagram; and
 - Information brief
- 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.

SECTION 6 MARKET TRADING NODE

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.

6.2 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:
- a) 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;
 - b) 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
 - c) As much as possible, represent the *connection point* between the *Network Service Provider* and the *Trading Participant*

6.3 CLASSIFICATION OF MARKET TRADING *NODES*

6.3.1 MTN's can be classified as:

- a) *Generator nodes* – nodes that represent a registered generating unit or generating system directly connected to a network operated by the *System Operator*. It is a *node* where power is injected into the *transmission network*.
- b) *Customer nodes* – nodes that represent where power is withdrawn by *Trading Participants* from the grid.
- c) *Battery Energy Storage System nodes* – nodes that represent a registered *battery energy storage system* directly connected to a network operated by the *System Operator*. It is a *node* where power is injected or withdrawn through the *transmission network*.
- d) *Pumped-Storage Unit nodes* – nodes that represent a registered *pumped-storage unit* directly connected to a network operated by the *System Operator*. It is a *node* where power is injected or withdrawn through the *transmission network*.

6.3.2 Where available remote telemetering facilities are situated at a location net of the station service, the *Trading Participant* shall have a generator and a customer MTN registered in the WESM to accurately reflect the direction of power flow.

6.4 CRITERIA FOR THE DEFINITION OF MTN

The following are the general criteria for the definition of MTN:

- 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*.

6.4.5 If the *Trading Participant* is a dispatchable generator connected to a distribution system (embedded facility), then its MTN and *scheduling point* shall be assigned to the nearest *scheduling point* represented in the MNM. Adjustments to the real-time monitoring of the Customer *scheduling point* shall be made accordingly to reflect the total power consumed by that Customer *scheduling point* accounting for the power generated by the dispatchable generator situated downstream.

6.4.6 A generating facility shall be modelled as a scheduling point.

6.5 GENERATOR MTN

6.5.1 A MTN is considered a generator *node* if *energy* is supplied into that *node* and the direction of the power flow is from the apparatus or equipment (i.e. generator) operated by the Trading Participant to the network operated by the *Network Service Providers*, including the *System Operator*.

6.5.2 During the submission of offers to supply electricity, the participant generator shall specify the location of the connection point and the relevant market network *node*.

6.5.3 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*.

6.6 CUSTOMER MTN

6.6.1 A *customer node* is the point where *energy* is withdrawn by the *WESM participant* and the direction of the power flow is from the network operated by the *Network Service Providers*, including the *System Operator*, to the *energy* consuming apparatus or equipment (i.e. load) owned by or connected to the customer trading participant.

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 MTN

6.7.1 A MTN is considered a *battery energy storage system node* if energy is injected or withdrawn through that node and the direction of the power flow is from the apparatus or equipment operated by the Trading Participant to the network operated by the *Network Service Providers*, including the *System Operator*.

- 6.7.2 During the submission of *offers* to supply or consume electricity, the participant *battery energy storage system* shall specify the location of the connection point and the relevant market network *node*.
- 6.7.3 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.

6.8 PUMPED-STORAGE UNIT MTN

- 6.8.1 A MTN is considered a *pumped-storage unit node* if the facility is a pumped-storage plant where energy can either be injected or withdrawn through that node and the direction of the power flow is from the apparatus or equipment operated by the Trading Participant to the network operated by the *Network Service Providers*, including the *System Operator*.
- 6.8.2 During the submission of *offers* during generation mode, the participant *pumped-storage unit* shall specify the location of the connection point and the relevant market network *node*.
- 6.8.3 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.

6.9 PROCEDURE FOR MTN IDENTIFICATION

- 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 MTN based on the criteria set out in Section 6.4 - Criteria For Definition of MTN of this document.

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 Network³
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 ⁴	As Available
7. Transformer reactance, X	Mandatory
8. Transformer Thermal limit under Normal Operation, MVA	Mandatory

³ All are “Mandatory” requirements that shall be determined between the *Market Operator* and the *System Operator*

⁴ Shall be “Mandatory” for network or non-radial transformers

B. Impedances, Thermal Limits, Loss Functions	Provision
9. Switched Shunt Capacitor, MVAR	Mandatory
10. Switched Shunt Reactor, MVAR	Mandatory
11. Core Loss, MW	As Available

C. Limits on the voltage of the HVDC Equipment⁵
1. HVDC Bus Voltage
2. HVDC Power Transfer Rating

D. Generator parameters⁶
1. Maximum generator Real Power Output MW
2. Minimum generator Real Power Output, MW
3. Generator Ramp Rates

⁵ All are mandatory requirements

⁶ All are mandatory requirements