Proposed Revision to the WESM Manual on Market Network Model Development and Maintenance - Criteria and Procedures

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This Report is prepared by the
WESM Technical Committee

Executive Summary

The WESM Rules and Market Manuals are only as effective as their readers' understanding and interpretation of them. It is therefore critical that such documents are reader-friendly to encourage readership, compliance, and accountability, among others. Although revisions to these documents are always published for public reference, the TC observed that consistency checks are not performed regularly or thoroughly enough to detect gaps, or deviations from concepts or purpose.

For good governance, the Technical Committee (TC) believes that the following considerations should always be an inherent part of the deliberation process when writing or revising market rules and procedures.

- Promote clarity and deeper understanding,
- Recognize long-term objective of the market,
- Maintain wider and more balanced operational perspective, and
- Encourage compliance and improve accountability.

In relation to this, the TC undertook a review of the WESM Manual on Market Network Model Development and Maintenance - Criteria and Procedures Issue 5.1 to demonstrate, by example, how WESM documents can be improved to make them easier to read, more informative and useful for WESM governance and operations.

The revisions proposed by the TC on the MNM manual can be summarized into the following three major groups:

1) Rearrange Contents

    - Logical order and structure
    - Clarity and consistency of contents
    - Explain relevance of MNM in the WESM

2) Differentiate MNM Development from Maintenance

    - Define MNM development process
    - Define MNM maintenance process
        - Updates – grid, connection points, metering, EMS, MMS
        - Alterations – corrections, approximations, enhancements

3) Improve Terminology

    - Revise defined terms
    - Definitions for Undefined terms
    - Introduce new terms as necessary

The TC aims that this report will serve as a guide for other WESM Governance Committees (WGC), the Philippine Electricity Market Board (PEMB), and market participants towards improving the operation and governance of the WESM.

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1.0 INTRODUCTION

1.1 Background

Among the manuals published in the WESM, (it can be argued that) the “Market Network Model Development and Maintenance – Criteria and Procedures” is one of the least understood documents. One reason is that the fundamental concept requires some knowledge of electrical engineering (e.g., power system modelling and load flow analysis) which may require more effort not only for non-technical readers but even for readers with a technical background.

In making this observation, the TC applied the following principles of good technical writing:

- Clarity – easy to understand; minimize unnecessary word or effort for readers
- Organization – structured grouping and order of information
- Precision – exact use of terminology; consistent line of reasoning
- Economy – direct statement; avoid unnecessary words

The TC believes that this is a good foundation for writing and revising any WESM document, not only for the MNM manual but even for the less technical rules and procedures.

As suggested by the Office of the Chief Governance Officer (OCGO), the TC undertook a review of the MNM manual and drafted a new version of this document by applying the technical writing principles described above.

1.2 Objective

To draft a new version of the MNM manual that will demonstrate, by example, how WESM documents can be improved to make them easier to read, more informative and useful for WESM governance and operations.

1.3 Rationale

Amendments to market rules and procedures have been primarily justified by the following rationale:

- Address urgent market issues and problems
- Improvements in market systems and processes
- Address expanding scope of market services

However, it is seldom that a revision would be initiated for the following considerations:

- Promote clarity and deeper understanding
- Recognize long-term objective of the market
- Maintain wider and more balanced operational perspective

- Encourage compliance and improve accountability

Understandably, the majority of amendments to rules and procedures are focused on addressing the relevant issues and these latter considerations are just secondary if they are considered at all. For good governance, the TC believes that these considerations should always be part of the deliberation process when writing and revising market rules and procedures.

The TC attempted to take a wholistic approach by rewriting (revising) the MNM manual and in the process, demonstrate by way of example, how manuals for other rules and procedure can be improved.

1.4 Scope of Work

The revision work of the TC was divided into two major activities, the review of relevant documents and the revision of the existing MNM Manual, as presented in this report.

The first part involves a review of the Philippine Grid Code, the WESM Rules, and the MNM Manual Issue 5.1 to gain a clearer understanding of the MNM as it relates to physical dispatch and market price determination. Other references listed at the end of this report were also used in the review process.

The second part presents the proposed revisions of the MNM document based on the overall understanding of the reviewed documents by the TC. The proposed revisions were organized as to arrangement of contents, terminology, conventions, and processes.

2.0 DOCUMENTS REVIEW

In reviewing the Philippine Grid Code, the WESM Rules, and the MNM Manual Issue 5.1, the TC focused on answering the following questions based on the relevant provisions of these documents. Additional explanations were provided for further clarifications.

2.1 What is a Market Network Model?

The Market Network Model (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 (MNM) 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.

2.2 What is the relevance of MNM in the WESM?

To appreciate its relevance in the WESM, the Market Dispatch Optimization Model (MDOM) must be understood.

The Market Dispatch Optimization Model (MDOM) contains the mathematical algorithm used for determining dispatch schedules, nodal energy prices, regional reserve allocation, and reserve prices for each dispatch interval based on the Price Determination Methodology (PDM) approved by the Energy Regulatory Commission (ERC).

To facilitate the trading in the WESM, the MO produces real-time and projected security-constrained dispatch schedules and nodal prices according to the WESM Timetable using the MDOM.

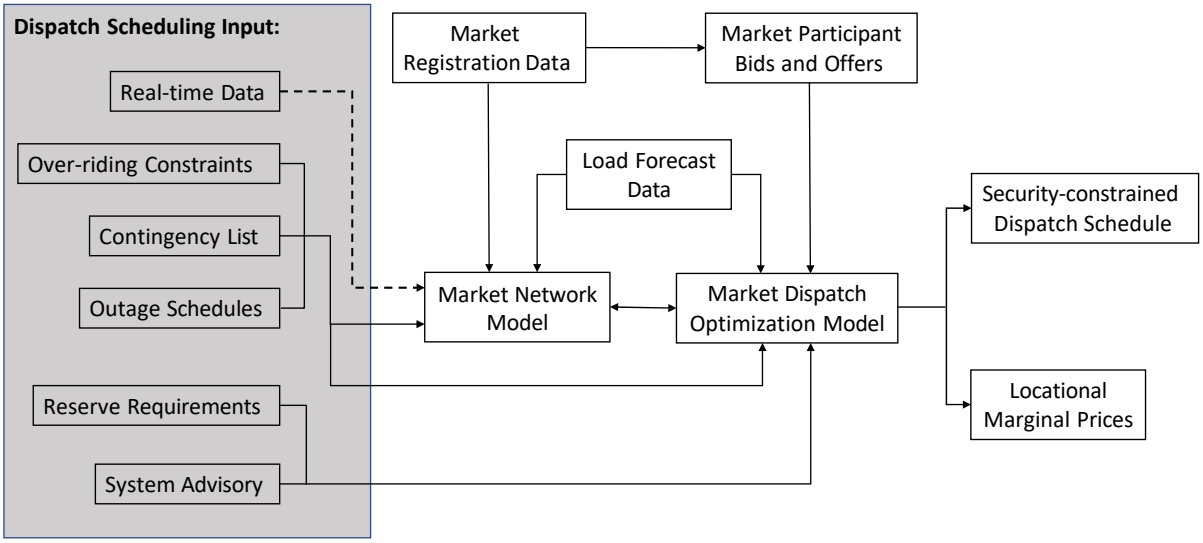
In formulating the MDOM, the Market Operator and System Operator shall ensure that the dispatch for each dispatch interval is subject to certain network conditions such as:

- Network constraints implied by the MNM, and system security constraints provided by the SO
- Loss and impedance characteristics of market network lines and power transformers
- Constraints on HVDC link operations
- Power flow (Load flow) equations

The MNM provides all these necessary inputs to the MDOM for both real-time and projection to ensure that the dispatch implementation is feasible and market pricing takes into account all network constraints and other security limits on the Grid.

The diagram below provides a simplified process flow of how dispatch schedules and market prices are simultaneously determined in real-time and during market projections. The shaded portion are inputs provided by the SO which are based on actual physical conditions of the Grid including network contingency and reserve requirements.

Figure 1. Simplified Process Flow for WESM Dispatch and Pricing



It should be understood that modelling of the grid is just an initial step in determining dispatch and pricing in the WESM. The MNM interprets the network constraints to the MDOM to calculate the security-constrained economic dispatch optimization problem. The Price Determination Methodology (PDM) is the algorithm applied to the MDOM to simultaneously determine the dispatch and pricing for each dispatch interval.

2.3 What is a Market Trading Node?

A Market Trading Node (MTN) is a designated point in the MNM where energy is bought or sold based on the prices determined by the MDOM.

Each registered Trading Participant is assigned at least one MTN in the MNM which serves as the point of reference for dispatch scheduling, pricing, revenue metering, and financial settlement.

The variations of market clearing prices and quantities on the MTN are influenced not only by demand and supply but also by actual transmission network conditions. These conditions are reflected in the MNM which feeds the information to the MDOM for dispatch scheduling and pricing.

2.4 How is the MNM developed?

The Market Operator shall be responsible for the development, validation, maintenance, publication, and revision of this document (MNM Manual) in coordination with Trading Participants and the System Operator.

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

- 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.
- Network data that accurately reflects the conditions prevailing on the network, including losses, constraints, and contingencies, at any trading interval.
- Necessary simplifications based on the current best international industry practice.
- Pursuant to it (MNM) 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”.
- 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).

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.

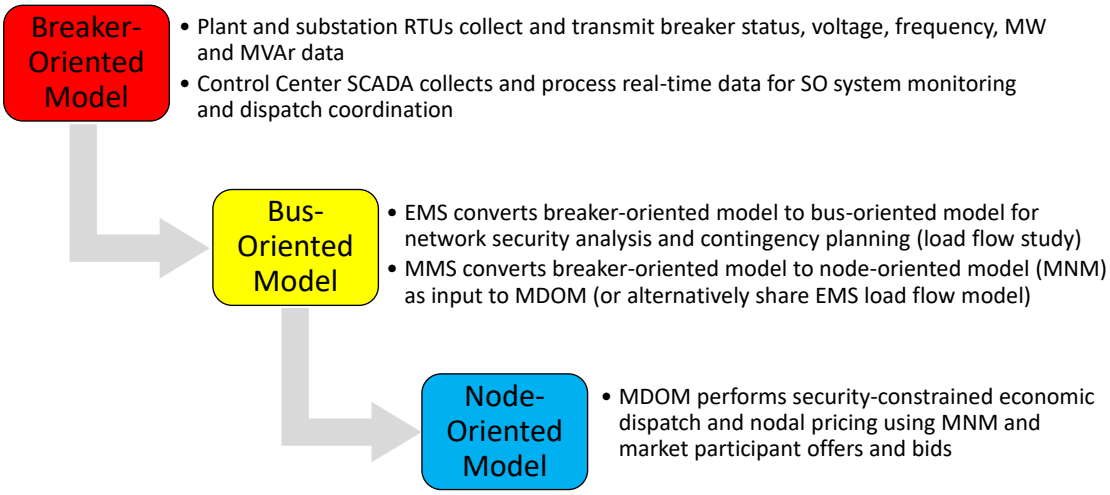
The MNM may contain simplifications related to the representation of Generation and Customer Trading Nodes upon request of a Trading Participant and approved by the Market Operator, System Operator, and if necessary, the Network Service Provider.

Mathematical modelling of power systems is a globally accepted practice in the electric power industry since the advent of computers. Among the power system applications used

commercially today are short-circuit, load flow, and stability (Dynamics) simulation programs. The MDOM is an enhanced load flow program used primarily for real-time auctioned-based security-constrained economic dispatch and pricing.

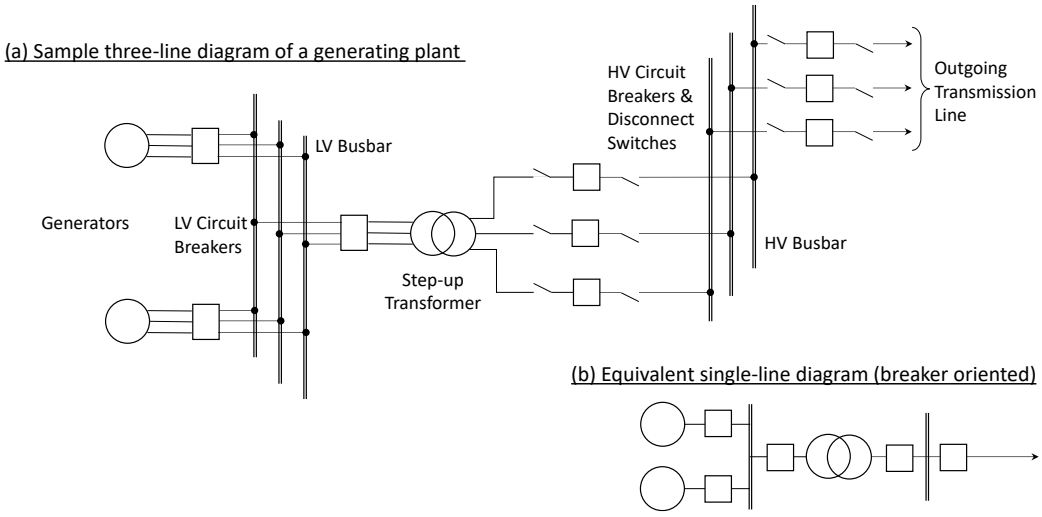
The real-time nature of the MDOM requires adequacy, accuracy, and timeliness in the update of inputs, particularly in the MNM. To appreciate this complex task, consider the different levels of steady-state network modelling to arrive at the MNM as explained in Figure 2.

Figure 2. Levels of Steady-state Network Models



The closest representation of the physical system is the breaker-oriented model which is used by SO for EMS/SCADA applications. Note that even this level of modelling has some simplifications depending on the application software. Figure 3 illustrates an example of how a (a) three-phase model of a power plant is simplified to a (b) single-phase model. Often, real-time applications require simplifications to provide clear and timely information to SO or MO for prompt operational decisions or actions.

Figure 3. Three-phase and Single-phase Breaker-oriented Models



The second level of modelling used for load flow simulations assumes a balanced three-phase system such that all three phases are represented by one phase (single-line) and per unit quantities are used for calculation. Both MO and SO employ load flow simulation in the MMS and EMS respectively. They may or may not share identical network data depending on their own software applications.

The third level of modelling, which is the MNM, is derived from a load flow network model which allows auctions (bids and offers) from Market Resources (generators, load, and energy storage systems) through the MTN. The nodes in the MNM are equivalent to the buses in the load flow network model in terms of topology and electrical characteristics. The PDM algorithm in the MDOM uses the load flow results as an initial estimate for dispatch and pricing calculation. However, MTN is unique to the MNM in that it provides the reference points for dispatch, pricing, revenue metering, and settlement.

The application of network modelling in real-time requires many simplifications both in the EMS/SCADA of SO and the MMS/MDOM of MO. Such simplifications are often justified in achieving the mission-critical objectives of MO and SO. However, the implications of these simplifications may sometimes be difficult to quantify.

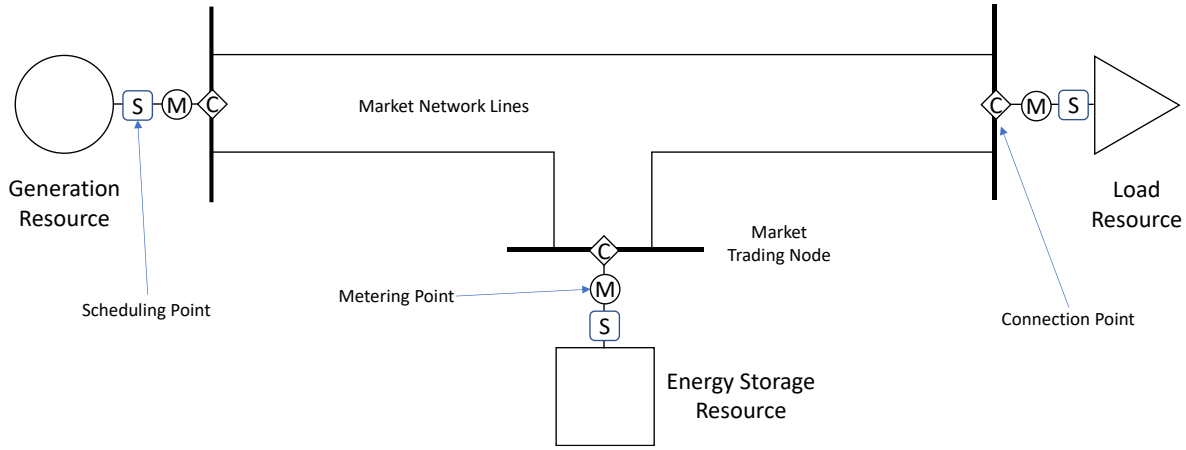
2.5 What are the components of the MNM?

A comparison of the WESM Rules and MNM Manuals indicate some differences on the defined components of the MNM. Below is a combined list of MNM components:

- Market Trading Nodes (WESM Rules and MNM Manual)
- Customer Pricing Zones (WESM Rules only)
- Generator plant/unit representation (MNM Manual)
- Load representation (MNM Manual)
- Battery Energy Storage System representation (MNM Manual)
- Pump-Storage unit representation (MNM Manual)
- Transmission and Sub-transmission lines (MNM Manual)
- Transshipment nodes (MNM Manual)
- Power Transformer (MNM Manual)
- Shunt and Series Devices (MNM Manual)
- Power Circuit Breaker and Disconnect Switches (MNM Manual)
- Scheduling Points (WESM Rules and MNM Manual)
- Real-Time Data (MNM Manual – actual)

The very basic components of the MNM are the (a) Market Trading Nodes, (b) Market Network Lines, and (c) Market Resources. Figure 4 shows a simple MNM diagram showing these basic components.

Figure 4. Illustrative Example of an MNM



The other network components such as Transshipment Nodes, Power Transformers, Power Circuit Breakers/Disconnect Switches, and Shunt/Series Devices are used to provide a more accurate translation from the breaker-oriented and bus-oriented network models.

There are also other components listed which are used for data exchange (input/output) and referencing. Real-time data is just one of the data inputs provided by the SO EMS/SCADA to the MMS (MNM/MDOM) of MO. Figure 1 shows that there are more inputs that SO provides to the MNM/MDOM through the MO-SO interface (or the dispatch protocol).

Data referencing is essential in the WESM dispatch, pricing, and settlement processes. These processes are influenced by the MNM, directly or indirectly. These reference points refer to the Scheduling Point, Metering Point and Connection Point. However, Scheduling Point is the only one listed as MNM component since Metering Points and Connection Points are physical (not mathematical). Notwithstanding, the last two are very relevant to the Trading Participants when it comes to settlements and network losses.

2.6 Why are there variations in MNM terminologies?

The Grid Code, WESM Rules, and other market procedures are always subjected to revision as the market and the industry evolves over time. However, the issue is not the revisions themselves but in maintaining the consistency of concepts and purpose for which the relevant document provisions were written.

DOE through PEMC are the keepers of the WESM Rules and Procedures while the Grid Code is managed by ERC. It can even be observed that WESM Rules, MNM Manual, and MNM Reports issued by IEMOP have some variations among them. Although revisions to these documents are always published for public reference, the TC observed that consistency checks are not performed regularly or thoroughly enough to detect gaps of deviations from concepts or purpose.

The TC does not intend to address this issue since regular review of different document revisions is a full-time undertaking. This report intends to offer a clearer and deeper understanding of the concepts and purpose of the MNM Manual (and relevant documents) to

help the Service Providers and Trading Participants make better plans and decisions as they navigate through the changes.

The document review presented was prepared by the TC to provide a better understanding and appreciation of the MNM using Q&A approach with simple graphical illustration and explanations while avoiding rigorous mathematical formulation or rigid legal/regulatory interpretations. Given a clearer understanding of the MNM, the next section will present the major revisions on the MNM Manual as proposed by TC.

3.0 DOCUMENT REVISION

The proposed revisions of TC to the MNM Manual involve reorganizing of contents, harmonizing definitions, and some contextual modifications. Additional information is added to clarify these changes while some are self-explanatory. The TC is aware that rewriting the whole document has never been attempted before. In this respect, the TC will seek guidance from PEMC management as to how this could comply with the current rules change process of the RCC.

3.1 Organization of Contents

The first major step in the proposed revision is rearranging the contents and provisions of the MNM Manual. Table 1 shows a comparison of the table of contents of the current document (ver. 5.1) to the proposed rearrangement.

Table 1. Structure of Market Network Model Manual Revision

Market Network Model Development and Maintenance – Criteria and Procedures (5.1)	Market Network Model Development and Maintenance Procedures (Proposed revision)
1. Introduction 1.1 Background 1.2 Purpose 1.3 Scope 1.4 Approval of Market Network Model	**1. Introduction** 1.1 Background 1.2 Purpose 1.3 Scope
2. Definition, References, and Interpretations 2.1 Definitions 2.2 Interpretations	**2. Interpretations** 2.1 Definitions 2.2 Interpretations 2.3 Conventions
3. Responsibilities 3.1 Market Operator 3.2 System Operator and Trading Participants 3.3 Network Service Providers	**3. Responsibilities** 3.1 Market Operator 3.2 System Operator 3.3 Transmission Service Provider 3.4 Metering Service Provider 3.5 Ancillary Service Provider 3.6 Generating Company 3.7 Energy Storage Companies 3.8 Distribution Utilities 3.9 Load Customers
4. Market Network Model Development 4.1 Definition	**4. Market Network Model Development** 4.1 Principles for Development

Market Network Model Development and Maintenance – Criteria and Procedures (5.1)	Market Network Model Development and Maintenance Procedures (Proposed revision)
4.2 Responsibilities in Market Network Model Development 4.3 Criteria for Market Network Model Development 4.4 MNM Components and Modelling 4.5 MNM Development Timetable 4.6 Market Impact Study	4.2 Modelling Components 4.3 Registered Data Inputs 4.4 Operational Data Inputs 4.5 Modelling Procedures
5. Alterations to the Market Network Model 5.1 Dynamism of the MNM Using Real-time Data 5.2 Developments and Updates to the MNM 5.3 Simplifications on the Market Network Model 5.4 Market Network Model Maintenance 5.5 Reporting of MNM Updates 5.6 Information Disclosure 5.7 Auditing of MNM 5.8 Regulatory Compliance 5.9 Dispute Resolution 5.10 Continuing Obligations and Responsibilities	**5. Market Network Model Maintenance** 5.1 Update of Existing MNM 5.1.1 Power System/Grid 5.1.2 Energy Management System 5.1.3 Market Management System 5.1.4 Metering System 5.1.5 Participant Connection 5.2 Alteration of Existing MNM 5.2.1 Correction 5.2.2 Network Approximation 5.2.3 Enhancements 5.3 Market Impact Assessment 5.4 Participant Agreement
6. Market Trading Node 6.1 Background 6.2 Definition 6.3 Classification of Market Trading Nodes 6.4 Criteria for Definition of MTN 6.5 Generator MTN 6.6 Customer MTN 6.7 Battery Energy Storage MTN 6.8 Pumped-Storage Unit MTN 6.9 Procedures for MTN Identification	**6. Approval and Documentation** 6.1 MNM Development 6.1.1 Public Consultation 6.1.2 Independent Audit 6.1.3 PEMB Approval 6.2 MNM Maintenance 6.2.1 Change Request 6.2.2 Participant Agreement 6.2.3 PEMC Approval 6.2.4 Change Record 6.3 Documentation and Archiving 6.4 Dispute Resolution
7. Amendments, Publication, and Effectivity 7.1 Amendments to this Manual 7.2 Publication and Effectivity	**7. Publications** 7.1 Latest version of MNM 7.2 Changes to MNM 7.3 Amendments to this Manual 7.4 Date of Posting and Effectivity
Appendices A. List of Required Transmission Network Parameters	**Appendices** A. Transmission Network Data B. Connection Point Details C. Generating Unit Data D. Distribution Utilities Network E. Customer Load Data F. Real-time Data
	References A. Wholesale Electricity Market Rules B. Price Determination Methodology

Market Network Model Development and Maintenance – Criteria and Procedures (5.1)	Market Network Model Development and Maintenance Procedures (Proposed revision)
	C. Philippine Grid Code D. Philippine Distribution Code E. Market Network Model Development and Maintenance – Criteria and Procedures F. Registration, Suspension and De-Registration Criteria and Procedures G. Metering Standards and Procedures H. Procedures for Changes to the WESM Rules, Retail Rules and Market Manuals

Referring to Table 1, the following comments provides some of the justifications for rearranging the provisions in the manual:

- Title – the title can be modified as: “Market Network Model Development and Maintenance”

- Chapter 1 – the approval of the MNM is an important provision and should be specific for (a) initial model development, (b) update, and (c) alterations. The three aspects of MNM development and maintenance will be explained later.

- Chapter 2 – the title can simply be “Interpretation”. A provision on “Conventions” (e.g., identification, referencing, variables, symbols, and diagram etc.) should be added to assist in the understanding of the MNM.

- Chapter 3 – responsibilities should be more clearly defined between trading participants and service providers, including MSPs. Responsibilities of Generating Companies and DUs should also be defined separately.

- Chapter 4 – this chapter should be focused on the initial construction of the MNM prior to market launch in specific Regions (i.e., development). The definition of terms should be located in one glossary for quick reference. The responsibilities in MNM development should already be defined in the previous chapter. Development timetable may be difficult to determine for the initial development. Market Impact Study is not necessary during initial development.

- Chapter 5 – alterations in the MNM after development (Chapter 4), should be categorized into two: (a) model update which is triggered by physical changes in the grid and (b) model alterations which are corrections or simplifications not involving physical changes in the grid. This should form MNM maintenance.

- Chapter 6 – this chapter dedicated to MTN should already be covered by Chapter 4 (MNM Development) under MNM Components. A more detailed explanation or illustration of the MTN can be appended at the end of the document.

- Chapter 7 – this may be extraneous because any amendments of documents in the WESM is always subject to the rules. For transparency, it is more important to publish any approved amendment as listed in the second column.

- Appendices – should be enhanced to contain more detailed explanation and illustration to unclutter the main document.

- References – should be added to avoid extraneous and repetitive provisions.

The second column in Table 1 shows the rearranged document contents as it compares to the current version of the MNM Manual. It can be noted that a distinction was made between MNM development and maintenance. This is explained further in the following section.

3.2 Differentiating MNM Development from Maintenance

One of the major shifts in the proposed revision is creating a clear delineation between development and maintenance. The intent of this change in concept is to provide clarity in the procedures and in the process improve transparency and accountability given the importance of MNM in the market dispatch, pricing, and settlement processes. The delineation implies that the procedures between development and maintenance will also be different as discussed in the succeeding sections of this report.

While reviewing the MNM Manual, it was observed that the word “development” has been used in different contexts throughout the document, but no term or phrase has been defined containing this word. Table 2 cites a few selected provisions to demonstrate this point:

Table 2. Contextual Uses of the word “development” in MNM Manual

Provisions	Contexts
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.
1.4 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.

Provisions	Contexts
	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).
4.5 MNM DEVELOPMENT TIMETABLE (From: SEC 4. MARKET NETWORK MODEL DEVELOPMENT)	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
5.2 DEVELOPMENT OF UPDATES TO THE MNM (From: SEC 5. ALTERATIONS TO THE MARKET NETWORK MODEL)	5.2.1. The Market Operator shall develop updates to 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

The following observations can be noted in the provisions cited above:

- The methodology for development, alterations, and maintenance are the same based on the purpose of this manual. The use of these words has no clear distinction among them.

- Development, revision (alteration), and maintenance of the MNM is a joint responsibility of the Market Operator, the System Operator, the Network Service Providers, and the Trading Participants. It is not the sole responsibility of the MO.

- Integration of regional grids into the MNM (part of development) prior to WESM launch in that Region requires power industry consultation and PEMB approval. Appropriately, this is the “development” process.

- MNM Development is triggered by changes in the power system from the System Operator. This should be referred to as an MNM update but it should not solely come from SO. Any concerned trading participant or service provider should be able to initiate such an update.

- The Market Operator shall develop updates to the MNM in view of changes to Transmission and Sub-transmission Systems. This is similar to the previous observation.

Based on the above observations, the TC recommends the following changes to the concept and conventions of the MNM Manual:

1) MNM Development shall be defined as the initial buildup of the MNM for a regional grid prior to launching of the WESM in that Region. The new MNM shall be subject to electric power industry consultation and approval by the PEMB. Any network approximation within this process shall not be considered a MNM Alteration.

2) MNM Maintenance shall be defined as the modifications in the existing MNM due to physical changes in the grid or alterations in modelling details due to required approximations and corrections. Changes in MNM due to maintenance shall be subject to the agreement with affected trading participants and service providers and final approval of the PEMC (not PEMB). MNM Maintenance is not part of MNM Development.

    a. MNM Update shall be triggered by the following:

        i. Addition of generators, energy storage, lines, transformers, and other facilities
        ii. Reconfiguration of existing substations or switchyards
        iii. Decommissioning of generators, energy storage, lines, transformers, and other facilities

    b. MNM Alterations shall be triggered by the following:

        i. Modification of station and equipment identifications due to change in ownership
        ii. Changes in connection points, metering points or telemetering points designations
        iii. Corrections in the electrical parameter of generators, energy storage, lines, transformers, and other facilities
        iv. Other corrections requested by trading participants or service providers from their registered data
        v. Approximations based on agreements with affected trading participants and service providers to address operational issues

All approved MNM developments, updates, and alterations shall be published and audited based on WESM Rules.

3.3 Development of MNM

In the proposed revision, the TC considers the MNM development as the initial step in model building (at ground level) prior to the launch of the market. For this purpose, Section 4 Market Network Model Development of the manual can be re-written as follows:

1) Definitions (4.1) and Responsibilities (4.2) were transferred to Sections 2 and 3, respectively. This is to provide a single location for definitions and responsibilities to facilitate referencing when reading.

2) Section 4.3 Criteria for Market Network Model Development is more like a guiding principle or guidelines for MNM developments. It can be rewritten in a more organized and less redundant way as shown below:

   Section X.X Principles for Development

   The MNM is an essential part of the security-constrained economic dispatch and locational pricing process in the WESM. It provides the necessary information on network characteristics and constraints to the MDOM to ensure a feasible dispatch schedule and accurate nodal pricing for each dispatch interval. Its influence on market dispatch and pricing affects all trading participants in their financial settlements.

   Considering the importance of the MNM in WESM, the following principle shall guide the MO and SO in the development process.

   - Network Topology – the connectivity of lines, transformers, and other network equipment with respect to load substations and generating facilities in the grid shall be consistently reflected in the MNM all the time.
   - Network Characteristics – the impedances, thermal ratings, and other electrical parameters of network equipment used for modelling shall have correct values to ensure accuracy in calculation of losses, constraints, and contingencies.
   - Operational Data – real-time data, scheduled outages, and contingency limits shall always be available in a timely and complete manner to continuously update the MNM before each trading interval.
   - Registered Data – the data provided by trading participants relating to their respective resources shall always be complete and correct to ensure their proper representation and designation in the MNM.
   - Trading Nodes – all registered trading participants shall be assigned at least one point of trade (market trading node) in the MNM where their dispatch schedules and nodal prices are determined. This trading node shall represent the physical connection point, metering point, and scheduling point of the participant which serves as basis for financial settlements in the WESM.
   - Network Approximations – in the event the metering or scheduling points are not electrically co-located at the connection point, the designation of trading nodes shall be agreed upon by concerned trading participant with MO and other service providers if network or data approximations are required.

3) Section 4.4 MNM Components and Modelling can be made more concise by transferring some definitions to Section 2 and adding new sections on registered and operational input data. This section can be rewritten as shown below.

   Section X.X Modelling Components

a) Node – MNM representation of switchyards or switchgears which connects network equipment, load substation, and generating plants in the grid.

- Market Trading Node – a node which connects the market resource to the power system model and assigned to trading participants owning the resource for buying or selling energy or reserve based on MDOM dispatch and pricing process.
- Market Network Node – a node which is not connected to any market resource used in MNM represents a topology consistent with breaker-oriented and bus-oriented network models.

b) Resource – MNM representation of equipment, systems, or facilities for energy injection to or withdrawal from a designated MTN.

- Generator – representation of generating units or plants in the MNM for injection of energy to the designated MTN.
- Load – representation of load substation facilities or large direct connected loads in the MNM for the drawing of energy from the designated MTN.
- Energy Storage – representation of equipment, systems or facilities that store energy for injection to or withdrawal from the designated MTN.

c) Branch – MNM representation of network equipment, system or facilities which connects two nodes for transfer of power.

- Line – a branch which transfers power from a sending node to a receiving node at the same voltage level.
- Transformer – a branch which transfers power from a sending node to a receiving node across different voltage levels.

d) Auxiliary Equipment – used in the MNM to reflect other network-related information.

- Circuit Breaker and Disconnect Switch – translates the on-/off-line status of network equipment and market resources in the MNM.
- Shunt and *Series Compensation* – represents the reactive power equipment, system or facilities which influence the AC load flow results.

Note that these are all definitions which are grouped together to provide a clearer picture of the MNM. Other conditions in the MNM Manual may still apply but they are not fully detailed in this report. This can be handled during the actual document revisions.

4) Registered Data Input – these are information submitted by the WESM members or generated in the registration process relevant to MNM Development. Examples of registered data used in MNM development are the following:

- Connection Points
- Remote Terminal Unit (Scheduling Points)
- Metering Points
- Regional, zonal, and other group identifications
- Aggregation (multiple units)
- Pmax and Pmin
- Ramp rates
- Station use

The above information is necessary in the designation and assignment of the MTN to the trading participants.

Compared to operational data, this information is considered permanent unless revised through the same registration process. The post-registration procedure in the registration manual states the following provisions:

"3.3.3. Representation in the Market Network Model

3.3.3.1. Changes in the manner of representation of any generating unit or customer facility in the Market Network Model may be initiated by the Trading Participant transacting such facilities in the WESM.

3.3.3.2. The criteria and procedures for approval/disapproval, and effectivity of any change shall be as set forth in relevant market manuals governing changes to the WESM Market Network Model.

3.3.3.3. In case of disapproval, the requesting Trading Participant may elevate the matter to the PEM Board for resolution or submit the matter as a dispute to the Dispute Resolution Administrator pursuant to Chapter 7 of the WESM Rules and relevant market manuals."

Participant registration data provides relevant inputs to MNM development and should be stated clearly in the MNM Manual.

5) Operational Input data – these are updated information provided by SO to MO on a regular or ad hoc basis to ensure that the security-constrained economic dispatch and pricing reflects the real condition of the grid for the specific dispatch intervals. These operational data can be summarized as follows:

   - Real-time Data
   - Outage Schedules
   - Reserve Requirements
   - Contingency List
   - Over-riding constraints
   - System Advisories

Peak and off-peak demand forecasts are also provided but MO internally prepares nodal load forecasts and projections for each trading interval.

A more detailed explanation is provided in “SECTION 7 - SYSTEM OPERATOR INPUT DATA AND REPORTS” of WESM Dispatch Protocol Manual.

Similar to the registration input data, this information (operational input data) should be clearly stated in the MNM Manual.

6) Modelling Procedure

It should be pointed out that in the proposed revision, MNM Development and MNM Maintenance will have different procedures. Maintenance assumes that there is already an existing MNM that is being modified while development is the initial construction of a model from ground zero. For the same reason, the timetable in the MNM manual cannot apply to both procedures. In the proposed revision the timetable was converted to modelling procedure.

MNM development starts with the collection of information from different sources as follows:

- EMS/SCADA network models and RTU points from SO
- Network facilities data and topology from NSP
- Resource Data from TP registration data
- Connection Points from NSP and TP connection agreement
- Metering Point from MSP and TP metering service agreement

The breaker-oriented and bus-oriented network models from the EMS/SCADA serve as the foundation for network model development. This information is verified for consistency with the network facilities data and topology submitted by the network service providers.

The trading participants (generator, customers, and energy storage) provide technical details of their facilities during the registration process to be used in the market resource modelling in the MNM.

Information on the connection points and metering points are used for the designation of MTN and their corresponding assignments to the trading participants. The RTU monitoring points provided by SO representing the scheduling point is also considered in the MTN designation.

In cases where the metering points or scheduling points of trading participants do not coincide with their connection points to allow straightforward MTN designation, network approximation is implemented by MO. The following are examples of network approximations used for modelling procedures:

- Generating unit aggregation

- Load disaggregation
- Site Specific Loss Adjustment
- Station use/local load approximation

Trading participants are consulted on these approximations if it affects dispatch, pricing, and settlement in their assigned trading nodes. Data estimation during settlement may be necessary in most cases.

After initial completion of the MNM, the model is tested with respect to input interfaces with the EMS/SCADA of SO. Limited testing with trading participant interface can also be performed as necessary.

The new MNM model is deployed in the MMS after successful testing subject to necessary documentations and approvals.

3.4 Maintenance of MNM

The maintenance process differs with development, as explained earlier. Modifications in the MNM after development can be classified into two categories: update and alteration. Section 3.2 of this report already enumerates what necessitates updates and alterations of existing MNM. The following conditions shall apply for MNM Maintenance:

- The MO shall continuously maintain the MNM to reflect the actual conditions of the grid at all times based on the latest information provided by trading participants and service providers.
- Trading Participants and service providers shall submit proposed MNM updates or alterations to the MO if it affects their performance or participation in the WESM.
- The MO may initiate changes in the existing MNM model if the trading participant or service providers fail to propose the necessary changes. However, this will require prior agreement with the concerned party before any change is implemented.
- The trading participant or service provider may require a Market Impact Assessment if the change is being initiated by MO. The study should explain potential risk in dispatch, pricing, and settlement to the party concerned.
- The change in the existing MNM shall be approved/noted by PEMC only after the agreement of concerned parties.
- Changes to the MNM and issuance of new MNM version shall be published by MO after approval by PEMC.
- The MO shall provide a separate timetable and procedures for the update and alteration of existing MNM.

These conditions shall form part of the revised MNM Manual including the timetable and procedures mentioned above.

3.5 Terminologies

The definition of terms and the context by which they are used affects the overall clarity and consistency of the MNM Manual in itself, and in relation to other documents. Appendix 1 of this

report shows a sampling of the terms in the WESM Rules, the Grid Code, and the MNM Manual which are relevant to the subject of MNM, security-constrained dispatch, locational pricing, and reserve. A few terms from the MNM Updates published by IEMOP were also included if they have a different definition or contextual usage. The sampling is by no means exhaustive and is used only for demonstrating how the terminology for the MNM Manual can be improved.

Table 3 summarizes the terms that were defined and undefined based on sampling of different documents. Defined terms in some of the documents may not always have a clear definition and may require some revisions as will be pointed out later. Terms that are not defined but are used would require more thorough review regarding their contextual uses within the documents. Lastly, undefined terms (see Table 5), which were not used may be necessary only if the proposed document revision requires it.

Table *3*. Summary of Sampled Terms from Different Documents

	WESM Rules	MNM Manual	MNM Updates	Grid Code
Defined Terms	29	10	7	13
Used terms; not defined	7	21	0	19
Undefined Terms	12	17	41	16
Total Sampled	48	48	48	48

Focusing on the MNM Manual, it can be observed that a significant portion of the terms which were mentioned in the document were not defined (21/48). This provides a good opportunity for expanding the terminology for this manual. Any changes in the defined term (10/48) would be less significant while the undefined terms (17/48) can be introduced as may be necessary.

Table 4 is a summary of proposed revisions for definition of terms which have been previously defined in the MNM Manual. In addition, some terms were recommended for deletion or replacement as explained in the same table.

Table 4. Proposed Revisions for Defined Terms

Terms	Proposed Revision	Justification
Generator Interconnection Lines	Delete the term	This is extraneous since it is already part of the “Connection Asset”
Load flow	Numerical calculation of the steady-state behavior of a power system based on given information such as load, generation, network characteristics and topology. (Also known as power flow simulation)	The current definition is inaccurate since the calculation may involve steady-state, dynamic or transient behavior of the power system. It would be better to add the word “simulation” since load flow is literally just “the flow of power”.
Market Network Model	A mathematical representation of the Grid, used in the MDOM for security-constrained dispatch	This definition was taken from the WESM Rule with modifications to be more concise:

Terms	Proposed Revision	Justification
	scheduling and nodal energy pricing.	*"A mathematical representation of the ~~power system~~ Grid, ~~which will be~~ used ~~for the purpose of determining~~ in the MDOM for security-constrained dispatch ~~schedules~~ scheduling and nodal energy ~~prices~~ pricing ~~and preparing market projections~~."*
Market Trading Node	A designated point in the MNM where energy is bought or sold based on the prices determined by the MDOM	This was copied from the WESM Rules
Scheduling Point	An electrical (physical) location near the connection point where energy (or power) or reserve of Market Resources in a designated MTN can be dispatched and monitored for compliance in real-time.	Scheduling Point is supposed to be physical since it requires an RTU for telemetering. The logic is the similar with Metering Points which requires revenue metering.
Substation	A facility which uses transformers to change the AC voltage levels to allow connection of networks with different operating voltages.	There is no such thing as "physical representation of nodes in the power system". It does not make any sense.
Sub-transmission Lines	A High Voltage facility operated and maintained by DUs to provide intermediate connection between their distribution franchise area to the Grid, local generating plant (EG) or to other DU franchise areas	For completeness and clarity.
Transmission and Sub-transmission lines	Delete this term.	The definition is extraneous.
Transshipment Node	Replace the term with "Market Network Node" (MNN) or "Network Node" and define this as "A node in the MNM which connects Market Network Lines or (Market Network) Transformers". Further, a secondary description can be added such as "It is also defined as a node where no market resource is connected".	The term is appropriate for transportation modelling and not for electrical engineering. The definition merely implies that it is <u>not</u> an MTN. The term refers to an MNM component and it cannot connect two (physical) equipment. A simple and direct definition is better.

The proposed definitions for undefined terms in Table 5 were sampled based on the subject of MNM and other relevant topics such as security-constrained dispatch, locational pricing, and reserve. Some terms were not recommended for use in the MNM Manual if they do not contribute to the clarity and completeness of the document.

Table 5. Proposed Definitions for Undefined Terms

Undefined Terms	Proposed Definition	Justification
Connection Assets	Assets that are put primarily to connect a User to the Grid for purposes of transmission network services.	Adopted from the PGC with modification: "Assets that are put primarily to connect a User to the Grid ~~and used~~ for purposes of transmission ~~connection~~ network services ~~for the conveyance of electricity.~~ The definition from the WESM Rules requires an opinion from the MO who has no authority on this issue.
Constrained Dispatch Schedule	The term should be replaced by "Dispatch Schedule" and redefine as "The target loading levels of generators, energy storage systems, and loads for specific dispatch intervals after considering grid constraints, generating unit availability, and forecasted information".	The term "Dispatch Schedule" which is already defined in the Philippine Grid Code should be used instead. All dispatch schedules should consider resource and security constraints when used for dispatch implementation. Unconstrained dispatch schedule is not readily implementable. In the absence of WESM, the SO prepares the dispatch schedule; not MO using the MDOM. Energy storage systems should be considered in dispatch scheduling
Customer	An entity engaged in the purchase of electricity for distribution or consumption	This is a simplified definition taken from the WESM Rules and the Grid Code.
Customer Pricing Zone	A group of Customers in the market subjected to a uniform price ~~for~~ in their purchase of electricity.	The WESM Rule definition should be simplified. Customer may purchase electricity for consumption or distribution.
Dispatch Implementation	The issuance of Dispatch Instructions to Market Participants to execute their respective Dispatch Schedules.	New definition.
Dispatch Instruction	Refers to the directions or orders issued by SO to Market Participants.	Definition was revised since the term is not confined to Dispatch Implementation. This may apply

Undefined Terms	Proposed Definition	Justification
		to emergency and restoration procedures.
Dispatch Scheduling and Dispatch Parameters	Do not use in MNM Manual.	This term does is a combination of a process (scheduling) and a set of information (parameters). It does not make sense.
Load Group	Do not use in MNM Manual.	This term is defined in the MNM Update of IEMOP as “used to define the particular group of loads in the MMS”. It does not provide any specific purpose except that it is used in the MMS.
Locationally Specific Reserve Requirements	Do not use in MNM Manual.	Generally, reserve requirements are determined per regional grid which makes them locational by default. The intent of this term in the WESM Rules is to distinguish certain reserve requirements for specific grid users (Market Participants) for equitable cost recovery (i.e., causers pay). However, reserve requirements are determined per Region because load and generation balancing is done by SO for each regional grids not per zone/s or per grid user/s.
Market Network Line	It is proposed to replace the term with "Market Network Branch" and define it as; "a representation of lines or transformers in the MNM which connects market network nodes".	The use of "or" creates ambiguity and should be avoided. If the intent of this term is to create a mathematical model of a transmission line in the MNM, then it must be "notional" and not "actual". Note that the definition used the phrase "market network node" which is now a proposed term (MNN). Further there is no term for transformer modelling in the MNM (e.g., Market Network Transformer which also connects MNNs.
Node	Replace the term with "Market Network Node" (MNN) or	The definition in the WESM Rules ambiguous due to the use of "or".

Undefined Terms	Proposed Definition	Justification
	"Network Node" and define this as; "A node in the MNM which connects Market Network Lines(/Branch)"	The intent is to use this term in MNM therefore it is notional (i.e., mathematical representation of a switchyard or switchgear). The words “Market Network” in the MNN indicates that it is a representation in the MNM not a physical structure.
Reserve Cost Recovery Zone	Do not use in MNM Manual	The WESM Rules define this term with respect to “Locationally Specific Reserve Requirements” which may have some conceptual flaws as earlier explained. The term can only apply to Reserve Regions, but *Region* already refers to the whole grid (not a zone).
Reserve Region	Refers to the regional grids (i.e., Luzon, Visayas, and Mindanao grids) where reserve requirements, allocations and cost recovery are determined.	Reserve Regions already refers to the whole grid (not a zone) and all regional reserve requirements are at grid level.
Reserve Requirement Constraint	Do not use in MNM Manual	Disregard this
Resource Node	Do not use in MNM Manual	This ambiguous term is used in the MNM Update of IEMOP and may refer to an MTN or Market Resource.
Zone	Redefined to include other purpose: "The grouping of MTN and their respective Market Resources in the MNM for purposes of geographical grouping, load forecasting by area, customer price zoning or network congestion analysis."	IEMOP MNM Issue 197 Definition: “the geographical location assigned to a particular resource and station. A numerical prefix is used to all resources and stations from 1-9 to identify a particular zone in which they are connected.” There is no specific purpose for which Zones are applied.
Zone Name	The name used to identify a particular zone in the MNM`	The IEMOP definition is “The name used to identify a particular zone in the MMS”.

There are terms or phrases repeatedly used in the MNM Manual in different contexts that were not defined or explained clearly in the document provisions. These are summarized in Table 6 together with their proposed definitions.

Table 6. Additional Terms and Proposed Definitions

Additional Terms	Proposed Definitions	Justification
Battery Energy Storage System	This term could be replaced by “Energy Storage System” and defined as; “a facility capable of storing electrical energy in significant commercial quantity”	The new term will cover Pump Storage Unit and other similar technologies that maybe developed in the future.
Connection Point	The PGC definition can be adopted with minor change; “The ~~point of~~ electrical connection of the User System ~~or Equipment~~ to the Grid or to the Distribution System”.	The WESM Rule definition is confined to WESM. It can be interpreted as an MTN.
Constraint	Refers to the representation in the MDOM of any inherent physical limits (including outages) in the network, loads, or generating facilities as well as reserve requirements, network contingencies and other security limits imposed by SO.	This term should be defined as a mathematical representation in the MDOM. The PDM formulation in the MDOM is an optimization problem composed of objective functions, constraints, and variables.
Dispatch	This definition can be omitted.	This term is simply preparation of "Dispatch Schedule". The definitions in the WESM Rules and PGC seem to point to SO as preparing the dispatch schedule, not MO. In the absence of WESM, dispatch schedules are prepared by SO, but this is not the normal case.
Dispatch Schedule	Retain definition from the WESM Rules with the following modification: "The target loading levels of generators, energy storage systems and loads for a specific dispatch interval."	In the absence of WESM, which is an exception, dispatch schedules are prepared by SO. In this case MO does not issue or prepare the schedules though the MDOM.
Generator	Define as: “An entity authorized to operate and maintain generating facilities for the production and selling of electrical energy or provide Ancillary Services. Aka: Generating Company.	The term is often referred to as a “Generating Company”, a regulatory entity. Sometimes it is used as generating equipment or a plant.

Additional Terms	Proposed Definitions	Justification
	When used without a capital letter, it refers to an equipment, a system or a facility which produces electric energy.	
Grid	The High Voltage backbone system of interconnected transmission lines, substations and related (i.e., generation, load and energy storage) facilities, located in each (region) of Luzon, Visayas and Mindanao, or as may be determined by the ERC in accordance with Section 45 of the Act.	Adopted from WESM Rules and PGC with modification.
Load	Redefine: "An entity that draws electrical energy for consumption or distribution" "When used without capital letter, it refers to and equipment or a facility which draws electric energy".	The WESM Rule definition is not accurate. PGC definition has the same problem as that of the term "Generator" although the concept is correct.
Load flow or Power flow study	Use the term "Load flow or Power flow Simulation" and defines as follows: "Numerical calculation of the steady-state behavior of a power system based on a given information such as load, generation, network characteristics and topology."	The term "Load flow" can be a study which involves offline analysis of simulation results or just a simulation for offline or online applications such as the MDOM. The latter is more appropriate for WESM.
Market Dispatch Optimization Model	The computational software in the MMS which contains the mathematical algorithm (PDM) used for determining dispatch schedules and nodal prices	Adopt definition from WESM Rules with modification: "The ~~optimization model~~ computational software in the MMS which contains the mathematical algorithm (PDM) ~~to be~~ used for ~~the purposes of~~ determining dispatch schedules and nodal dispatch prices ~~and preparing market projections based on the price determination methodology approved by ERC~~ Note: Preparing market projection also involves dispatch and price determination. Approval of ERC is already in the rules.
Market Management System	The information system and technology infrastructure which	New definition.

Additional Terms	Proposed Definitions	Justification
	supports the operation of the WESM	
Metering Point	Redefine: “An electrical location near the connection point where power and energy on a designated MTN is intended to be measured by revenue metering equipment for purposes of market settlement.”	The WESM Rule definition is not accurate because the equipment can never be located exactly at the Metering Point for various physical reasons. It is the point where energy and demand are measured.
Power System	The integrated system of transmission, distribution network and Generating Plant for the Supply of Electricity.	The term is generically defined in the Grid Code but the insertion of the phrase "...in the Philippines" in the WESM Rules definition causes some overlap with the "Grid" definition. The options are to retain the generic term in the Grid Code or omit it in and use the term "Grid".
Price Determination Methodology	Mathematical formulation applied to the MDOM for security-constrained dispatch and pricing in the WESM	New definition.
Pumped Storage Unit	This term could be replaced by “Energy Storage System” and defined as; “a facility capable of storing electrical energy in significant commercial quantity”	The new term will cover BESS and other similar technologies that maybe developed in the future.
Region	Redefine: "refers to the geographic locations of major grids with which they are identified."	The major power grids in the Philippines are named after the Regions where they are located but a Region itself is not a power grid.
Station	Do not use in the MNM Manual. These are substation identifications in the MNM.	This is a broad term used by IEMOP in their naming convention for substation in the MNM
Transmission Lines	Redefine; "A High Voltage facility which connects two stations for the purpose of delivering large amount of power over significant distance."	The WESM Rule definition is inadequate.
Transmission Network	Redefine for simplicity; "The Transmission Lines and Connection Assets developed, operated and maintained by the Transmission Network Providers in accordance with the Grid Code"	The WESM Rule definition is over-specified. Other information should be in the rules.

Additional Terms	Proposed Definitions	Justification
Transmission System	Same definition as Transmission Network	This is an extraneous term and can be deleted.

The terms and definitions presented in this section are recommended by the TC according to its contextual use in the MNM Manual for completeness and clarity. It also intends to minimize inconsistencies with other documents which may give rise to ambiguity in interpretation.

4.0 SUMMARY AND CONCLUSION

The revisions proposed by the TC on the MNM manual can be summarized into three major groups as follows:

1) Rearrange Contents

- Logical order and structure
- Clarity and consistency of contents
- Explain relevance of MNM in the WESM

2) Differentiate MNM Development from Maintenance

- Define MNM development process
- Define MNM maintenance process
  - Updates – grid, connection points, metering, EMS, MMS
  - Alterations – corrections, approximations, enhancements

3) Improve Terminology

- Revise defined terms
- Definitions for Undefined terms
- Introduce new terms as necessary

Drafting a new version of the MNM manual that will demonstrate, by example, how WESM documents can be improved to make them easier to read, more informative and useful for WESM governance and operations.

For good governance, TC believes that these considerations should always be an inherent part of the deliberation process when writing or revising market rules and procedures.

- Promote clarity and deeper understanding
- Recognize long-term objective of the market
- Maintain wider and more balanced operational perspective
- Encourage compliance and improve accountability

The TC prepared this study as an input to the other WGC and the PEMB towards improving the operation and governance of the WESM.

The Committee would welcome input from trading participants and service providers for corrections or suggestions to improve this report.

5.0 REFERENCES

- Market Network Model Development and Maintenance – Criteria and Procedures
- Price Determination Methodology
- Wholesale Electricity Spot Market Rules
- Philippine Grid Code
- Philippine Distribution Code

6.0 APPENDICES

Appendix 1 – Terminologies
Appendix 2 – Updated MNM Information from IEMOP

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