Wholesale Electricity Spot Market

Proposed Changes to the WESM Rules for the Implementation of Enhancements to Market Design and Operations

Philippine Electricity Market Corporation

December 2015

I. SUMMARY OF THE PROPOSED RULES CHANGE

Amendments to the WESM Rules are being proposed in accordance with the policies for further enhancement of the Wholesale Electricity Spot Market (WESM) design and operations as provided under the DOE Circular 2015-010-0015.

II. BACKGROUND

The WESM Design Study was commissioned on 02 April 2013 to review the WESM design and operations and address the findings and recommendations of the Independent Spot Market Audits on the Systems and Procedures of Market Operations (MO Audits).

The study was presented and discussed with market participants and interested parties in a series of consultation meetings held by the consultants to confirm their findings and develop their recommendations (see Attachment 1).

The final reports, incorporating the comments and inputs from stakeholders, were submitted to the Department of Energy (DOE) on 12 February 2014 and published in the WESM website on 28 February 2014.

On 05 November 2015, the DOE issued and published DOE Circular 2015-010-0015, which required, among others, PEMC to submit to the Rules Change Committee the proposed rules changes to the WESM Rules and Market Manuals which are necessary to implement its directives (see Attachment 2).

III. THE PROPOSED RULES CHANGE

The proposed amendments cover the following enhancements in WESM design and operations as provided under the said Department Circular (See Table 1):

1. Shortening of trading and dispatch interval from one (1) hour to five (5) minutes.
2. Ex-ante pricing only for energy and reserves for every 5-minute dispatch interval.
3. One (1) hour settlement interval for settlement purposes based on weighted average of the 5-minute ex-ante prices.
4. Automatic pricing corrections.
5. Implementation of hourly day-ahead projections (DAP) with sensitivities and hour-ahead projections (HAP).
6. Implementation of nodal-based short-term demand forecasting.
7. Automatic dispatch conformance monitoring for energy and reserves.

Table 1. Proposed Enhancements to WESM Design and Operations

Market Feature	Current Design/Rules/ Implementation	Proposed Changes	Clauses	Rationale
Trading and Dispatch Interval	The length of a trading interval and a dispatch interval are at 1 hour. Both terms are used interchangeably in market projections, dispatch scheduling and settlements.	Dispatch intervals are at 5-minutes. Issuance of real-time dispatch schedules and prices by the Market Operator and implementation of those schedules by the System Operator and generators will be done every 5 minutes.	3.1, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.13, 6.6, 10.4, 11	Facilitate more efficient scheduling and dispatch of energy and reserves, and mitigate the occurrence of intra-hour deviations and overriding of real-time dispatch schedules
Pricing	Ex-ante and ex-post	Ex-ante pricing only. No ex-post price	3.9, 3.10, 3.13	Ex-ante dispatch and pricing will be updated more frequently (i.e. every 5 minutes), reducing the need for ex-post pricing
Settlement	Calculation of settlement amount every hour (trading interval) based on ex-ante and ex-post prices.	Calculation of settlement amount every hour (settlement interval) based on the weighted-MW average of the 5-minute nodal dispatch prices.	3.13. 3.14	Consistent with the ex-ante only pricing.
Pricing Errors and Market Re-runs	Constraint violations results to pricing errors; manual market re-runs	Automatic management of constraint violations and market re-runs	3.6, 3.8, 3.10	To produce prices in real-time based on relaxation of constraints with non-zero violation variables, reducing the high frequency of pricing errors
Market Projections		NEW: HAP to extend the RTD process into the future for a 1 hour period, with the same resolution as the RTD process (5-minutes or 10-minutes).	3.1, 3.7	Facilitate generators in making short-term decisions and provides a short-term assessment of market outcomes.
	DAP is run every 4 hours up to 24-hours ahead	DAP is run every hour up to 24-hours ahead with sensitivities	3.7	
Load Forecasting	Top to bottom approach, curve-fitting technique	Bottom to top (nodal) approach	3.5	Mitigate forecast errors. Have more accurate forecasts
Compliance Monitoring	Monitoring of Trading Participants' compliance with the dispatch instructions and schedules within the dispatch tolerance level	Adoption of Dispatch Conformance Standards	2.3, 3.8	Implement automatic compliance monitoring for energy and reserves Provide incentives for market participants' compliance

The above-cited proposed amendments and other related proposed rules changes are discussed in the following sub-sections.

A. SHORTENING OF TRADING AND DISPATCH INTERVAL

The WESM currently operates on a trading and dispatch interval of 1 hour where the trading participants submit offers and the MO produces dispatch schedules, which are provided to the SO, and nodal prices on an hour-ahead basis.

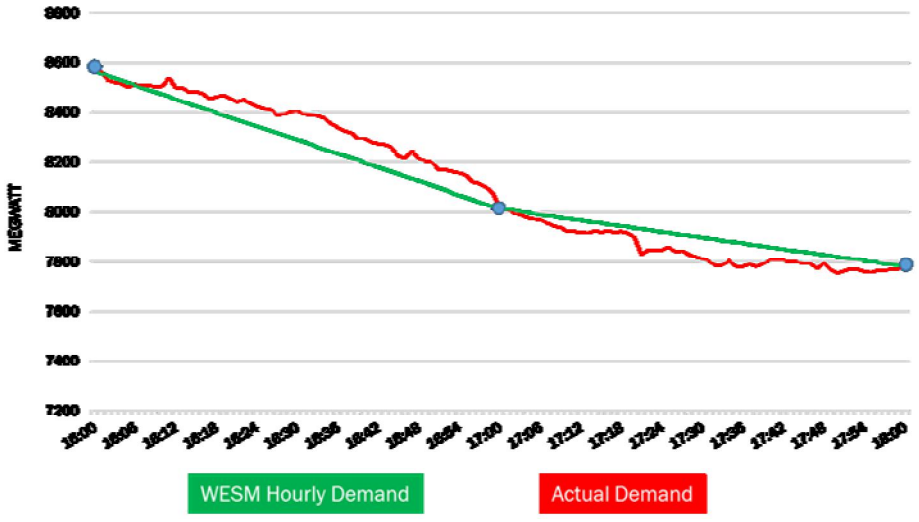
The main features of the existing arrangements are as follows:

- The MO provides the SO with the RTD schedules for the hour ahead for all generators and the merit order table (MOT);
- The SO uses this combined with the present demand levels, present generator outputs levels and the results of the day-ahead ancillary service nominations process (for regulation) to determine intra-hour dispatch instructions for the generators; and
- The generators also receive their RTD schedules via the Market Participant Interface (MPI), which they are required to follow linearly from one hour to the next, but subject to any over-riding instructions that may be issued by the SO.

Should there be an insufficient operating reserve in the grid to manage intra-hour variations, the SO uses the MOT in re-dispatching affected generating units. This, however, may not always result in the most economic dispatch for the WESM since the MOT does not account for any technical constraints such as the Pmins of generators, transmission limits or other network security limits.

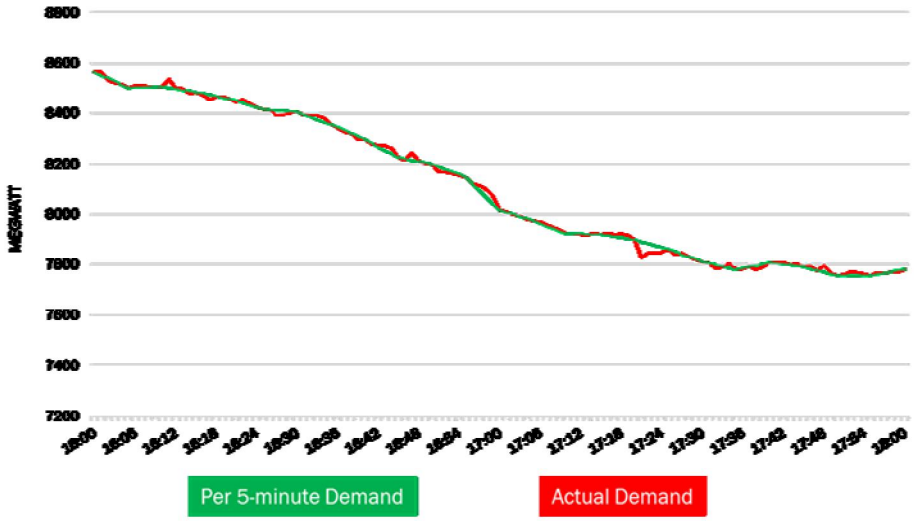
These intra-hour requirements can be quite significant and are difficult to manage on an ad-hoc basis as changes in conditions within a 1-hour period can be significant. As an example, Figure 1 shows the intra-hour variations with respect to the linear assumption in the current 1 hour dispatch interval.

Figure 1. Intra-hour Variations with respect to 1 Hour Linear Ramping



The maximum intra-hour deviation in Figure 1 from the 1-hour dispatch interval ranged from –128 MW to +105 MW. Should the dispatch interval be changed to a 5-minute dispatch interval, the intra-hour variations will be mitigated, as shown in Figure 2 wherein the deviations dropped to a range from –36 MW to +63 MW.

Figure 2. Intra-hour Variations with respect to 5 Minute Linear Ramping



A shorter dispatch interval would mean that the load following would be done using an optimization rather than a simple merit order and hence should be more economically efficient. The electricity market is able to address a greater number of issues directly, in particular, the energy market is able to perform a greater amount of load following and also ensure that the power system is operated within security levels defined by the SO.

If a shorter dispatch interval is in place, and the state of the network (e.g. the transmission elements in and/or out of service and the dynamic ratings of the transmission lines) is automatically fed through to the market dispatch and pricing process, then the MO will be able to deliver to the SO a secure dispatch shortly following the occurrence of contingencies. The market dispatch will be updated frequently to reflect the present state of the power system, including any security constraints that the system operator may require and generators will be able to actively manage their Pmins.

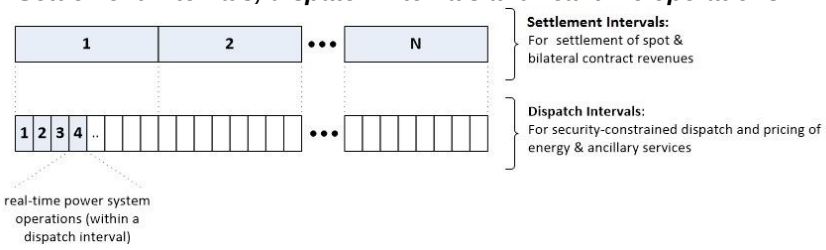
These should minimize the need for the SO's discretion and manual intervention and consequently reduce the likelihood of needing to intervene in the market. Under this scenario, the SO does not need to be concerned with actively dispatching generators. Priority will be shifted to the monitoring of generator conformance to market dispatches (see Section F).

Within a 5-minute dispatch interval, there will be less capacity required for regulating frequency as compared to say a 30-minute or 1-hour period. Also, some categories of reserve service, namely those that have long response times (such as 10-minute or 30-minute), can be sourced via the energy market. There will also be a reduced need for calling upon MRUs to manage

issues that arise within a 1-hour period (for example, fast-start units that take 10 to 15 minutes to start-up can be directly dispatched in the energy market - provided the gate closure is reduced).

Figure 3 illustrates the proposal to implement 5-minute trading and dispatch intervals in relation to retaining the 1-hour settlement interval (see Section B below).

Figure 3. Settlement intervals, dispatch intervals and real-time operations



Amendments to the WESM Rules provide the following:

- A dispatch interval of 5-minutes that is the period of time used for the ex-ante security-constrained economic dispatch and pricing of energy and ancillary services. The MMS workflows for RTD and HAP (see Section D) will be run every dispatch interval. Hence, RTD schedules and nodal prices will be produced for the next 5 minutes at a rate of every 5 minutes. Likewise, the HAP for the next hour will be produced every 5 minutes.

- A settlement interval, which is at 1 hour, is the period of time used for settlement of WESM transactions.

- MMS workflows for DAP and week ahead projection (WAP) will be executed every hour.

Affected Rules

The proposed shortening of the dispatch interval from 1 hour to 5 minutes will require amendments to WESM Rules provisions pertaining to market implementation. Specifically, the proposed changes to the length of a dispatch interval will impact the submission of offers, process of scheduling, pricing and dispatching, determination of settlement prices, and publication of market information.

B. EX-ANTE PRICING AND REVISED SETTLEMENT FORMULA

The WESM currently uses ex-ante and ex-post pricing in the settlement of market transactions, such that:

- The “ex-ante” dispatch and pricing are both based on the same optimization, utilizing ex-ante information regarding load, transmission,

ramping, and generator offers (which also reflect their plant availability); and

- The discrepancies between planned and actual outcomes are managed by determining “ex-post” prices, which are applied to that discrepancy.

The purpose of this two (2) settlement process is to encourage predictable behavior by participants by rewarding the provision of reliable information and reinforcing the penalties imposed on participants who are found to have mislead the market. This would address the relatively long dispatch period of one hour.

If the dispatch intervals were to be reduced from 1 hour to 5 minutes, then ex-ante dispatch and pricing will be updated more frequently, based on more accurate demand forecasts and snapshots of the present state of the power system. The next 5-minute ex-ante price would be expected to be similar to the ex-post price for the previous 5-minutes, since it will be based on current information about loads, available units and other system conditions, only it is forward-looking to the next dispatch interval. This reduces the need for ex-post pricing.

The hourly settlement prices are proposed to be derived from the weighted-MW average of the 5-minute ex-ante nodal dispatch prices, as follows:

$$\text{Settlement Price}_{i,h} = \frac{\sum_j^n [MW_{i,j} \times \text{Price}_{i,j}]}{\sum MW_{i,j}}$$

Where: i refers to resource node
h refers to the settlement interval
j refers to dispatch interval
n refers to the number of dispatch intervals in a settlement interval h
MW refers to the RTD schedule in a dispatch interval
Price refers to the nodal dispatch price

If the MW-sum for a span of dispatch intervals is 0, then the arithmetic average of the price shall be the settlement price for a settlement interval.

For spot market settlements based on ex-ante only pricing, settlement prices will be multiplied by the metered generation or consumption for the hour. Retention of hourly settlements would mean that there would be no need to amend the processes and infrastructures for metering and BCQ declaration.

Affected Rules

The proposed implementation of an ex-ante only pricing in the WESM will impact clauses 3.9, 3.10, and 3.13 of the WESM Rules. The revised settlement methodology will impact clauses 3.13 and 3.14 of the WESM Rules. Both amendments will cause changes in the WESM PDM.

C. AUTOMATIC PRICING CORRECTIONS

When a constraint is violated in the ex-ante or ex-post market runs, the prices calculated by the market dispatch optimization model (MDOM) reflect the violation penalties that are associated with the constraints that have been violated. In these cases, PENs are issued and the prices are substituted according to the WESM Rules, which require the following:

- where there is pricing error in the ex-ante market runs, the ex-post prices if valid shall serve as ex-ante prices, and
- where there is pricing error in the ex-post run, the prices as determined in the market re-run (the "market re-run prices" or "MRR prices") shall be used as substitute prices.

When PENs and MRRs occur, it creates price uncertainty for participants and there have been many episodes since market start where a large number of successive trading periods have been affected by CVCs.

The current market re-run process removes all previously violated constraints and uses the prices from this fully relaxed model as the ex-post prices. This approach of removing all binding constraints is unlikely to result in the correct price signals. Further, the current approach of replacing the ex-ante prices with ex-post prices is distorting the purpose of having ex-ante prices which is to give everyone price signals at the start of the hour.

With a shorter dispatch interval, this proposal provides the implementation of an automatic MRR process to produce ex-ante prices before the start of the dispatch interval. This would be done by minimally relaxing violated constraints so that the resulting dispatches are almost the same as the run with the violated constraints but the nodal prices for energy and reserves reflect the demand and supply balance and the dispatch of any offers or any load shedding. This proposed automatic pricing correction process is expected to address the significant number of PEN conditions. However, if the violation is beyond the relaxation limit then PENs may still be issued.

This proposal is expected to yield greater market efficiency because customers and generators would know nearly all of ex-ante prices at the start of the dispatch period due to a reduction in pricing error notices. This would facilitate more efficient market trading and enable the demand side to better manage their loads and participate in the market by responding to the publication of firm ex-ante prices. Embedded and non-scheduled generators will be able to respond to market price signal. Further, this will improve the accuracy of re-run prices as the constraints would be minimally relaxed and the scope for human error in the re-run process is greatly reduced.

Manual MRRs will only be done for PENs due to bad input data.

Affected Rules

The proposed implementation of automatic pricing re-runs and enhanced management of constraint violations will affect clauses 3.6, 3.8, and 3.10 of the WESM Rules. This will likewise cause changes to the WESM Manual on Constraint Violations Coefficients and the Criteria and Guidelines for the Issuance of Pricing Error Notices and Conduct of Market Re-Runs, among others.

D. ENHANCED MARKET PROJECTIONS

Aside from the ex-ante (RTD) and ex-post market runs, market processes currently include the market projections in Table 2.

Table 2. Current Market Projections

Market process	Frequency	Horizon	Periodicity
DAP (day-ahead projection)	4-hours	Up to 24-hours ahead	1 hour
WAP (week-ahead projection)	Daily	Up to 1-week ahead	1 hour

The DAP is used to provide information to generators, customers and the SO on the projected system forecast. These projections are used to determine commitment and other generator decisions. However, the existing DAP process has a number of limitations.

Firstly, it is executed only every four (4) hours, which is too infrequent for generators that have short start-up times and for providing information on changes to system conditions since the state of the power system could change considerably over a period of 4 hours. As a result, it can be out of date and inaccurate if the load has deviated significantly from the forecast or where there has been an unexpected generator or network outage.

Secondly, the horizon is “up to 24 hours ahead”, so as the trading day proceeds, the look-ahead becomes increasingly myopic. A third issue with the DAP process is that it only executes a single scenario, which may be insufficient for market participants to make “robust” commitment and other decisions.

To address the said limitations, it is being proposed that the DAP:

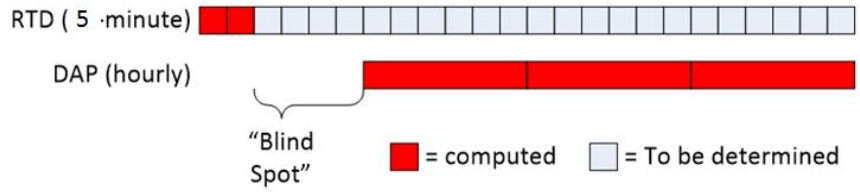
- be executed on an hourly basis;
- period is extended to always be at least 24 hours ahead; and
- be executed for multiple scenarios (have a number of high and low demand sensitivities) to overcome demand forecast uncertainties

If a shorter dispatch interval were to be introduced, the above DAP enhancements may still not provide sufficient information for some generators, e.g. hydro plants managing small / limited storages and fast-start

plants deciding whether to start-up. This is due to the "blind spot" between the RTD interval and the first trading period of the DAP.

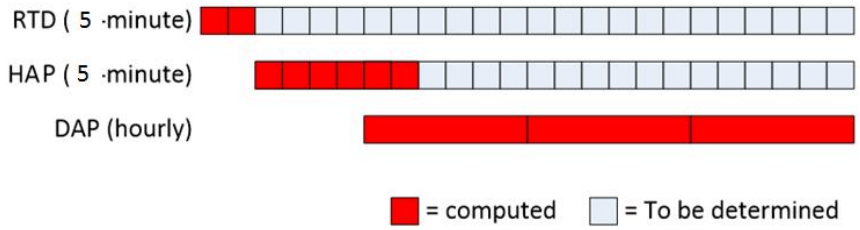
For the purposes of illustration, if the dispatch interval were reduced to 5-minutes then there would be a period of up about 1-hour for which the market participant has no forward information as shown in Figure 4.

Figure 4. Hourly DAP and 5-Minute RTD



To address this is the proposed implementation of HAP, which would augment the RTD and fill in the gap (or "blind spot") between RTD and DAP. The HAP process would essentially extend the RTD process into the future for a 1 hour period, with the same resolution as the RTD process (5-minutes). The concept and horizon of HAP is illustrated in Figure 5.

Figure 5. Hourly DAP, 5-minute RTD, ad 5-minute HAP



The HAP process would facilitate generators in making short-term decisions and provide a short-term assessment of market outcomes. Generator decisions on timescales of 1-hour or more can be made based on the enhanced DAP process. The HAP would likewise facilitate fast-start units in monitoring the need to commence the process of starting-up and allow any small reservoir hydro generators to better manage their reservoirs over the next hour.

Units concerned about being dispatched between 0 and their minimum stable level could monitor the outcomes of HAP and adjust their generation offers accordingly should they have an undesirable dispatch level in a dispatch interval. For this to be effective, it would be necessary to shorten the gate closure.

Affected Rules

The proposed implementation of enhanced market projections will affect clause 3.1 and 3.7 of the WESM Rules. The WESM Dispatch Protocol and the Load Forecasting Manual will likewise be changed to reflect the updated timetable and corresponding load forecasting methodology, respectively.

E. NODAL LOAD FORECASTING

The MO currently prepares a forecast around an hour ahead of the target interval using a curve-fitting technique where the latest demand level is the most crucial data input. The regional hour-ahead demand projection is developed based on measurements (5-minute SCADA snapshots) of demand 5-minutes ahead of the current settlement interval, the present conditions (primarily climate conditions) and adjusted for previous errors. The measured demand levels at each market trading node (MTN) are then used to apportion the regional-level (Luzon and Visayas) hour-ahead demand projection to be on a nodal basis.

For example, the 1000H RTD workflow is executed at 08:55:30 AM. The MO prepares the forecast (around an hour) before the 1000H RTD workflow is executed.

Forecasts for DAP and WAP is based on the Similar Day Load Forecast (SDLF) approach. Regional forecasts are produced and it is disaggregated to the individual MTNs based on load distribution factors.

By introducing a shorter dispatch interval, it will be possible to introduce short-term demand forecasts for each MTN that should be more accurate than the present approach. This is because for a shorter dispatch interval, there will be less demand uncertainty and since they will be done on a nodal basis the need to disaggregate the regional forecast is avoided.

Affected Rules

The proposed implementation of nodal forecasts will affect clause 3.5.4 of the WESM Rules and the WESM Load Forecasting Manual.

F. DISPATCH CONFORMANCE STANDARDS

Compliance monitoring in the WESM is currently associated with the concept of “Dispatch Tolerance”, which is the extent to which a generator may deviate from its schedule, and the MOR, under Clause 3.8.7 and Appendix A1.1 of the WESM Rules, respectively.

Conformance is presently assessed on a trading interval basis and is the joint responsibility of MO and SO. Under a shorter dispatch interval, an automated conformance monitoring system (ACMS) is proposed to be introduced to assess conformance on a 5-minute dispatch interval basis.

The ACMS will cover the monitoring of conformance for energy and reserves based on Dispatch Conformance Standards. The benefits of ACMS are reduced manual intervention or human error and enhanced transparency

since participants will know the details of the algorithm(s) used to check for conformance.

Affected Rules

The proposed implementation of an ACMS will affect clause 2.3 and 3.8 of the WESM Rules.

G. OTHER PROPOSED RULES CHANGES

This proposal also provides amendments related to the following:

1. Co-optimization of energy and reserves (WESM Rules 3.3, 3.6, and 3.13)
   - Principles on how to define and develop the detailed reserve categories to be traded and settled in the WESM (only) and the parameters to be used to define reserve providers' capabilities to deliver reserves etc.
   - The categories and procurement of ancillary services by the SO for those ancillary services that are not traded in the WESM will be provided under the PGC. This will cause the deletion of the provisions in the WESM Rules on ancillary services that are not traded in the WESM.
   - Close monitoring of reserves through the ACMS will replace the requirement for the determination of Reserve Effectiveness Factors (REFs).

2. Information Disclosure (WESM Rules 3.2, 3.5, and 3.11)
   - Identification of additional information that will be made available in the Market Participant Interface (MPI) and public WESM Website

3. Terminologies and cross-references (Glossary and various provisions)

IV. BACKGROUND AND DESCRIPTION OF THE PROPONENT

The proponent is the Philippine Electricity Market Corporation (PEMC). PEMC is a private, non-stock and non-profit corporation, which functions as both the market operator and governance arm of the WESM.

Top Officers:
M. L. Ocampo – President
C. C. Claudio – VP, Trading Operations
M. P. Gandia – VP, Corporate Services
C. S. Heruela – VP, Market Assessment
R. P. Descanzo – VP, Corporate Planning & Communications
C. S. Martin-Funelas – VP, Legal
C. G. Ubaldo-Dema – VP, Office of Corporate Secretary
P. S. Fernandez – OIC, Information Systems and Technology

V. CONCLUSIONS AND RECOMMENDATIONS

To address the design and implementation issues in the WESM as cited in the MO Audits and WDS, the proposed amendments to the WESM Rules are recommended for approval.

To ensure the efficient implementation of market enhancements, there is a need to harmonize the PGC and WESM Rules and enhance system operations, e.g. dispatching, power system security and ancillary services management, content of system snapshot files.

Proposed amendments to the Price Determination Methodology (PDM), WESM Manuals, and Retail Manuals will be subsequently submitted to the RCC.

VI. REFERENCES

- WESM Design Study, Intelligent Energy Systems
  - Phase 1 Final Report, 29 November 2013
  - Phase 2 Final Report, 02 December 2013

- Independent Spot Market Audit Report on the Systems and Procedures of Market Operations
  - Deloitte Touche Tohmatsu, July 2010 (For the period 1 July 2007 to 25 June 2009)
  - PA Consulting Group Ltd, 30 September 2011 (For the period 26 June 2009 to 25 June 2011)

Wholesale Electricity Spot Market

Attachment 1 - Series of Public Consultations on the WESM Design Study

Date/Venue	Attendees	Agenda
15-18 April 2013 at PEMC Office	DOE, PEMC, NGCP-SO, and other stakeholders (AES-MPPCL, FGP Corporation, First Gas, MERALCO, NPC, PANASIA, PSALM, SNAP, and SPPC)	Phase 1 issues
17-20 June 2013 at PEMC Office	DOE, PEMC, NGCP-SO, and other stakeholders (Aboitiz Power, AES-MPPCL, AP Renewables, Bac-Man, CEDC, CIP II Power Corp., EDC, First Gas, First Gen, GMCP, Green Core, HEDCOR, Luzon Hydro, Northwind, NPC, One Subic Power, PANASIA, PEDC, Petron, SEM-Calaca, SPC Island Power Corp., SMC Global, SNAP, Therma Luzon, Therma Mobile, Toledo Power Company 1590 EC/Vivant)	• Phase 1 findings and recommendations • Phase 2 issues
12-16 August 2013 at PEMC Office	DOE, GMC, ERC, PEMC, WESM Committees, NGCP-SO, and stakeholders (AES-MPPCL, ALECO, AP Renewables, BENECO, CAGELCO I, CANORECO, CASURECO II, CASURECO IV, CEBECO I, CEC, CELCOR, CENECO, DECORP, GUIMELCO, GN Power, IEEC, ILECO II, ILECO III, INEC, LEYECO, LEYECO II, MERALCO, NEECO, NEECO-Area I, PEDC, San Jose City Electric Cooperative, SMEC, SNAP-Benguet Inc., SNAP-Magat Inc., SPC Island Corporation, TARELCO II, VECO)	Phase 2 findings and recommendations
13-15; 19-20 November 2013 at PEMC Office	DOE, ERC, PEMC, WESM Committees, NGCP-SO	Phase 3 recommendations
18 November 2013 Stakeholders' Consultation Meeting at the Development Academy of the Philippines	DOE, DMC, GMC, ERC, PEMC, NGCP-SO, and stakeholders (1590 EC, Aboitiz Power, AES Masinloc, Angeles Power, AP Renewables, BATELEC II, BENECO, CAGELCO I, CAGELCO II, CANORECO, CASURECO II, Clark Electric Distribution Corporation, Dagupan Electric Corporation, EAUC, Ecozone Power Management Inc., FLECO, GN Power, Green Core Geothermal Inc., Guimaras Electric Cooperative, INEC, MERALCO, MOPRECO, MPower, NEECO II – Area I, NEECO – Area II, NORECO I, Northern Renewables, PANASIA, Panay Power Corporation, PENELCO, Pilipinas Shell Petroleum Corporation, PERC, PSALM, Samar II Electric Cooperative Inc., SMEC, SEM-Calaca, SNAP-Benguet, South Premier Power Corp., SPC Island Power Corp., SPDC, TARELCO II, Tarlac Electric Inc., Team Energy, Therma Luzon, Therma Mobile, Toledo Power Company, TPEC, VECO, Vivant, VRESCO)	Phase 1, Phase 2, and Phase 3 findings and recommendations