Philippine Electricity Market Corporation

Market Audit Report

Independent Operational Audit of the Systems and Procedures on Market Operations

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Executive Summary

This external audit of the Philippines Wholesale Electricity Spot Market (WESM) covers the systems and procedures on market operations, billing and settlement, including the interfaces with the System Operator, the Metering Services Providers, WESM Participants, the Energy Regulatory Commission (ERC) and the Department of Energy (DOE).

Although some material on which we reported to PEMC and the Audit Committee is not contained in this report for reasons associated with confidentiality and data security, the report does not otherwise differ materially from that provided to PEMC and the Audit Committee.

Specifically the audit covers four areas:

- Market Software Testing;
- Operational Procedure Review;
- Operational Process Review; and
- IT Systems Review.

The following sections provide summaries of what we have found for each of the four areas.

Market Software Testing

In undertaking the market software testing, we have found that, other than the settlements software which is currently being replaced, the market software generally complies with industry standards and/or with their specified formulations. There is, however, room for improvement in each of the five software areas in order to take advantage of improving methodologies and technologies, and/or to better reflect aspects of the system that are unique to the Philippines.

We have found that:

- The market network model does not contain facilities within the Metro Manila system which can critically affect market outcomes;
- Load forecasting accuracy is constantly being improved through monitoring of results and acquisition of additional historical data. This review process could be widened to consider alternative forecasting approaches, including up to date international best practices. The manner in which SCED uses the data must be also considered;
- The current review of the Market Management System should continue and should consider the issues identified in our SCED testing and in previous testing, particularly those around Pmin generation and the values and use of Constraint Violation Variables. Changes are likely to be needed before the introduction of a reserve market;
- WESM Manuals and certain WESM Rules related to billing and settlements need to be updated to accurately reflect the settlements process and the new settlements system, which should include a full audit trail. Potential errors in the old settlements spreadsheets need to be addressed; and
- The Market Assessment System would benefit from more complete documentation of how indices are calculated, including all adjustments, exclusions and validations performed.

PUBLIC

Improvements in these areas would not only improve the efficiency and competitiveness of the market, but would also improve the usability of the market for trading participants, and would reduce the workload on PEMC staff.

Operational Procedure Review

In undertaking the Procedure Review, we noted that a number of the Procedures are of very high quality and are consistent with international best practice standards. However, some Procedures have room for improvement and we have found four recurring themes:

- Missing Rule obligations;

- Misalignment between Rules and Procedures, and between Procedures and operational practice;

- Incorrect accountability; and

- A lack of overall governance of Procedures in terms of poor administration of Procedures.

Addressing the areas above will ensure that Market Operator's Procedures and Manuals are more closely aligned to international best practice standards and will aid PEMC in improving efficiency and compliance.

Operational Process Review

During our process and compliance review, we have noted a number of very good practices: Notwithstanding the good practices, the purpose of the audit is to test the Market Operator for non-compliance and to assess processes for risk of non-compliance, so that such areas can be targeted for better performance. As such, we have noted the following key themes:

- The implementation of the Rules relating to Prudential Requirements and collection and payment of invoices is flawed, and is the cause of several material non-compliances with the WESM Rules;

- There are deficiencies in the current market design that are directly related to non-compliance with Rules clauses which set out the purpose and objectives of the WESM;

- The ERC and/or DOE should review the SO with respect to their responsibilities under the Market Rules. As a minimum they should review whether the SO's management of Must Run Units is transparent and whether it has the potential to distort market signals and cause undesirable behaviour amongst Trading Participants;

- The Market Operator's current approach to compliance and performance monitoring can be greatly improved; and

- There is room for improving current data security practices.

We believe that addressing the areas above will greatly reduce compliance risk in the future, and will help to improve the smooth running of the market and settlements.

IT Systems Review

On the whole, IT services are moving in the right direction and there are good plans in place. However it will require appropriate implementation of plans to sit in line with international best practice. There are some specific recommendations the need addressing:

- Architecture, technology and IT management models

    - High priority should be given to achieving, and maintaining, the ISO 27001 certification for IT security;

- – Information classification and logical security policies are well documented but require implementation;
- – The availability target of the corporate infrastructure should be re-assessed. Based on international standards, the availability target seems low and the design, specification and disaster recovery approach of the infrastructure seems unsuitable.
- Interface tests
  - – One test failure requires priority investigation: EMSI interface - logic of aggregating MW values appears to be inconsistent. The IT Function and Market Operator staff should collectively examine the validity, rationale and consistency of the aggregation logic used by merger application.
- Software review (non-market)
  - – Software lifecycle practices were found to be inconsistent and not following best practice.

The international best practice standards considered included ISO 27001 and ISO 27002 for IT security, TIA-942 for Data centre infrastructure, BS 25999 for BCP/DR, and ITIL v3 for IT Service Management.

Conclusion

The market has been in operation for 5 years and has "bedded down" well.

The majority of the recommendations that were made by previous audit have been implemented, or are in the process of being implemented.

The operation of the WESM generally complies with the obligations set out in the Market Rules - we found 18 instances of material non-compliance with the Rules

Apparent problems with the operation of the market are generally due to identified "problems" with the Rules for which appropriate measures have been identified

The recommendations set out above will further improve the efficiency with which both the market and PEMC will operate. The Market Operator's responses to the recommendations are set out in the appendix.

PUBLIC

Contents

PUBLIC

Index of figures and tables

Figures

Tables

PUBLIC

1   High level objectives and scope

This external audit covers the systems and procedures on market operations, billing and settlement associated with the operation of the WESM as performed by PEMC, including the interfaces with the SO, the MSPs, WESM Participants, the ERC and the DOE.

1.1   Audit objectives

In accordance with Sections 7.2.2 and 8.1 of the PEM Audit Market Manual, the general objectives of this audit are to:

    a.   Review and assess the procedures and working processes of the Market Operator;

    b.   Review and assess the usefulness and appropriateness of systems settlement system, data management and other procedures and working processes used by the Market Operator to administer the WESM, in order to:

        i.   identify the appropriate steps and measures to help the Market Operator effectively and efficiently perform its responsibilities in time and form in accordance with the WESM Rules;

        ii.   assess if the Market Operator practices and work processes ensure the necessary transparency, independence, predictability and non-discrimination, and are in compliance with the WESM Rules and best international practices; and

        iii.   assess if the systems, calculations, information flows and data management protect the accuracy and quality of the data and results in generation scheduling, dispatch, prices and settlement, as well evaluate if internal controls exist and are sufficient to guarantee security and confidentiality where appropriate; and to propose recommendations to improve the procedures to collect and process the information and controls of quality and security of data in the WESM.

    c.   Review and assess the usefulness and appropriateness of the interfaces and exchange of information among the Market Operator, System Operator, Metering Service Provider and other service providers in relation to generation scheduling, constraints, dispatch, prices and settlement, and metering;

    d.   Review and assess compliance of the Market Operator with the WESM Rules and WESM Manuals; and

    e.   Review and assess the effectiveness of the Market Assessment System.

1.2   Audit scope

The following areas are considered to be within the scope of this audit:

- Market Software Testing:
    - The market network model;
    - The load forecasting software;
    - The market clearing and pricing software;
    - The settlements software; and

- The market assessment software.
- Operational Processes and Procedures:
  - WESM Market Manuals and Internal Procedures related to Market Operations and Market Assessment System; and
  - A list of high risk and/or high materiality processes to be selected using the review of historical information and examining procedural gaps.
- IT Systems Review:
  - The architecture, technology and IT management model used;
  - The validation of selected systems and sub-systems beyond those included in the Market Software Testing; and
  - The system interfaces.

The remainder of this report is set out following these areas of scope.

PUBLIC

2   Market Software Testing

This section summarises PA's assessment of the market software employed by the Market Operator. We give a brief overview of the scope and of our approach to the testing, and then set out our key findings and recommendations with respect to each item of software.

2.1   Scope

Market Software Testing covers the compliance and accuracy of key algorithms and calculations within the suite of market software. Specifically, the purpose of the Market Software Testing is to evaluate whether:

- The Market Network Model fairly represents the transmission network under the control of the System Operator;

- The load forecasting software results in suitably accurate and unbiased load forecasts;

- The market scheduling and pricing software complies with the WESM Rules and Manuals;

- The Settlements software complies with the WESM Rules and Manuals; and

- The Market Assessment System software calculates output variables such as market monitoring indices correctly.

2.2   Approach

While our approach differs for each of the five software areas, the focus in each case is on mathematical accuracy and appropriateness, and on compliance of the implementation with the WESM Rules and Manuals.

2.3   Key findings

2.3.1   Market Network Model

- **Assets common to the Market and System Network Models**

  – We believe that these assets are appropriately represented in the Market Network Model.

- **Assets specific to the Market Network Model**

  – We believe that the modelling of these assets in the Market Network Model is appropriate for its intended use.

- **Assets not included in the Market Network Model**

  – We believe that the additional interconnections between Meralco connection points should be included within the Market Network Model.

2.3.2   Load forecasting software

- **Type of software used**

  – The software used by PEMC employs a standard approach used by many market and system operators. However, other approaches, such as neural network software, are now available for

hour ahead forecasting and we understand that PEMC is already examining the use of such software.

- **Regional load forecasts**

  – Luzon load forecasts achieve a reasonable accuracy. However, the Visayas load forecast inputs require further "tuning" to improve their accuracy, the small size of the regional load notwithstanding.

  – Because the regional forecasts cover a considerable geographic area, and with Visayas cover a number of islands, which can have different weather conditions across the regions, forecasting loads for a number of areas within each region should produce a more accurate forecast. For example, the forecast load for Luzon might be aggregated from a number of areas within Luzon while that for Visayas might be aggregated from island load forecasts.

- **Nodal load forecasts**

  – In principal, the accuracy of the nodal load forecasts should be comparable to that of the regional forecasts, given that they are derived from the regional forecasts which are then allocated to the market nodes using historical data.

  – However, our analysis has indicated that nodal forecasts have high error rates. We accept that forecasting for small loads where switching on of one or two items of equipment - perhaps pump motors - can represent a relatively large change in load is not straight forward.

  – If the regional load forecasts were prepared on an area basis, the nodal load forecasts within each area would then be based upon those area forecasts with an expected increase in accuracy.

2.3.3   Market clearing software

- **Forced dispatch of Pmin generation undermines the integrity and purpose of the WESM**

  – The forced dispatch of the minimum stable operating limit, Pmin, contradicts Market Rule 3.6.1.5(c) which states that nodal prices will be such that "the recommended dispatch targets … would be optimal for that participant at those prices, given their offers … and after accounting for other constraints which may affect that Trading Participant".

  – Generators are essentially forced into not complying with Market Rule 3.5.5.1 which specifies that generators must submit standing offers and is commonly known as the "must offer rule".

  – This situation negatively impacts the ability of the Market Operator to meet the WESM Objectives specified in Rule 1.2.5. The following objectives are impacted:
    - Market competitiveness;
    - Market efficiency;
    - Market transparency;
    - Market reliability; and
    - Pricing that reflects commercial and market forces.

  – Rules 1.2.2(c)(2)-(3) deal with encouraging market access and participation, and are clearly compromised by this issue.

  – Rule 1.2.2(i) states that a purpose of the WESM Rules is to "encourage the use of environment-friendly renewable sources of energy…", and this is also potentially negatively impacted.

- **Violation of HVDC limits is not possible**

  – HVDC line flow limits are set by imposing a Security Limit. It is our understanding that security limits cannot be violated in the market scheduling and pricing software and therefore the

violation variables specified in the formulation for Security Limit constraints are effectively not present in the market scheduling and pricing software. This means that a Security Limit violation is not possible and other violations will occur instead.

- **Constraint Violation Coefficient values require revision**
  – Constraint Violation Coefficient prices currently used in the market scheduling and pricing software are those that were originally set with the intention that they be used only until more representative prices could be determined, and could easily be improved upon.

2.3.4   Market settlement software

The present market settlements software is to be replaced by the Wholesale Billing and Settlement System. Hence, our findings are largely of historical interest with one exception which leads to a recommendation. Nevertheless, we have found that with the exception of those set out below, the versions of the settlements programs tested were found to produce correct results when used according to the correct manual procedures.

- **Lack of audit trail**
  – Several aspects of the settlements programs, and the way they are used, result in the lack of a definitive audit trail. The results of the settlements programs are dependent on actions and data that are not recorded, and there is not a central repository of all the files used for every billing period. As a result, it is not definitively recorded how any settlement period's settlements values were arrived at, and it may not be possible to reproduce particular settlements values. This is a major concern given the materiality of these program's results.

- **Errors found in settlement calculations**
  – Significant material errors have been found in the settlements calculations implemented in the Price Substitution and Generation Price Index programs. The Price Substitution software appears to have not considered the "Lumped load" meter readings while the Generation Price Index spreadsheet we received appears to include incorrect data. Because we have carried out a sample test, we have not been able to fully quantify the extent of this problem. Nevertheless, it is possible that market participants have been charged or paid incorrect amounts.

- **SSLA program does not report input/output data errors**
  – The SSLA program makes use of a programming technique that suppresses the reporting of errors to users. As a result, if the program fails to open certain input data files, or to save certain output data files, the program will continue executing without any error being readily apparent to the user. Consequently, the results will be incorrect or be those from a previous billing period, without it being apparent that anything is wrong.

- **Incorrect formula in SSLA formulation**
  – The formulation of the SSLA calculations is specified in of the appropriate manual in which the formula for line loss ($Line_{kW-Loss}$) is missing the division by a factor of 1000 that is required to calculate a kW quantity from a current in Amperes and a resistance in Ohms. However, the software does include the factor, so is correct in this respect.

2.3.5   Market Assessment System

Our testing of the calculation of market monitoring indices in the Market Assessment System confirmed the appropriateness and accuracy of the calculations with no major issues uncovered in the calculations or the reported results. We found one or two minor areas where calculations could be

PUBLIC

improved in minor ways but nothing with a significant impact on the final values of the indices. Our only key finding relates to documentation of the calculations.

- **Full details of calculations and adjustments are not documented**
  - The "Catalogue of Market Monitoring Data and Indices" specifies high-level formulae for calculating the indices; however, there are many details and adjustments that are not included. The formulae are therefore ambiguous and could be implemented in many different ways.

2.4   Recommendations

2.4.1   Market Network Model

We recommend that:

- An examination be conducted of the additional interconnections between Meralco connection points be undertaken to determine whether they do indeed have a material effect on the scheduling, dispatch and pricing of the WESM; and

- If they do have a material effect on the scheduling, dispatch and pricing of the WESM, they be included within the Market Network Model.

2.4.2   Load Forecasting Software

We recommend that:

- The Market Operator investigate the use of more recent approaches to load forecasting in an attempt to reduce the forecasting errors, particularly for the real time dispatch;

- The Visayas load forecasts be improved by improving the standard of the input data;

- Consideration be given to forecasting the regional loads on an area basis with the regional load being aggregated from the associated area load forecasts; and

- Consideration be given to monitoring the effects of nodal forecast errors on the scheduling and dispatch of generation.

2.4.3   Market clearing software

We recommend that:

- The forced dispatch of Pmin generation in the market scheduling and pricing software be reviewed and an alternative methodology be chosen that would remove the negative impact on the market that the current situation has;

- The market scheduling and pricing software, or the method of setting HVDC limits via Security Limits, be changed to allow the violation of the security limit constraints as intended in the Formulation;

- Prior to the start of the reserve market, the Market Operator should investigate options for combined ramping constraints and decide whether to remove or replace the apparently existing constraint, or to document it in the Formulation; and

- The Market Operator conduct the intended review and setting of Constraint Violation Coefficients and nodal VoLL prices.

PUBLIC

2.4.4 Market settlement software

We recommend that the Market Operator:

- Implement a definitive audit trail within the new settlements system;

- Address the errors PA has uncovered in the Price Substitution and Generation Price Index programs by:
    - Confirming our findings with respect to the errors found;
    - Correcting any errors found; and
    - Advising affected market participants accordingly.

- Modify the SSLA program to ensure that any error conditions that occur in the program are reported to the user;

- Review the results of the SSLA program from past billing periods to check that unreported error conditions have not resulted in incorrect SSLA results; and

- Correct the $Line_{kW\text{-}Loss}$ formula in manual in section 9.8.3 of manual WESM-SDM-MM-05 to include the required division by 1000;

2.4.5 Market Assessment System

We recommend that full details of the MAS calculations of indices be documented.

PUBLIC

3   Operational procedure review

The Procedure Review assesses whether the Market Operator and the Market Assessment manuals and procedures are aligned with WESM Rules and meet best practice standards as assessed by the PA procedure evaluation framework

3.1   Scope

The scope of the review includes both the WESM Market Manuals and Market Operator Internal Procedures.

3.2   Approach

Procedures have been reviewed and scored against six criteria and allocated a summary Red-Amber-Green (RAG) score that indicated how well each procedure performed overall. The Procedure Assessment Framework is illustrated in Figure 1 below.

Figure 1: Procedure assessment framework.
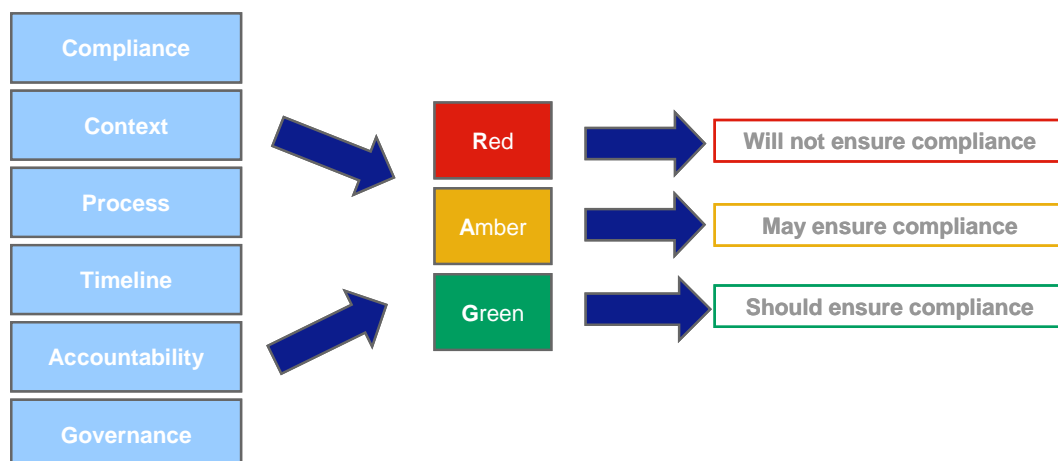
Compliance scoring

To determine the compliance score in Figure 1 above, we employed an obligation mapping approach, which mapped all Market Rules obligations to existing Procedures with a view to determining which obligations were not addressed by the Procedures being reviewed.

3.3   Key findings

In undertaking the Procedure Review exercise we have found four recurring themes as follows:

- Missing Rule obligations - one of the drivers of low compliance scores in our assessment was missing (undocumented) obligations imposed on PEMC by the WESM Market Rules;

- Misalignment between Rules and Procedures, and between Procedures and operational practice - in some instances the wording of the Rules and Procedures was inconsistent, while at other times Procedures did not accurately reflect operational practice;

PUBLIC

- Incorrect accountability - in many Procedures, outdated team names are still being used to assign accountability;
- Lack of overall governance of Procedures in terms of:
  – Inconsistent quality of procedures across teams; particularly with respect to process descriptions;
  – Inconsistent context to Market Rules and related Procedures;
  – Inconsistent use of document approval and revision control mechanisms; and
  – Poor administration of procedures.

3.4   Recommendations

As noted above, the four recurring themes we noted during our Procedure Review were:

- Missing Rule obligations;
- Misalignment between Rules and Procedures, and Procedures and operational practice;
- Incorrect accountability; and
- Lack of overall governance of Procedures.

To address the four key deficient areas described above, we propose two sets of recommendations as follows:

- Recommendation 1: Establish a Procedure Framework that provides a consistent basis for addressing all issues highlighted above; and
- Recommendation 2: Revise all existing Procedure in line with the above framework to bring them up to a "green score".

Each recommendation is described in further detail below.

3.4.1   Recommendation 1: Establish a Procedure Framework

Establishing a Procedure Framework will provide a consistent basis for addressing all of the issues highlighted above. We envisage the Procedure Framework would take the form of a "Procedure on Procedures" that provides firm guidelines in the following areas:

- *Compliance*:
  – The obligations which must be included or addressed in a Procedure; and
  – How obligations that cannot be directly included should be handled (e.g. those that are automated via software systems or supported through other tools) For example, an introductory sub-section addressing obligations covered via other means might be warranted.
- *Context*:
  – How and when the obligations should be referenced (e.g. a clause reference, or an excerpt);
  – Referencing of all associated Market and Internal Procedures; and
  – References to other external documents or software applications (e.g. software manuals, website links, and other documents).
- *Governance*:
  – Classification of Procedures. This will involve:

- Listing all current Market Manuals and Internal Procedures that are currently in use;
  - Classifying them by process; and
  - Enumerating them using a consistent taxonomic structure.
  - Version control and document approval mechanisms; and
  - When and how these mechanisms will be applied.
- *Ownership of Procedures* - responsibility for maintaining Procedures (i.e. what team/staff position).
- *Defining the triggers for Procedure change and implementing a process for recognising what Procedures are affected by a particular Rule Change or ERC/DOE ruling.* This could include:
  - Listing the various events that would require a Procedure Change (e.g. Rule Change, ERC/DOE Ruling); and
  - Developing a database/excel tool that maps each Rule obligation to the relevant Market Manual and Internal Procedure. Furthermore, the database tool could map a particular Rules obligation to specific sections within the related Procedure. This would serve as a tool to identify which parts of which Procedure require updating when a Procedure change trigger is activated.
- *Document structure and style*:
  - The section numbering/page numbering conventions to be used;
  - When and how visual aids (e.g. process maps, screenshots) are to be used;
  - Guidelines around high-level introductions used as a preamble to detailed process descriptions;
  - When and how cross-referencing is to be used; and
  - What level of detail should be included when describing different processes. The varied nature of Market Operations means that all processes will not be documented in a similar manner. For example a high level description of scheduling and dispatching processes is appropriate given the high volume nature of the tasks. However, for non-daily processes such as prudential security drawdown and registration it is appropriate to include more detailed implementation instructions. Thus, it would be helpful to set down some guidelines around the level of detail required for different processes.

3.4.2   Recommendation 2 – Revise existing Procedures

Having developed a consistent framework on which to base all Procedures, the next step is to revise existing Procedures using the guidelines established in the framework above.

We recommend:

- As a minimum, Market Operator amend all red Procedures in line with the established framework with a view to bringing them up to a "green" score;
- Prioritise amber procedures to be revised. The order of priority will depend on Market Operator staff's workload. For example:
  - In the short-term it may be prudent to bring up the "high" amber scores (e.g. the Market Network Model Internal Procedures and some of the TOD Internal Procedures) to "green standard" as it will involve minimal work; and
  - In the medium to longer term, amber procedures requiring more work can be addressed (e.g. those procedures with low to medium scores across all categories).

We note that a number of Settlement, Metering and Account Management Procedures will have to be revised as PEMC transitions to the new Wholesale Billing and Settlement System (WBSS). We

recommend PEMC use this as an opportunity to revise those Procedures in line with our recommended framework.

PUBLIC

4 Operational process review

The Process Review assesses whether selected Market Operator and Market Assessment processes are in compliance with the WESM Rules; and consistent with best practice standards defined by our process evaluation framework.

4.1 Scope

Table 1 summarises the processes that are in-scope for the process and compliance review. The list of obligations within each process that we have tested for compliance is provided in the full Process Review report.

Table 1: In-scope processes

Process	Sub-processes	Notes
MO Performance and Responsibilities	Significant variations report, etc	Compliance only
Market fees and budget		
Trading and Operations	Market Network Model	Compliance testing covered by the Market Network Model Testing
	Market Reruns and Pricing Error Notices	
	Scheduling & Dispatch	Compliance testing of MDOM provisions covered as part of the Market Software Testing
	Load forecasting	Some of the compliance testing covered as part of the testing of the Load Forecasting software
	Pricing	
Settlements	Settlement quantities and amounts	Compliance testing covered as part of the Settlements Software Testing (with the exception of the Net Settlement Surplus obligations in Rules 3.13.16.2 and 3.13.16.3)
	Metering	
	Settlements and Reconciliation	
	Collections and Payments	
	Prudential Requirements	
	Disputes and revisions	Process only review.
Market Assessment Group	Market Monitoring	Process only review.

PUBLIC

4.2   Approach

In undertaking the process and compliance review we have adopted a four stage approach as follows:

1. We first short-list the Market Operations, Settlement and Market Assessment processes to audit based on risk and materiality:

2. For the short-listed processes (see Table 1 for list of in-scope processes) we:

   – Identify Rules obligations to be tested for compliance based on risk and materiality; and

   – Identify controls and measures to be used to determine non-compliance against the Rules.

3. Having developed the control measures to be used to test compliance, we next undertake the compliance review by analysing PEMC data and interviewing relevant teams.

4. We then use PA's review framework (see Figure 2) to assess the short-listed processes for compliance risk, by reviewing each process against process management, process scale and complexity, resourcing and the results of the compliance review.

Figure 2: Process assessment framework
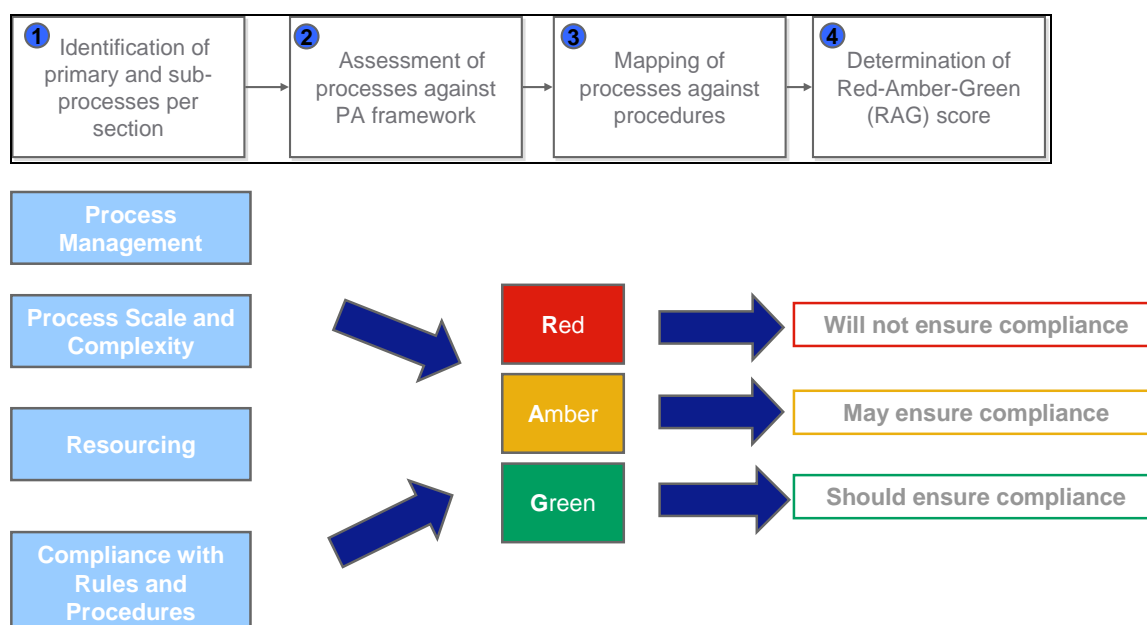
4.3   Key findings

- During our process and compliance review, we have noted a number of very good practices by PEMC:. However, notwithstanding the good practices noted above, the purpose of the audit is to test PEMC for non-compliance and assess processes for risk of non-compliance, so that such areas can be targeted for better performance. As such, we have noted the following key themes:

   – The implementation of the Rules relating to Prudential Requirements and collection and payment of invoices is flawed, and is the cause of several material non-compliances with the Wholesale Electricity Spot Market (WESM) Rules

- There are deficiencies in the current market design that are directly related to non-compliance with the Rules setting out the purpose and objectives of the WESM as envisaged in Rules 1.2.2 and 1.2.5. Specifically:

- The Rules and Procedures around mandatory dispatching of generators at their Pmin level causes generators to be non-compliant with the "must-offer" rule (Rule 3.5.5.1). Furthermore, it is inconsistent with the principles of economically efficient dispatch and promoting competition;

- The Procedures around pricing errors and market reruns should be reviewed. The large incidence of pricing errors may be related to the SO's requirement to use contingency constraints at the boundary between the market and Meralco. This overly constrains the interface and produces problems. Furthermore, the decision to ignore constraint violation penalties and rerun the market may be inconsistent with market objectives related to economic efficiency and transparency; and

- The management of must-run-units by the System Operator is out of scope of this audit, as it involves assessing decision making made by the SO. However, we note that the decision to nominate MRUs is somewhat opaque and has the potential to significantly distort market outcomes;

- PEMC's current approach to compliance and performance monitoring can be greatly improved. PA has reviewed the PEMC's compliance monitoring records and has noted that it is not transparent, and not sufficiently thorough.

- The quality of the procedures for certain processes can be improved. The Procedure Review report addresses procedure quality in more detail. However, in short, we have noted that some processes have very poor quality procedures that need to be immediately revised (e.g. Accounts Management); and some business processes are undocumented.

- There is room for improving current data security practices.

4.4 Recommendations

PA has made a large number of recommendations, and we appreciate that it is not practicable to implement all of these at once. As such, in this section, we propose a prioritised approach to implementing our recommendations as follows:

- PEMC should focus on reviewing various aspects of the implementation of the WESM design that have flagged as being most problematic;

- PEMC should implement a staged approach to revising the poorest performing Procedures

- The ERC and/or DOE should review the System Operator with respect to their responsibilities under the Market Rules. As a minimum they should review whether the SO's management of Must Run Units is transparent and whether it has the potential to distort market signals and cause undesirable behaviour amongst Trading Participants;

- PEMC should adopt a more rigorous approach to compliance testing and the development of robust performance metrics;

- Finally, the PEMC should improve IT security and implement the classification of information.

PUBLIC

5   IT Systems review

The IT Systems Review provides an assessment against international best practice standards with respect to software management, operations and security. It also provides software validation for selected interfaces and systems beyond those included in the Market Software Testing.

5.1   Scope

The scope of the review covered the following areas:

- Application architecture - assessing IT security and data management;

- Technology and infrastructure assessment - assessing the network and data centre designs, Business Continuity Plans (BCP) and disaster recovery arrangements;

- IT Service Management - assessing PEMC's approach to change management, incident management and operating a service desk;

- Interface testing - verifying transmittal of information between various software systems maintained by PEMC as well as between PEMC and third parties; and

- Software validation - making an assessment of the software applications used other those included in the Market Software Testing workstream.

5.2   Approach

The review included an assessment of both PEMC's policies and practices including a verification of current practice against recommendations made in the previous audit. The international best practice standards considered included ISO 27001 and ISO 27002 for IT security, TIA-942 for Data centre infrastructure), BS 25999 (for BCP/DR), and ITIL v3 (for IT Service Management).

5.3   Key findings

It is evident that many of the key IT recommendations of the previous audit have been implemented. The benefits to PEMC have included:

- Improved physical security within PEMC to restrict access to sensitive areas;

- Clear logical security policies to provide guidance and consistency on improving the security of PEMC networks and systems;

- Up-to-date and centrally managed anti-virus software on all corporate servers and desktops to help prevent malicious attacks to PEMC; and

- Clear procedures to manage change to PEMC applications, giving better control and management of these applications.

The summary details of our findings in this workstream are not reported for security reasons. However, we can report that:

PUBLIC

- PEMC have documented their IT security policies. The policies documented provide sound guidance for PEMC IT operations although we compared the coverage of the policy document against ISO 27002, some areas were not covered,

- The IT security policy document is expected to be further improved as a result of the PEMC ISO 27001 project.

- The security of the Market Management Systems, data centre and network was appropriate in most areas. However, the security of the corporate systems, data centre and network does not meet the same standard.

- The scope and content of the recently released Business Continuity Plan is compliant with many of the criteria of the standard BS 25999 Parts 1 and 2 while the Disaster Recovery plan in place provides a clear approach to responding to the MMS system becoming unavailable. The plan has been simulated annually and also used in a real situation.

On the whole, IT Services are moving in the right direction but require implementation of plans to sit in line with international best practice.

5.4   Recommendations

To address the issues discovered when assessing the IT systems, we recommend:

- Ensuring that PEMC do achieve ISO 27001 certification and maintain on-going compliance with the standard;

- Information classification and logical security policies, although well documented, require implementation;

- Simulating, as much as possible, the entire disaster recovery plan. This includes forming the defined teams that will respond to a disaster and follow the process closely.

- In line with the PEMC incident management procedure, prioritising incidents to enable high priority issues to be resolved quickly,

- Initiating a project to investigate the benefits of other ITIL services to PEMC. We suggest that PEMC would benefit from implementing the Configuration management service to give better control of assets and control when releasing software;

- The availability target of the corporate infrastructure should be re-assessed. Based on its use and international best practice and standards, the availability target seems low and the design, specification and disaster recovery approach of the infrastructure seems unsuitable.

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Appendix A: Summary of recommendations and PEMC response

The table below summaries the recommendations made in this report together with PEMC's response to them.

	PA recommendation	PEMC response
Market Software - Market Network Model		
1	An examination be conducted of the additional interconnections between Meralco, and other distribution system, connection points, be undertaken to determine whether they do indeed have a material effect on the scheduling, dispatch and pricing of the WESM; and if they do have a material effect on the scheduling, dispatch and pricing of the WESM, they be included within the Market Network Model.	We will coordinate with MERALCO and NGCP in the conduct of a study on the representation of the MERALCO subsystem in the network model.
Market Software - Load Forecasting		
2	The Market Operator investigates the use of more recent approaches to load forecasting in an attempt to reduce the forecasting errors, particularly for the real time dispatch.	We will assess the actual variances of forecasting on a nodal basis, in coordination with the System Operator. PEMC receives forecasting input data from the System Operator. After said assessment, we will explore other possible forecasting methodologies, e.g. * Multiple linear regression analysis * Forecasting using ANN (Artificial Neural Network) * Node based approach in determining nodal forecasts However, some of these approaches require enhancement of the current MMS and the Energy Management System (state estimator) of the System Operator. We will also consider tapping external experts.
3	The Visayas load forecasts be improved by improving the standard of the input data.	We expect the load forecast for Visayas to improve with the accumulation of 1-year worth of historical data.

		We are coordinating with the System Operator to improve the accuracy of the input data used for load forecasting.
4	Consideration be given to forecasting the regional loads on an area basis with the regional load being aggregated from the associated area load forecasts.	As noted in item 2, we will explore nodal based approach in determining nodal forecasts. This will be considered in the MMS enhancement.
5	Consideration to be given to monitoring the effects of nodal forecast errors on the scheduling and dispatch of generation.	As noted in item 2, we will conduct monitoring of the forecast on the nodal level to determine the effects of nodal forecast errors and provide this as input to the forecasting study.
Market Software - Market Clearing Software		
6	The forced dispatch of Pmin generation in SCED to be reviewed and an alternative methodology be chosen that would remove the negative impact on the market that the current situation has.	The options provided by PA will be further studied, which may include simulations, by a third party. This study may be bid-out to educational/technical institutions.) An external consultant may be commissioned to conduct a study and provide expert recommendation of other alternative methodology.
7	The SCED software, or the method of setting HVDC limits via Security Limits, is changed to allow the violation of the TCG constraints as intended in the Formulation.	We will coordinate with the vendor (ABB) to effect the necessary changes in the MMS consistent with the PDM/ formulation and we will accordingly request for the necessary budget with the ERC.
8	Prior to the start of the reserve market, the MO should investigate options for combined ramping constraints and decide whether to remove or replace the apparently existing constraint, or to document it in the Formulation.	We have coordinated this matter with the vendor (ABB). We are currently waiting for ERC approval on the funding for the MMS enhancement to address this matter.
9	The MO to conduct the intended review and setting of Constraint Violation Coefficients and nodal VoLL prices.	We will conduct study and provide recommendations to Rules Change Committee (RCC).
Market Software - Settlements Software		
10	Implement a definitive audit trail within the new settlements system.	We will improve the audit trail of current settlements process in the WBSS.

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| 11 | Address the errors PA has uncovered in the Price Substitution and Generation Price Index programs by confirming our findings with respect to the errors found, correcting any errors found; and advising affected market participants accordingly. | We have validated both Price Substitution and GPI programs.

We have found no errors in the Price Substitution program while an error was discovered in the template used for the GPI program. Participants have already filed for compensation related to past GPIs and the process of such filing will automatically correct the said error. |
|---|---|---|
| 12 | Modify the SSLA program to ensure that any error conditions that occur in the program are reported to the user. | We will enhance the current MS Excel program used for SSLA in line with the auditor's recommendation.

An enhanced software/program will be developed for SSLA, in coordination with IST. |
13	Review the results of the SSLA program from past billing periods to check that unreported error conditions have not resulted in incorrect SSLA results.	Thereafter the enhancement of the current SSLA program in item 16, the SSLA data for the past billing periods will be reviewed.
14	Correct the Line kW-Loss formula in manual in section 9.8.3 of manual WESM-SDM-MM-05 to include the required division by 1000.	We will correct the manual to include the required divisor of 1000 upon approval by the RCC and the Board. To be presented to the next RCC meeting in October 2011.
Market Software - Market Assessment System		
15	Full details of the MAS calculations of indices be documented, including:

Exact data sources;

All pre-processing and validation of input data, both manual and automated; and

Details of all adjustments made, such as outages, security limits, MRR, etc.. | With regard to bullet 1, the formulas for calculating market monitoring indices are provided in the "Catalogue of Market Monitoring Data and Indices." In response to this audit finding, MAG will document the MAS detailed calculation of market monitoring indices.

MAG's proposed timetable for the undertaking is until end of October 2011.

Bullets 2 and 3 refer to the collection, processing and validation of market monitoring data. The MAG has approved/adopted on 18 July 2011 an internal business manual entitled "Procedures for Monitoring and Assessing the Performance of the WESM (Issue 1.0). The manual, in particular, sets out the procedures in the collection, processing and validation of the market monitoring data and indices. This document was developed in accordance with the earlier findings of the Internal Audit Department (IAD). A copy of the manual was provided to PA on 01 August 2011. |

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		As way forward, MAG will conduct a review of the manual with the end view identifying processes that need further details.
Procedures		
16	Establish a Procedure Framework that provides a consistent basis for addressing all issues.	There is an existing procedures manual that prescribes a template for documentation of business processes, but this may not have adequately covered the issues raised by the auditors. The current document will be revised to establish a framework as suggested.
17	Revise all existing Procedures in line with the recommended framework to bring them up to a "green score".	The recommendation will be complied with.
Processes		
18	The ERC and/or DOE should review the SO with respect to their responsibilities under the Market Rules. As a minimum they should review whether the SO's management of Must Run Units is transparent and whether it has the potential to distort market signals and cause undesirable behaviour amongst Trading Participants.	We will refer this recommendation to the ERC and DOE because audit of the SO is not provided under the WESM Rules.
19	The MO to adopt a more rigorous approach to compliance testing.	We will review the existing compliance testing and make appropriate enhancements to internal procedures.
IT Application Architecture		
20	Ensuring that PEMC do achieve ISO 27001 certification and maintain on-going compliance with the standard.	Target on the ISO 27001 certification by end of 2011. 2012 Corporate Strategic plan and budget include the maintenance of the ISMS.
Business Continuity Planning and Disaster Recovery		
21	Simulating, as much as possible, the entire disaster recovery plan. This includes forming the defined teams that will respond to a disaster and follow the process closely.	The auditor's recommendation will be included in the next revision and implementation of the DRP.
IT Service Management		
22	Initiating a project to investigate the benefits of other ITIL services to	ITIL as well as CMMI for software application process improvement models needs extensive

| PEMC. We suggest that PEMC would benefit from implementing the Configuration management service to give better control of assets and control when releasing software. | implementation effort which is similar to the ISO 27001 that is currently on-going. Such initiatives should be included in subsequent ISSP updates subject to approval of PEM Board since this will entail additional expenditures and work program for those that will be involved in the project.

Funding will be requested from ERC by way of market fees. |

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