

**Report on the Independent Software Audit
of the
Central Registration and Settlement System (CRSS)**

PEM Audit Committee

September 2018

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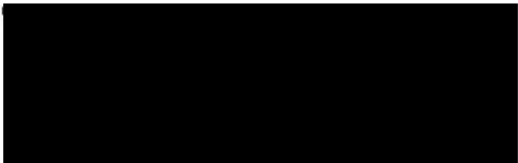

FOREWORD

The PEM Audit Committee herein submits this report detailing in summary the results of the recently-concluded audit of the Central Registration and Settlement System (CRSS). An evaluation of the newly-developed CRSS was initiated to affirm and strengthen the confidence of market participants on the accuracy and effectiveness of the said system which shall be used in parallel with other new market systems formulated for the implementation of the Enhanced WESM Design and Operations. This activity was capped with Intelligent Energy Systems Pty Ltd., the external auditor commissioned by PAC, issuing a certification indicating the compliance of the CRSS with respect to the following: the WESM Rules (as approved by the DOE 2016-10-0014), proposed Price Determination Methodology, proposed WESM Market Manuals, proposed Retail Rules and Manuals implementing the Enhanced WESM Design and Operations.

The PAC acknowledges that the conduct of this audit would not have been possible without the cooperation and support of PEMC, through its management and staff and thus wishes to thank them for their usual cooperation and support in this undertaking.

For the PEM Audit Committee,



Felixberto U. Bustos, Jr.
Chairperson
Eduardo Alejandro O. Santos
Member

Christian M. Orias
Member

I. ABOUT THIS REPORT

This report provides an executive summary of the results of the Software Audit of the Central Registration and Settlement System (CRSS).

The Philippine Electricity Market Corporation (PEMC) embarked on the development of an automated system called the CRSS, to facilitate a central registration and integrated settlement system for the wholesale and retail market. The CRSS is an information technology (IT) system consisting of computer software and hardware. It is envisaged that the software product shall be PEMC's tool to process electricity market participant registration.

The Department of Energy (DOE) issued DOE Circular DC2016-10-0014, amending the WESM Rules for the further enhancement of the WESM Design and Operations. In summary, such enhancements involved the following:

1. Shortening of the trading and dispatch interval from one (1) hour to five (5) minutes;
2. Removal of the minimum stable load (Pmin) constraint in the Market Dispatch Optimization Model (MDOM);
3. Ex-ante pricing only for energy and reserves for every 5-minute dispatch interval;
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; and
7. Automatic dispatch conformance monitoring for energy and reserves.

These changes in the WESM design correspondingly required enhancements to the CRSS then being developed by PEMC. These enhancements were then incorporated into the design of the CRSS.

The general objective of this review is to validate that the CRSS complies with the WESM Rules, proposed Retail Rules and Manuals, and the proposed Price Determination Methodology (PDM) implementing the Enhanced WESM Design and Operations.

Further, the purpose of this audit is to test the output of the relevant CRSS components to ensure that they are consistent and compliant with the settlement and metering formulations and procedures prescribed under the WESM Rules, Retail Rules and relevant Manuals, and the PDM under the Enhanced WESM Design and Operations. The audit also aimed to ascertain if the mathematical algorithms used in the CRSS are mathematically equivalent to the formulations prescribed under the WESM and Retail Metering Manuals as applicable under the Enhanced WESM Design and Operations.

II. EXECUTIVE SUMMARY

Intelligent Energy Systems Pty Ltd (IES) was engaged by the Philippine Electricity Market Corporation (PEMC) to undertake the audit project entitled, "Independent Software Audit of the Central Registration and Settlement System (CRSS)".

The objective of this project is to undertake an independent audit of specific CRSS components to validate their conformance with WESM Rules (approved as of DOE DC2016-10-0014), proposed Wholesale Market Manuals, the proposed Retail Rules and Manuals, and the proposed PDM implementing the Enhanced WESM Design and Operations and the RCC-approved WESM and RCOA Metering Standards and Procedures Manuals.

The audit consisted of five tasks. Each task involved the audit of a specific CRSS component. The five tasks are as follows:

A. AUDIT TASKS:

Task 1: Review of Settlement Module. To determine if the mathematical algorithms used in the Settlements Module to calculate the billing amount for each Trading Participant (TP) in the network are mathematically equivalent to the formulation described in the PDM Manual 1.0, Settlement and Reconciliation Mathematical Instruction manual and likewise to confirm that VAT calculations are according to the Philippine Tax Code Section IV (Value Added Tax).

Task 2: Review of Interim Metering Macro Tools (IMMT) for WESM. To confirm that the data exchanged between the CRSS database and the IMMT and the WESM Site Specific Loss Adjustment (SSLA) spreadsheets are correct.

Task 3: Review of Interim Metering Macro Tools for RCOA. Confirm that the data exchanged between the CRSS database and the IMMT for RCOA, are correct. To likewise confirm that the RCOA SSLA calculations are correct according to the Transition Metering SSLA Tool- Business Requirements Documents.

Task 4: Review of Metering Module. Check that metering data are correctly validated using the Validation, Estimation and Editing (VEE) process according to the RCC-approved WESM and RCOA Metering Standards and Procedures manuals.

Task 5: Review of Data Warehouse Module. Confirm that the metering data sent to the CRSS Data Warehouse (DW) are correct.

B. CONCLUSION

The CRSS software elements above described were thus found to be compliant with the appropriate Rules and Manuals as described in the report and IES has accordingly issued a software certification to that effect. (Appendix A)

29 November 2017

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Dear Mr. Bustos

SCOPE OF THIS CERTIFICATE

The certification testing verifies the functionality of five software modules within the Central Registration and Settlement System (CRSS) software version 2.0. The five software modules and the scope of the certification for each are listed below.

- **Settlements Module.** The scope of certification for this software module is to determine if the mathematical algorithms used in the Settlements Module to calculate the billing amount for each Trading Participant (TP) in the network are mathematically equivalent to the formulation described in PDM Manual 1.0, Settlement and Reconciliation Mathematical Instruction manual (BMS.B01.MID.1). VAT calculations are according to the Philippine Tax Code Section IV (Value Added Tax).
- **Interim Metering Macro Tools (IMMT) for WESM.** The scope of certification for this software module is to confirm that the data exchanged between the CRSS database, the IMMT for WESM, and the WESM Site Specific Loss Adjustment (SSLA) spreadsheets, are correct.
- **Interim Metering Macro Tools (IMMT) for RCOA.** The scope of certification for this software module is to confirm that the data exchanged between the CRSS database and the IMMT for RCOA, are correct. It will also confirm that the RCOA SSLA calculations are correct according to the Transition Metering SSLA Tool - Business Requirements Document (BRD-1701-002.1702.SEQ).
- **Metering Module.** The scope of certification for this software module is to check that metering data is correctly validated using the Validation, Estimation and Editing (VEE) process by the CRSS metering module according to the RCC-approved WESM and RCOA Metering Standards and Procedures manuals.
- **Data Warehouse Module.** The scope of certification for this software module is to confirm that the metering data sent to the CRSS Data Warehouse (DW) are correct.



APPENDIX A

CERTIFICATION TESTING METHODOLOGY

For each software module, test data used by the Philippines Electricity Market Corporation (PEMC)-CRSS project team to test the functionality of the respective software module was provided to IES. The method used by IES to certify the functionality of each software module is described as follows:

- **Settlements module:** IES independently developed a software model, derived through the relevant formulas defined in *PDM Manual 1.0*, *Settlement and Reconciliation Mathematical Instruction manual (BMS.B01.MID.1)*, and *VAT calculations according to the Philippine Tax Code Section IV (Value Added Tax)*. IES used the provided test data to test their independently developed software model and then compared results against that of the CRSS Settlement Module.
- **Interim Metering Macro Tools (IMMT) for WESM.** IES used the provided test data to check that data are correctly transferred between the CRSS database, IMMT, and WESM SSLA spreadsheets.
- **Interim Metering Macro Tools (IMMT) for RCOA.** IES used the provided test data to check that data are correctly transferred between the CRSS database and the IMMT and also to check that the calculation of the RCOA SSLA is according to the method specified in *Transition Metering SSLA Tool - Business Requirements Document (BRD-1701-002.1702.SEQ)*.
- **Metering Module.** IES used the provided test data to check that the VEE process for WESM and RCOA meters is being implemented correctly according to Section 6.3.1 of the RCC-approved WESM and RCOA Metering Standards and Procedures manuals.
- **Data Warehouse Module.** IES used the provided test data to check that metering data are correctly transferred to the CRSS database.

Considering the above methods used by IES for testing, the scope of the testing IES has performed, and hence of this certification, is limited by the following factors:

1. IES has had no direct access to the CRSS software.
2. PEMC has been responsible for running test cases of their own design on the CRSS and providing IES with the input and output files.

In addition, there were instances in the reference documents where a formula definition or method description was inadequate. These instances are listed below, included is the revised method implemented by IES for certification.

1. The definition for Line Rental Trading Amount (LRTA):

$$\text{Line rental trading amount} = \text{BCQ}_{G-L} (\text{EAP}_L - \text{EAP}_G)$$

APPENDIX A

in manual *Segregated Line Rental Trading Amounts (SLRTA)*, Issue 1 is correct but only for one transfer of energy between a generator and a load. In each time interval there can be multiple transfers for the one load, where the load receives energy from multiple generators. The equation should reflect this and be written as the sum of all transactions between a load and all generators that supplied energy to the load.

PEMC responded that *"Under the revised Billing and Settlement Manual, LRTAs are calculated per bilateral contract declaration. This would consider multiple suppliers"*

IES Revised Certification Method: For each time interval the SLRTA is calculated using the sum of all transactions between a load and all generators who supplied energy to the load. This method produced the same results as given in PEMC test data.

2. For the Energy Market Fee (MF), for each Trading Participant (TP), IES was able to calculate the same value for field Metered Quantity(gen-i) as did PEMC and, as a result, the same MF(gen-i). This was not the case for Reserve MF. The method for how to calculate MF for each TP used by IES is adequate when calculating Energy MF, but not for Reserve MF. A number of different methods for calculating the Reserve MF were trialled but none resulted in the same calculated values for Metered Quantity(gen-i) as produced by the PEMC test results.

PEMC responded that *"The Market Fee Quantity (MFQ) for reserves per TP is apportioned according to reserve schedule"*

IES Revised Certification Method: The Market Fee Quantity (MFQ) for reserves per TP is apportioned according to reserve schedule. This method produced the same results as given in PEMC test data.

The CRSS software version 2.0 has been tested and found to be functionally identical to that described in the reference documents with the following caveats:

1. Taking into account the limitations of the certification as described in the aforementioned factors
2. The IES Revised Certification Method was used for the instances listed above where a formula definition or method description in a reference manual was inadequate.

APPENDIX A

CERTIFICATION OF CRSS WITH RESPECT TO REFERENCE DOCUMENTATION

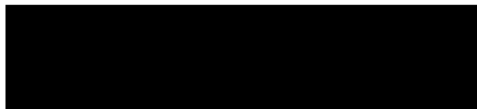
The following is our certification of the extent to which the CRSS software version 2.0 is functionally equivalent to that specified in the reference documents.

"Subject to the limitations and caveats expressed in the foregoing text, we believe that the software provided in CRSS version 2.0 is functionally identical with respect to the software specifications contained in the reference documents, as supplied to us, within the meaning of 'functionally identical' being that as defined above".

LIMITATION OF LIABILITY

In furnishing this certification, Intelligent Energy Systems specifically limits its liability to the cost of repeating all and any certification tests necessary, and any necessary re-certification in reliance on those tests, if any differences are found in results from the software version of a nature not explicitly described above. No person shall be entitled to claim against Intelligent Energy Systems, any losses or damage whether indirect, special or consequential, in excess of that limitation, and PEMC shall ensure that all persons or parties who may rely on this certification are aware of this limitation of liability.

Yours sincerely



Hugh Bannister
Chairman and CEO