



Report on the Independent Software Audit of the New Market Management System and the Central Registration and Settlement System

**Enhancements to the Market Systems in compliance to the ERC Decision
promulgated on 29 December 2020**

AUGUST 2021

This Report is prepared by the
Philippine Electricity Market Corporation –
Market Assessment Group for the
PEM Audit Committee

FOREWORD

The PEM Audit Committee (PAC) supervised the independent software audit of the enhancements to the New Market Management System (NMMS) and the Central Registration and Settlement System (CRSS). These enhancements were implemented in compliance to the ERC Decision on Price Determination Methodology (PDM) application which was promulgated on 29 December 2020¹.

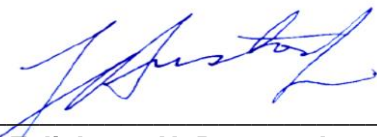
The audit was conducted to determine the compliance of the NMMS and CRSS enhancements with the Market Rules and Manuals and directives of the Energy Regulatory Commission (ERC) through its orders and issuances, and to review whether the development of software enhancements followed the Market Operator's (MO) ICT Change Management process and secured appropriate approval.

The audit was handled by the Intelligent Energy System (IES), the external auditor previously commissioned by the PAC to audit the CRSS and NMMS modules in 2018 and 2019, respectively, and the subsequent supplemental audits of the NMMS and CRSS in 2020.

Upon completion of the audit of PDM-related enhancements to the NMMS and CRSS, IES issued software certificates confirming that the enhancements were implemented correctly in accordance with ERC Decision promulgated on 29 December 2020 and relevant Market Rules and Manuals.

The PAC wishes to express its appreciation and gratitude to the management of the Philippine Electricity Market Corporation (PEMC) as well as the auditee, Independent Electricity Market Operator of the Philippines (IEMOP), for the cooperation and support they extended to the external auditor for the successful completion of this audit project.

For the PEM Audit Committee,



Felixberto U. Bustos, Jr.
Chairperson



Eduardo Alejandro O. Santos
Member



Christian M. Orias
Member

¹ ERC Decision promulgated on 29 December 2020, "In the Matter of the Application for the Approval of the Price Determination Methodology for the Wholesale Electricity Spot Market", filed by PEMC and docketed as ERC Case No. 2017-042RC

1. ABOUT THIS REPORT

This report provides an executive summary of the results of the independent software audit of the PDM-related enhancements to the NMMS and the CRSS for the enhanced WESM design and operations.

2. EXECUTIVE SUMMARY

2.1. Background

On 29 December 2020, the ERC promulgated its Decision on the ERC Case No. 2017-042RC, *In the Matter of the Application for the Approval of the PDM for the WESM*, which necessitated the implementation of additional changes to the NMMS and CRSS².

The descriptions of software changes based on the directives in the ERC Decision are listed below:

Category	Description	Affected Module
NMMS enhancements	Changes to conditions in the application of the Administered Price (AP)	Post Market Run Calculation - Dispatch Interval Pricing Calculation
	Changes to the Price Substitution Methodology's (PSM) pricing and trigger factor calculation	Post Market Run Calculation - Dispatch Interval Pricing Calculation
	Changes to the application of prices during simultaneous indication of AP and Secondary Price Cap (SEC)	Post Market Run Calculation - Dispatch Interval Pricing Calculation
	Changes to the automatic pricing re-run model during over-generation and under-generation	Market Dispatch Optimization Model
CRSS enhancements	Eligibility of constrained-on generators for additional compensation during PSM intervals. Additional compensation amount calculation for Market Intervention/Suspension (Administered Price), Secondary Price cap and PSM. Additional scope items relating to additional compensation for Trading Participant designated as must-run unit (MRU), including Constrain-on generators as MRU.	Settlement Module
	Identification of customer rate impact per trading participant for Additional Compensation claims;	Settlement Module

² NMMS and CRSS were audited and certified in 2020. [PAC Audit Report](#) was published in PEMC website on 22 October 2020 (Source: <https://www.wesm.ph/market-governance/market-performance-and-audit/market-audit>)

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Category	Description	Affected Module
	customers with rate impact greater than PHP 0.005/kWh will be billed four (4) instalments	
	Ability to modify the mapping of customer switch of supplier from billing month affected to the current month and integration of outputs with AMS ready tables	Settlement Module

In compliance with the ERC Decision, PEMC engaged IES to conduct the independent software audit of the PDM-related enhancements to the NMMS and the CRSS, under the supervision of the PAC. The IES was the external auditor previously commissioned by the PAC to audit the CRSS and NMMS modules in 2018 and 2019, respectively, and the subsequent supplemental audits of the NMMS and CRSS in 2020.

The objectives of the audit engagement are as follows:

- Examine the enhancements to the NMMS and CRSS to assess compliance with the Market Rules and Manuals, and directives of the Energy Regulatory Commission (ERC) through its orders and issuances;
- Issue software certification on the enhancements to the NMMS and CRSS;
- Review whether the development of software enhancements followed the ICT Change Management process and secure appropriate approval; and
- Make recommendations for identified issues.

The kickoff meeting for the audit engagement was held on 11 January 2021 while the actual audit commenced in February 2021. The NMMS enhancements audit was completed in March 2021 with the final report and software certificate finalized in June 2021. On the other hand, the CRSS enhancements audit was completed on the 1st week of August 2021 with the final report and software certificate finalized on 16 August 2021.

2.2. Scope of Review

The scope of the NMMS and CRSS enhancements audit covers the following:

Category	Scope
NMMS enhancements	<ul style="list-style-type: none"> • Post Market Run Calculation - Dispatch Interval Pricing Calculation (DIPC) <ul style="list-style-type: none"> – Administered Price (AP) Conditions – Price Substitution Methodology (PSM) – Price during simultaneous AP and Secondary Price Cap (SEC) • Market Dispatch Optimization Model (MDOM) <ul style="list-style-type: none"> – Automatic pricing re-run <p>Other functions and calculations of the DIPC and MDOM modules are out of scope and were not re-tested. However, relevant features were still tested as part of a compressed regression test in view of the enhancements made to the modules.</p> <ul style="list-style-type: none"> • Change Management Procedures and Controls related to NMMS enhancements
CRSS enhancements	<ul style="list-style-type: none"> • Settlement Module <ul style="list-style-type: none"> – Data retrieval of relevant claim intervals – Eligibility for Additional Compensation and compensation amount – Recovery of additional compensation – Collection of additional compensation – Customer switching – Integration with AMS database <p>Other functions and calculations of the CRSS modules are out of scope.</p> <ul style="list-style-type: none"> • Change Management Procedures and Controls related to CRSS enhancements

2.3. Approach and Testing

The NMMS and CRSS enhancements audit testing approach was consistent with previous supplemental audits. All software testing activities were carried out remotely and the external auditor performed the following:

- Carried out walkthrough of changes with the auditees/process owners and discussed testing requirements

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- Determined whether the changes to the NMMS and CRSS components were consistent with those described in the Market Rules and Manuals, ERC directive, issuances or orders, and software specifications;
- Provided specific recommendations as to how the identified inconsistencies and non-compliance to the rules could be corrected;
- Re-tested and examined software fixes/releases that were deployed to address or remediate the initial findings, to make the relevant NMMS and CRSS components compliant; and
- Reviewed whether the development of software enhancements followed the ICT Change Management process and secured appropriate approvals.

The testing was based on assessing and reviewing the results against an independently determined expected result (a black box testing approach) - this is because the NMMS and CRSS itself cannot be set up as an offsite system. Where relevant, the external auditor also requested for witness testing to ensure data flows across systems were as expected.

For the Change Management Procedure and Controls audit, the documented evidence was audited against the relevant applicable procedures provided by the auditee. As part of the process, the external auditor held meetings with auditees to clarify aspects of the documents provided and, in some cases, requested additional documented evidence which was kindly provided.

2.4. Findings and Recommendations

2.4.1. NMMS Enhancements Audit

All four (4) NMMS enhancements comply with the formulation specified in the ERC Decision:

NMMS Enhancements	Result	Comments
Changes to conditions in the application of the Administered Price (AP)	Pass	None
Changes to the Price Substitution Methodology's (PSM) pricing and trigger factor calculation	Pass	None
Changes to the application of prices during simultaneous indication of AP and Secondary Price Cap (SEC)	Pass	None
Changes to the automatic pricing re-run model during over-generation and under-generation	Pass	None

Meanwhile, the Change Management Procedures and Controls audit revealed two (2) non-conformances in the area of 1) technical assessment; and 2) presenting merits of a change

to the approving authority, that were repeated across all the Change Order Forms reviewed. The auditee has noted the identified non-conformances and indicated that it will undertake a review of the ICT Change Management Procedure to allow flexibility in terms of complying with the requirement. Given that the substantive task of review has been undertaken and that a review of the procedures will be undertaken, the external auditor viewed these 2 non-conformances as minor non-conformances.

However, the external auditor still recommended that the auditee address these non-conformances.

2.4.2. CRSS Enhancements Audit

Likewise, all CRSS enhancements comply with the formulation specified in the ERC Decision:

CRSS Enhancements	Result	Comments
Eligibility for Additional Compensation and compensation amount	Pass	None
Recovery of additional compensation	Pass	None
Collection of additional compensation	Pass	None
CRSS Data retrieval	Pass	None
Customer Switching	Pass	None
AMS Integration	Pass	None

However, there are four areas of improvement relating to consistency between the Business Requirement Document (BRD) and the WESM Billing and Settlement Manual Issue 6.2 dated 29 April 2021 and WESM Price Determination Methodology (PDM) Manual Issue 3.0 dated 25 June 2021, as follows:

- The calculation of eligible quantity for additional compensation in the BRD is inconsistent with the formula in the Billing and Settlement Manual Section 10.3.2. It is recommended that the formula included in the BRD be updated to be consistent with the Billing and Settlement Manual.
- The calculation of the additional compensation claim amount is not specified in the Billing and Settlement Manual or the PDM Manual. It is recommended that the formula included in the BRD is represented in the Billing and Settlement Manual.
- The process of the recovery of additional compensation is inconsistent between the BRD and PDM Manual Section 8.3.4 (c). The BRD refers to recovery on a system-wide and region basis whereas PDM Clause 8.3.4 (c) refers to recovery on a region basis. The external auditor has completed the testing of the recovery of additional compensation

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claims based on PDM Clause 8.3.4 (c) which states that recovery is pro-rated within the region only and not system wide. It is recommended that this inconsistency be resolved.

- The process of the recovery of additional compensation is not specified in Billing Settlement Manual for claims other than MRU. The current recovery process is based on the recovery process for MRU in the PDM Section 8.3.4 (c). It is recommended that the recovery method for claims other than MRU be included in the Billing Settlement Manual.

As part of its mandate, the PAC will monitor the auditee action plans to address the audit recommendations or opportunities for improvements.

2.5. Conclusion

2.5.1. NMMS Enhancements Audit

The audit of the NMMS showed that the 4 NMMS enhancements listed in Section 2.4 were implemented correctly according to the ERC Decision promulgated on 29 December 2021 and Siemens Development/Design Specification dated 12 January 2021.

Meanwhile, the audit of the NMMS change orders revealed that the requirements of the ICT Change Management have been satisfied in the main but with two areas of non-conformance noted. It is recommended that the auditee address the non-conformances mentioned in Section 2.4.

2.5.2. CRSS Enhancements Audit

The audit of the Settlement Module in the CRSS was performed in accordance with the ERC Decision promulgated on 29 December 2020, WESM Manual on Billing and Settlement Issue 6.2 dated 29 April 2021 and WESM Price Determination Methodology Issue 3.0 dated 25 June 2021. The testing summarized in Section 2.4 showed that all six enhancement areas were implemented correctly.

The audit of the CRSS change orders revealed that the requirements of the ICT Change Management have been satisfied. It is recommended that the auditee also review the areas of non-conformance noted in the NMMS findings and recommendations and assess corrective action to be implemented.

Software certificates were accordingly issued attesting that the NMMS and CRSS enhancements were implemented correctly in accordance with ERC Decision promulgated on 29 December 2020 and relevant Market Rules and Manuals (See software certificates in Appendices A and B)

Appendix A – Software Certificate for Audit of NMMS Enhancements

10 June 2021

Mr. Felixberto U. Bustos, Jr.
Chairman, PEM Audit Committee
Philippine Electricity Market Corporation
18/F Robinsons Equitable Tower
ADB Avenue, Ortigas Center
1600 Pasig City, Philippines

Dear Mr. Bustos,

SCOPE OF THIS CERTIFICATE

The purpose of this software certificate is to confirm that the four (4) NMMS enhancements listed below are implemented correctly in accordance with ERC Case No. 2017-042 RC, promulgated on December 29, 2020 (ERC Decision) and Siemens Development/Design Specification, 12 Jan 2021.

- Changes to conditions in the application of the Administered Price.
- Changes to the Price Substitution Methodology's pricing and trigger factor calculation.
- Changes to the application of prices during simultaneous indication of AP and Secondary Price Cap.
- Changes to the automatic pricing re-run model during over-generation and under-generation.

TESTING METHODOLOGY USED FOR SOFTWARE CERTIFICATION

The method used by IES to certify the logic and, where applicable, calculations of each was as follows:

- **Changes to conditions in the application of the Administered Price:** IES independently calculated the administered price using historical EAP and AP flag and snapshot quantities based on the formulation in the ERC Decision and verified that the calculations are consistent under different scenarios of historical AP flags.
- **Changes to the Price Substitution Methodology's pricing and trigger factor calculation:** IEMOP provided the RTD and DIPC results retrieved from the database and IES independently calculated the Price Trigger Factor to confirm if Price Substitution Methodology (PSM) was triggered and that the applicable PSM prices were used in DIPC in scenarios where PSM was triggered. IES checked that the Price Trigger Factor value and trigger conditions was based on the updated formulation and conditions as outlined in the ERC Decision.
- **Changes to the application of prices during simultaneous indication of AP and Secondary Price Cap:** The implementation of this enhancement related to the existing pricing methodology where AP took precedent over SEC, and a feature



to enable the DIPC price to be set based on the minimum of the AP and SEC price. To verify that this was implemented correctly, IES examined the data provided by IEMOP that included intervals where both AP and SEC were triggered.

- **Changes to the automatic pricing re-run model during over-generation and under-generation:** IES received data provided by IEMOP for scenarios of over-generation and under generation. IES specifically checked that the marginal prices (highest offer stack that was cleared) were used instead of the shortage and excess prices.

CERTIFICATION OF NMMS ENHANCEMENTS WITH RESPECT TO REFERENCE DOCUMENTATION

Based on the audit results, the four (4) NMMS enhancements listed below are implemented correctly according to the ERC Case No. 2017-042 RC, promulgated on December 29, 2020 (ERC Decision) and Siemens Development/Design Specification, 12 Jan 2021.

- Changes to conditions in the application of the Administered Price.
- Changes to the Price Substitution Methodology's pricing and trigger factor calculation.
- Changes to the application of prices during simultaneous indication of AP and Secondary Price Cap.
- Changes to the automatic pricing re-run model during over-generation and under-generation.

LIMITATION OF LIABILITY

In furnishing this certification, Intelligent Energy Systems specifically limits its liability in accordance with Clause 5.08 (b) of the Contract for External Audit Services (Independent Software audit of the New Market Management System) dated 17 February 2017. 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



Charles Hugh Bannister
Chairman and CEO

Appendix B – Software Certificate for Audit of CRSS Enhancements

16 August 2021

Mr. Felixberto U. Bustos, Jr.
Chairman, PEM Audit Committee
Philippine Electricity Market Corporation
18/F Robinsons Equitable Tower
ADB Avenue, Ortigas Center
1600 Pasig City, Philippines

Dear Mr. Bustos,

SCOPE OF THIS CERTIFICATE

The purpose of this software certificate is to confirm that CRSS enhancements relating to additional compensation is implemented in accordance with the following:

- ERC Case No. 2017-042 RC, promulgated on December 29, 2020 (ERC Decision)
- WESM Manual Billing and Settlement Issue 6.2, 29 April 2021
- WESM Price Determination Methodology Issue 3.0, 25 June 2021

TESTING METHODOLOGY USED FOR SOFTWARE CERTIFICATION

The method used by IES to certify the calculations of each enhancement was:

- Based on a review of the ERC Decision, IES proposed a set of test cases designed to test the full coverage and correct implementation of the CRSS enhancements.
- IEMOP constructed and provided IES the requested test case files (both inputs and outputs) in Excel which included generator and load data, the additional compensation claims data and the resulting outputs in the CRSS database for each relevant interval in a sample billing month. This included test data across different eligibility criteria.
 - IES checked that the additional compensation claims in these instances were calculated correctly.
 - IES checked that the additional compensation calculated above is correctly allocated to the relevant customers.
 - IES checked the rate impact is calculated correctly and where applicable, there would be four instalments.
 - If the test case outputs are consistent with the relevant rules, manuals, directives, and specifications documents then the enhancement is given a pass.
 - If any issues were identified, IES worked with IEMOP to resolve the issue and have IEMOP remediate the issue.

- For any changes to the CRSS module such as instances where issues were identified and subsequently rectified, the full set of test cases were then re-tested.
- For test cases which involved data transfers from the CRSS system, IES performed witness testing to ensure that data flows across systems were in line with what was expected.

CERTIFICATION OF NMMS ENHANCEMENTS WITH RESPECT TO REFERENCE DOCUMENTATION

Based on the audit results, the CRSS enhancements relating to additional compensation are implemented consistently with the ERC Case No. 2017-042 RC, promulgated on December 29, 2020 (ERC Decision), the WESM Manual Billing and Settlement Issue 6.2, 29 April 2021 and WESM Price Determination Methodology Issue 3.0, 25 June 2021.

LIMITATION OF LIABILITY

In furnishing this certification, Intelligent Energy Systems specifically limits its liability in accordance with Clause 5.08 (b) of the Contract for External Audit Services (Independent Software audit of the New Market Management System) dated 17 February 2017. 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



Charles Hugh Bannister
Chairman and CEO