



# NATIONAL POWER CORPORATION

## SUPPLEMENTAL / BID BULLETIN NO. 1

to the Bid Documents for the  
**Design, Supply, Delivery, Installation, Testing and Commissioning of Palanan Solar PV-Diesel Hybrid System (with ESS) under PR NO. HO-PIB22-011 (PB2)**

**06 October 2022**

All prospective bidders and authorized copy holders of the Bid Documents of the above mentioned project are hereby informed of the changes/clarifications as follows:

### Section VI- Technical Specification

| REFERENCE SECTION              | PREVIOUS VERSION   | REVISED VERSION  |                               |   |                  |                                  |
|--------------------------------|--|--|-------------------------------|---|------------------|----------------------------------|
| EW – 2.0 Energy Storage System |  | <ul style="list-style-type: none"> <li>Replace the whole section with the attached revised EW-2.0 Energy Storage System</li> </ul> |                               |   |                  |                                  |
| TDS – Annex F-7.3              | <table border="1"> <tr> <td>Chemistry</td> <td>NMC, LMO or Blended LMO / NMC</td> </tr> </table> | Chemistry  | NMC, LMO or Blended LMO / NMC | <table border="1"> <tr> <td>Chemistry</td> <td>NMC, LMO, Blended LMO / NMC, LFP</td> </tr> </table> | Chemistry        | NMC, LMO, Blended LMO / NMC, LFP |
| Chemistry                      | NMC, LMO or Blended LMO / NMC  |  |                               |   |                  |                                  |
| Chemistry                      | NMC, LMO, Blended LMO / NMC, LFP   |  |                               |   |                  |                                  |
| TDS – Annex G-7.8              | <table border="1"> <tr> <td>G-7.8</td> <td>Housing</td> </tr> </table>                           | G-7.8  | Housing                       | <table border="1"> <tr> <td>G-7.8</td> <td>ESS Enclosure/Cabinet</td> </tr> </table>                | G-7.8            | ESS Enclosure/Cabinet            |
| G-7.8                          | Housing  |  |                               |   |                  |                                  |
| G-7.8                          | ESS Enclosure/Cabinet  |  |                               |   |                  |                                  |
| TDS – Annex G-8.3              | <table border="1"> <tr> <td>Chemistry</td> <td>Refer to EW-2.4.2(c)</td> </tr> </table>          | Chemistry  | Refer to EW-2.4.2(c)          | <table border="1"> <tr> <td>Chemistry</td> <td>NMC, LMO, Blended LMO / NMC, LFP</td> </tr> </table> | Chemistry        | NMC, LMO, Blended LMO / NMC, LFP |
| Chemistry                      | Refer to EW-2.4.2(c)   |  |                               |   |                  |                                  |
| Chemistry                      | NMC, LMO, Blended LMO / NMC, LFP   |  |                               |   |                  |                                  |
| TDS – Annex G-8.6              | <table border="1"> <tr> <td>• Cycle Lifetime</td> <td>At least 4000</td> </tr> </table>          | • Cycle Lifetime   | At least 4000                 | <table border="1"> <tr> <td>• Cycle Lifetime</td> <td>At least 5000</td> </tr> </table>             | • Cycle Lifetime | At least 5000                    |
| • Cycle Lifetime               | At least 4000  |  |                               |   |                  |                                  |
| • Cycle Lifetime               | At least 5000  |  |                               |   |                  |                                  |

### Bid Submission and Opening:

| FROM                                      | TO  |
|---|---|
| 13 October 2022<br>9:30 A.M. @ Kanao Room | 20 October 2022<br>9:30 A.M. @ Kanao Room |

All other part of the Bid Documents will remain unchanged. For the information and guidance of all concerned.

For the Bids and Awards Committee:

  
**RENE B. BARRUELA**

Vice President, Corporate Affairs Group and  
Chairman, Bids and Awards Committee

BIR Road cor. Quezon Avenue, Diliman  
Quezon City 1100, Philippines  
Tel. Nos. (632) 921-3541 to 80  
Fax No. (632) 921-2468  
Website: [www.napocor.gov.ph](http://www.napocor.gov.ph)



Management System  
ISO 9001:2015



[www.tuv.com](http://www.tuv.com)  
ID 9109650265

**PART I – TECHNICAL SPECIFICATIONS**

**EW – ELECTRICAL WORKS**

**EW – 2.0 – ENERGY STORAGE SYSTEM**

**TABLE OF CONTENTS**

| <u>CLAUSE NO.</u> | <u>TITLE</u>  | <u>PAGE NO.</u> |
|-------------------|---|-----------------|
| <b>EW-2.0</b>     | <b>ENERGY STORAGE SYSTEM .....</b>                    | <b>1</b>        |
| EW-2.1            | Definition of Terms .....                             | 1               |
| EW-2.2            | Scope of Works.....                                   | 2               |
| EW-2.3            | Site Conditions .....                                 | 3               |
| EW-2.4            | Energy Storage System (ESS) .....                     | 3               |
| EW-2.4.1          | Battery Management System (BMS) .....                 | 3               |
| EW-2.4.2          | Battery Modules/Batteries .....                       | 4               |
| EW-2.4.3          | Power Conversion System (PCS) / Battery Inverter..... | 5               |
| EW-2.4.4          | ESS Control System (ECS) / ESS controller .....       | 5               |
| EW-2.4.5          | ESS Digital Energy Meter.....                         | 5               |
| EW-2.4.6          | ESS Enclosure/Cabinet.....                            | 7               |
| EW-2.4.7          | ESS Transformer.....                                  | 8               |
| EW-2.5            | Warranty .....  | 17              |
| EW-2.6            | Track Record.....                                     | 17              |
| EW-2.6.1          | ESS Manufacturer .....                                | 17              |
| EW-2.6.2          | Battery Manufacturer .....                            | 17              |
| EW-2.7            | Measurement of Payment.....                           | 17              |

## PART I – TECHNICAL SPECIFICATIONS

### EW – ELECTRICAL WORKS

#### EW-2.0 ENERGY STORAGE SYSTEM

This section provides the definition, scope of works, functional/ performance requirements, technical specifications, and standards for the Energy Storage System (ESS).

#### EW-2.1 Definition of Terms

- a) **State of Charge (SoC)** is the level of charge of a battery system/module measured from 0%. 0% SoC refers to a fully discharged battery and 100% SoC refers to a fully charged battery.
- b) **Depth of Discharge (DoD)** is the level of charge of the battery system/module measured from 100% SoC. 100% DoD refers to a fully discharged battery and 0% DoD refers to a fully charged battery.
- c) **Maximum Normal State of Charge (MaxNSoC)** is the SoC at which the ESS can be charged at maximum rate (i.e. prior to taper/trickle charge).
- d) **Minimum Normal State of Charge (MinNSoC)** is the SoC specified by the ESS/battery manufacturer at which the ESS can inject power to the interconnection point at full rated power. At MinSoC, the ESS must be able to inject full power for at least 5 seconds.
- e) **Usable Range of SoC** is the range between MaxNSoC and MinNSoC.
- f) **Usable Energy** is the kWh capacity available of the Usable Range of SoC.
- g) **State of Health (SoH)** is an indicator of the remaining capacity of the battery system/module to deliver the required Usable Energy. It shall reflect remaining life, in equivalent full cycles of the battery, and indicate if the battery system/ module need replacement.
- h) **Beginning of Life (BoL)** is the instance that ESS begins operation during conduct of Commissioning Tests.
- i) **End of Life (EoL)** is defined as the instance where the Usable Energy falls below the required value as determined by the SoH indicator and/or a performance test.
- j) **Cycle Lifetime** is the number of full charge and discharge cycles between the EoL and BoL at nominal C rating @25°C.
- k) **Power Conversion System (PCS)** refers to the subsystem of the ESS that contains inverter(s), power electronics, circuit breakers, transformers, switchgears and safety systems required for the ESS to inject and absorb electricity between the interconnection point (e.g. busbar) and the battery system.



- l) **ESS Control System (ECS) / ESS controller** refers to the control system of the ESS.
- m) **Battery Management System (BMS)** refers to the sub-system of the ESS that monitors and controls the battery units and ensures proper charge and discharge of the battery modules.
- n) **Battery modules** are the smallest modules/ unit of energy storage that is user replaceable without the use of specialized tools and equipment. They are made of individual battery cells connected in series/parallel or combination thereof.
- o) **Energy Storage System (ESS)** refers to the system responsible for the storage and discharge of electricity depending on the power system requirements. It is composed of the following sub systems:
- Battery Management System
  - Battery Modules / Batteries
  - Power Conversion Systems / Battery Inverter
  - ESS Control System / ESS Controller
  - ESS Transformer

#### **EW-2.2 Scope of Works**

The general scopes of work are enumerated below. Additional details are provided in the relevant sections of the tender.

- a) All services, materials, and equipment necessary for the proper installation, maintenance, and operation of the ESS. (e.g. ESS enclosure/cabinet, ESS transformer, communication, control and power cabling, cable trays, conduits, connection hardware, safety, and protection equipment, etc.).
- b) The ESS shall be supplied and integrated as a complete operational equipment/system consisting of its appurtenances, tools, sub-systems, firmware, and software; including all items not specifically mentioned but are essential to the proper operation of the ESS as required herein. **The BMS, batteries and its racks shall be supplied together under one brand/manufacturer.**
- c) Back-to-back guarantee/warranty with equipment manufacturer(s). Supplier shall provide/extend all warranties provided by the manufacturer to NPC. In case the supplier is unable to rectify/remedy defects in the product, they shall shoulder all expenses that the manufacturer may levy to remedy/rectify the defects.
- d) Complete documentation:
- Design and as-built drawings.
  - Installation, Operation and Maintenance Manuals
  - Electrical circuit diagrams
  - Performance Monitoring Test, Factory and Site Acceptance Test procedures.
  - Back-up copies of control programs (firmware and other configuration software)



- Other relevant documents (if any).
- e) Training of plant and technical services personnel regarding ESS as part of the plant as specified in *GW-14.0 Training of NPC Personnel*.

**EW-2.3 Site Conditions**

- a) Environmental Conditions (refer to Section VI – GW 5.0, Design & Duty Conditions)
- b) The ESS enclosure/cabinet shall have a footprint/area adequate to house all the major and appurtenant equipment of ESS (considering clearance requirements from adjoining equipment and structures). Refer to Section IX – Reference Drawings, Proposed Equipment Layout for the allocated space for the ESS.

**EW-2.4 Energy Storage System (ESS)**

The ESS shall mainly function as **grid stabilization equipment** by providing ancillary services. It shall support the operation of the whole power plant by providing buffer power in the event there is power and/or frequency fluctuations (e.g. Power output of the solar plant suddenly drops due to shading caused by cloud formation).

It shall have a power rating of (*refer to Section VI – GW 6.0 Supplier's scope of works*) (continuous) and a usable energy of at least (*refer to Section VI – GW 6.0 Supplier's Scope of Works*).

Bi-directional (Import and Export) Digital Energy Meter shall be provided to account for energy import and export to and from the ESS. It shall be connected to the 3-phase, 60Hz system between the ESS and the ESS transformer.

The operating voltage of the ESS and the output voltage of the PCS respectively shall depend on the equipment manufacturer's specifications. However, the high voltage side of the ESS transformer shall be 13.8kV (line to line).

Roundtrip efficiency of the ESS must be at least 80%. Efficiency shall include/account the energy utilized by the cooling system, lighting, BMS, PCS and ECS/ESS Controller.

Detailed specifications of its components are provided in the succeeding sections.

**EW-2.4.1 Battery Management System (BMS)**

The BMS shall control and monitor all battery module parameters. e.g. SoC/DoD, string/module voltage, current, temperature, impedance (or equivalent parameter to indicate the "health" of the battery modules).

SoH data shall be available while the ESS is in operation and shall be revalidated by a performance test to be conducted at least once a year (or as the need arises).

The BMS shall automatically control the charge/discharge of all batteries including cell balancing, equalization and other maintenance and safety functions/procedures to ensure proper operation of the battery system. The same function can be triggered manually if necessary.

- a) The BMS must be capable of keeping the operational history of individual battery modules. Operation of the battery module shall be managed individually to account for different module characteristics. Minimum parameters to be logged are as following:
- Module voltage
  - Module current
  - Replacement history of battery module
  - Module faults/alarms
  - Module temperature
  - State of Charge (SoC) / Depth of Discharge (DoD)
  - State of Health
- b) The bidder/manufacturer shall specify the MinNSoC and MaxNSoC as defined in EW-2.1 of this section.

#### **EW-2.4.2 Battery Modules/Batteries**

- a) Usable Energy of the batteries shall be at least (*refer to Section VI – GW-6.0 Supplier's scope of works*) within the warranty period. Testing shall be performed during factory acceptance, commissioning and at least once a year, or as the need arises (i.e. performance test) to ascertain the amount of usable energy. Bidder/manufacturer shall provide all test procedures subject to review and approval of the National Power Corporation.
- b) Batteries shall have a minimum cycle lifetime of at least 5000 cycles @ nominal C-rate @25°C. The nominal C-rate of the battery to be supplied shall be 1C or higher. **It shall self-discharge for not more than 10% of its capacity per month.** The remaining cycles shall be translated into the SoH indicator parameter. This model shall be implemented in the BMS and shall be validated and adjusted (if necessary) during the conduct of annual performance tests.
- c) Battery cell shall be prismatic format with an acceptable battery chemistries such as Lithium Manganese Oxide (LiMn2O4–LMO), Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2–NMC), blended NMC/LMO and Lithium Ferrous Phosphate (LiFePO4–LFP).
- d) Battery Modules shall be self-contained, modular and user replaceable without the need for specialized equipment. For purposes of transport and installation, gross weight of each battery module shall not exceed 60kgs.
- e) Each battery module (if possible, each cell) shall be equipped with overcharge, short circuit, and thermal runaway protection. Each battery rack shall be protected by fuse and/or by DC circuit breaker against electrical fault, this also serves as the main disconnecting means for repair and maintenance.
- f) Batteries must be compliant to IEC 62619 or UL 1642. Test certificate of the batteries shall be submitted during post-qualification.

**EW-2.4.3 Power Conversion System (PCS) / Battery Inverter**

- a) The PCS shall have the following functionalities:
- Parallel operation;
  - Capable to provide ancillary services;
  - Provide Short Circuit Current sufficient to trigger circuit breakers and other protection devices for duration of not less than 50ms;
  - Provision of reactive power;
  - Frequency Control. The nominal system frequency shall be 60Hz and shall be maintained within the limits of 59.7Hz and 60.3Hz during normal conditions based from **Philippine Distribution Code 2017**;
  - Voltage Control; and
  - Fault ride through with programmable voltage and duration.
- b) The PCS shall have a nominal power rating (net of ESS auxiliary power requirements) with 110% overload capability of at least ten (10) minutes.
- c) PCS must be able to perform Power Swing necessary to compensate for sudden loss of generation from either the diesel generators or the solar PV plant.
- d) The PCS shall have the capability to support the changes in power direction of the battery (from charge to discharge and vice versa) within 200ms.

**EW-2.4.4 ESS Control System (ECS) / ESS controller**

- a) The ECS / ESS controller shall serve as the interface between the Hybrid controller and the ESS. It shall ensure that the ESS is able to respond to the commands of the Hybrid controller in performing all its functional requirements as specified herein.
- b) The ECS / ESS controller shall be equipped with its own control interface that can display the status of the ESS and its components. The interface must be capable of monitoring operational and maintenance history of the ESS (of the SoC and "health" of each battery module).

**EW-2.4.5 ESS Digital Energy Meter**

This specification covers the technical and associated requirements for the ESS digital energy meter including instrument transformer and accessories required for the electric generating plants.

**EW-2.4.5.1 Technical Characteristics and Requirements**

The ESS digital energy meter shall be furnished and installed by the Supplier as shown on the bid drawings complete with stainless steel housing, test block and associated metering instrument transformers (current transformers) of appropriate burden and accuracy and other accessories for indoor metering purposes. It shall be capable to measure the power generated and received by the ESS. It shall be designed to operate continuously for the normal life of the



meter. The digital energy meter shall meet the following minimum requirements:

| ITEM | DESCRIPTION   | REQUIREMENTS                         |
|------|---|--------------------------------------|
| 1    | Number of Wires   | 3 or 4                               |
| 2    | Voltage, V  | 120-480                              |
| 3    | Accuracy class  | 0.2s                                 |
| 4    | Current Range   | Class 10                             |
| 5    | Frequency, Hz   | 60                                   |
| 6    | Register Type   | LCD                                  |
| 7    | Soft Switches   | Available                            |
| 8    | LCD Display   | Programmable                         |
| 9    | The Kilowatt-hour meter to be provided is certified and approved by ERC | Yes                                  |
| 10   | Communication Port for Kilowatt-hour meter                              | To be Provided                       |
| 11   | Meter Test Block  |                                      |
|      | No. of Poles  | 10 (4 Voltage & 6 Current Terminals) |
|      | Rated Voltage, V  | 600V                                 |
|      | Equipment Standard  | ANSI C12.9                           |
|      | Test Block Cover  | Required                             |
| 11   | Metering Current Transformer  |                                      |
|      | a. Application (Indoor/Outdoor)   | Indoor                               |
|      | b. Insulation type  | Full cast epoxy resin                |
|      | c. Primary rated current, A   | By Supplier                          |
|      | d. Secondary rated current for all windings, A                          | 5                                    |
|      | e. No. of cores   | One (1) core Secondary CT            |
|      | f. CT ratio   | By Supplier                          |
|      | g. Burden, VA   | 2.5                                  |
|      | h. BIL, kV  | 10                                   |

In extreme cases, the Supplier shall furnish, if necessary, indoor type potential transformer with the same BIL rating. The transformer shall have appropriate voltage ratio which is suitable for ESS digital energy meter and ESS AC voltage system. All costs associated with the supply and installation of such transformer shall be to the account of the Supplier.

The ESS digital energy meter shall have but not limited to the following features:

1. Pilferage proof
2. Tamper Proof
3. Wrong Wiring Alarm
4. Current Flow display



5. Can withstand the temperature of -20°C to +70°C and Humidity of up to 95% non-condensing
6. With back light display
7. With built-in battery for LCD display and back-up battery
8. TOU Programmable Ready
9. Measure display (Energy, RMS voltage & current per phase, Reactive & Apparent Power, Power factor, Frequency, Calendar, Time and etc.)

The ESS digital energy meter with the required metering instruments shall be enclosed by a separate enclosure for proper protection and safety against water droplets, dust, exposure of energized conducting material and the like without additional cost to NPC.

For ESS digital energy meter, communication ports shall be provided or available in the energy meter exclusively intended for electronic reading, hence reading the data determined from the computer remotely from the meter. Electronically gathering of data can logged parameters to the computer such as instantaneous parameters, billing information, load survey, events or tampers, transactions, etc.

#### **EW-2.4.6 ESS Enclosure/Cabinet**

- a) The ESS shall be self-contained in its own free-standing enclosure/cabinet. It shall be supported with a suitable foundation. The ESS enclosure/cabinet shall have a footprint/area adequate to house all the major and appurtenant equipment of ESS (considering clearance requirements from adjoining equipment and structures).

For enclosure integrated by the ESS manufacture to package the system into a single compact or multiple containerized housing shall be permitted provided that it is rated for outdoor operation with a minimum required IP rating and shall comply all applicable provisions thereon.

- b) The ESS shall be equipped with a built-in redundant cooling system to control and maintain the temperature required inside the battery compartment. It shall be tropicalized and can operate automatically. It shall be configurable and programmable to be able to reboot and operate itself with automatic switchover, whenever there is a fault on the first cooling equipment, without human intervention (e.g. manual switching).
- c) ESS enclosure/cabinet shall be rated of at least IP55 and 2-hour fire rating.
- d) The ESS shall have adequate protection to prevent unauthorized access to the ESS.
- e) ESS shall be equipped with emergency stop buttons outside the enclosure/cabinet.
- f) ESS enclosure/cabinet together with its enclosed non-current carrying metal frame shall be connected to ground and protected from any unexpected electricity leakage.

**EW-2.4.7 ESS Transformer**

**EW-2.4.7.1 General**

This specification covers the technical and associated requirements for the ESS transformer and accessories for use in electric generating plants. The rating of this transformer is specified in the **Technical Data Sheets** and in **GW –6.0 Supplier's Scope of Works**. The supplied transformer shall be in accordance with the latest revision of IEEE Std. C57.12.00.

**EW-2.4.7.2 Technical Requirements**

The supplied ESS transformer for Palanan Energy Storage System shall meet the following minimum requirements:

| ITEM | DESCRIPTION                   | REQUIREMENTS   |
|------|-------------------------------|--|
| 1    | Type of Cooling               | ONAN   |
| 2    | Insulation                    | Mineral Oil with its electrical and chemical characteristics is compliant with IEC and is Polychlorinated Biphenyls (PCB) free |
| 3    | Type                          | Two-winding Transformer  |
| 4    | Audible Sound Level           | Refer to Table specified under EW-2.4.7.3.8  |
| 5    | Vector Group                  | YNd11  |
| 6    | Temperature                   |  |
|      | a. Ambient Temperature        | 40°C   |
|      | b. Temperature Rise           | 65 °C  |
| 7    | Winding Connection            |  |
|      | • H-Winding                   | Wye with Neutral Grounded  |
|      | • X-Winding                   | Delta  |
| 8    | Insulation Level              |  |
|      | a. Nominal Voltage Level, kV  |  |
|      | ▪ H-winding                   | 13.8   |
|      | ▪ X-winding                   | By Supplier  |
|      | b. Highest Voltage Level, kV  |  |
|      | ▪ H-winding                   | 15   |
|      | ▪ X-winding                   | By Supplier  |
|      | c. Basic insulation level, kV |  |
|      | ▪ H-winding                   | 95   |
|      | ▪ X-winding                   | By Supplier  |
| 9    | Winding Material              | 100% Copper  |
| 10   | Bushing Material              | Porcelain  |
| 11   | % Impedance at Rated kVA      | Manufacturer's Data  |



|      |  |   |
|------|--|---|
| 12   | Efficiency   |   |
|      | a. At 100% load  | By Supplier   |
|      | b. At 75% load   | By Supplier   |
| 13   | Tap Changer  | No-Load   |
| 14   | Taps   |   |
|      | a. H-Winding   | 13.8 kV ± 2 x 2.5%                                      |
|      | b. X-Winding   | N/A   |
| 15   | Transformer Losses   |   |
|      | a. No-Load Loss, W   | By Supplier   |
|      | b. Load Loss, W  | By Supplier   |
| 16   | Tolerances   |   |
|      | a. No-Load & Load Loss                                       | Not more than 10% of the manufacturer's specified value |
|      | b. Total Loss  | Not more than 6% of the manufacturer's specified value  |
|      | c. Impedance   | ± 10% of the manufacturer's specified value             |
| 17   | Ground Terminal Connection                                   | Suitable for 100 mm <sup>2</sup> copper conductor       |
| 18   | Weight of oil, kg  | By Supplier   |
| 19   | Total Weight, kg   | By Supplier   |
| 20   | Test and Experience Requirements                             |   |
| 20.1 | Test Requirements <sup>1</sup>                               |   |
|      | a. Routine Test to be performed                              | Yes   |
|      | b. Certified Design and Routine Test Reports to be submitted | Yes   |

**EW-2.4.7.3 Design Requirements**

**EW-2.4.7.3.1 Rating**

The transformer rating specified in the Technical Data Sheets shall be the basis of the Supplier's guarantee as to performance and temperature rise. The ratings indicated are based on actual load requirements at the service and operating conditions specified herein.

**EW-2.4.7.3.2 Voltage**

The transformer to be supplied shall be designed to withstand the over voltages for the duration of voltage excursions which may be expected as a result of full load rejection of the inverters.

<sup>1</sup> Test Report of a licenser instead of the Supplier's Manufacturer shall not be accepted.



**EW-2.4.7.3.3 Frequency**

Frequency for operation shall be 60 Hz.

**EW-2.4.7.3.4 Overload Requirement**

The overload rating and operation shall be in accordance with all cyclic loading duties as specified in IEC 60076-7. The overload capability of any auxiliary equipment such as bushings, LTC's, CT's, oil expansion tanks, leads, etc. shall not be less than the transformer overload rating. If other considerations will limit the overload capability of the transformer, the Supplier shall specify these limitations in his proposal.

**EW-2.4.7.3.5 Short Circuit Withstand Capability**

The transformer shall withstand the mechanical and thermal stresses produced by external short-circuit currents specified in IEEE Std. 57.12.00 (latest revision).

**EW-2.4.7.3.6 Transformer Loss Evaluation**

Depending on the requirement stated in the Technical Data Sheets, the Supplier is required to fill-in all the information for the transformer losses in the Technical Data Sheets for the ESS transformer and station service/dry-type transformer in order for the NPC to fully determine the most cost effective of the proposed transformer(s) to be supplied considering both cost of losses and first cost.

The transformer shall be designed for the most economical loss ratio (copper loss/iron loss) for the application as specified in the Technical Data Sheets for the transformer.

**EW-2.4.7.3.7 Impedance and Reactance**

The impedance and reactance shall be stated in the Proposal.

**EW-2.4.7.3.8 Audible Sound Level**

Sound levels decibels (dB) at rated voltage and frequency for liquid immersed ESS transformer shall be as below. The average sound level of the transformer shall not exceed these values when measured in accordance with the conditions outlined in the latest ANSI/IEEE C57.12.90 or IEC 60076-10 for oil-immersed transformers or ANSI/IEEE C57.12.91 or IEC 60726 for dry-type transformers.

| Equivalent Two-winding, kVA | Average Sound Level, dB |
|-----------------------------|-------------------------|
| 1-50                        | 48                      |
| 51-100                      | 51                      |
| 101-300                     | 55                      |



|         |    |
|---------|----|
| 301-500 | 56 |
| 750     | 57 |
| 1000    | 58 |
| 1500    | 60 |
| 2000    | 61 |
| 2500    | 62 |

**EW-2.4.7.3.9 Tolerances**

The transformer shall be designed and manufactured with tolerances in accordance with applicable ANSI/IEC/IEEE standards.

**EW-2.4.7.3.10 Electrical Insulating Oil**

The Supplier shall furnish oil with quality suitable as an insulant and coolant for transformers. The oil shall be new naphthenic based mineral oil meeting the requirements of the latest ASTM D3487 (Specification of Mineral Insulating Oil Used in Electrical Apparatus).

Insulating liquid must not contain more than 2PPM of Polychlorinated Biphenyl (PCB), classified as "PCB free". The Supplier shall submit a certification from the manufacturer of the transformer that the transformer oil does not contain PCB and the laboratory analysis shall be conducted by a DENR-Accredited Laboratory.

The Supplier shall state the commercial name and specifications of the oil to be furnished. NPC reserves the right in the future to use any oil which meets the above specifications and the use of such oil shall not affect the Supplier's guarantee.

**EW-2.4.7.4 Design and Construction Features**

**EW-2.4.7.4.1 General**

The transformer design, manufacture and assembly shall minimize vibration and shall prevent damage by inherent vibration and stress during operation, transportation and short circuits.

**EW-2.4.7.4.2 Cores**

Cores for the transformers shall be constructed of the highest quality, non-aging high permeability grain oriented silicon steel. The steel shall be in thin laminations, annealed after cutting and rolled to ensure smooth surface at the edges.

The laminations must be free from impurities and must receive stress relief treatment after punching. The laminations shall be accurately flattened, especially at the edges and insulated by suitable procedures with long life heat resistant insulating coat.



Both sides of each sheet shall be insulated with a durable, heat resistant insulation. The cores shall be held firmly by core clamp and brace to ensure adequate mechanical strength to support the winding and to withstand without damage or deformation, the forces, caused by short circuit stresses, transportation or handling to prevent shifting of the core laminations.

The core shall be solidly grounded to the tank and shall be provided with approved lifting devices or lifting lugs at suitable points of the core assembly for core lifting.

#### **EW-2.4.7.4.3 Windings**

Windings for transformer shall be of the best modern design of conductor having constant cross-section and uniform insulation or graded insulation as required. The coils shall be wound and supported in a manner to provide sufficient oil ducts which will be maintained without constriction.

End coils shall have extra insulation. Coils shall be made up, shaped and braced to provide for expansion and contraction due to temperature changes in order to avoid abrasion of insulation and provide rigidity to resist movement and distortion caused by abnormal operating conditions.

Adequate barriers shall be provided between windings and core and between high and low voltage windings. End coils shall have extra protection against abnormal line disturbances. Permanent current-carrying joint for splices shall be welded or brazed, properly formed and finished, and insulated to conform to the basic insulation.

Winding conductor shall be free from scars, burrs and splinters and shall be uniformly insulated.

The completed assembly of core and coils shall be vacuum dried, immediately impregnated and immersed in dry oil. They shall be adequately braced to withstand ocean shipment, short-circuit forces and earthquakes.

#### **EW-2.4.7.4.4 Bushing**

All porcelains used in bushing shall be wet process, homogenous, and free from cavities or other flaws. The glazing shall be uniform in color and free from blisters, burrs and other defects. All porcelain parts shall be one piece. The bushings of the same rating shall be interchangeable.

Bushing up to 110 kV BIL shall be porcelain bulk type whereas bushings above 110 kV BIL shall be condenser-type. In the latter case, the bushing shall be provided with capacitance test tap.

Bushings shall have the continuous current-carrying capacity necessary to carry the full 65°C temperature rise. The bushings shall also be capable of carrying overload currents as required by EW-2.4.7.3.4

The terminal pads shall be of high conductivity bronze or copper and shall be plated with hot flowed electro silver or electro-tin. Whenever a larger terminal

pad is required for higher current rating, the mounting holes shall conform to NEMA Standards.

The HV and LV terminations of the ESS transformer shall be fitted with suitable insulating shroud. The insulating shrouds shall be manufactured through dip moulding process and shall be made from flexible polyvinyl chloride (PVC) material, suitable for low voltage to high voltage applications. The insulating shroud shall be flame retardant, conforming with the UL 94 Standards. They shall be type tested for electric strength in accordance with IEC 60243-1 or approved equivalent standards.

#### **EW-2.4.7.4.5 Gasket**

Gaskets shall be unaffected by hot insulating oil, retain their resiliency during the life of the associated equipment, and be unaffected by weather while maintaining oil and gas tightness. Nitrile rubber gaskets are acceptable. Gaskets of neoprene and/or any kind of impregnated/bonded cork or cork only are not acceptable. Gasket flanges shall have grooves or metal stops to prevent over compression of gaskets. All bolted transformer tank or accessory openings shall be gasketed.

#### **EW-2.4.7.4.6 Tank**

The transformers shall be housed in a steel tank with all permanent joints molded, backed up by a sturdy steel structure as required to obtain the desired rigidity and strength. The material shall be of high grade steel plate having good welding qualities. All seams, flanges, lifting and jacking lugs, braces and other parts attached to the tank shall be welded. No rivets shall be used. The cover shall be bolted type. The tank shall be able to withstand an internal pressure with oil at operating level.

All openings such as joint between the case and cover, bushings insulation mountings, etc., shall have welded on flanges to provide gaskets surfaces and allow for bolt holes. No bolts shall pass to the inside of the case and cover. Flanges shall have gaskets which will remain oil-tight and will not deteriorate under severe conditions. The tank with radiator fitted shall be tested for leaks before painting.

#### **EW-2.4.7.4.7 Radiators**

Radiators, if to be provided, shall be bolted to the main transformer tank and readily detachable. Isolation valves shall be fitted to the tank to permit radiator removal without draining the main tank. Separate filling plugs, air bleed plugs and drain plugs shall be fitted to each radiator section. Radiators shall be galvanized externally prior to etching and painting. Particular attention shall be given to their internal cleaning and painting to ensure that the radiators arrive in a serviceable condition. All radiators shall be completely sealed with blanking plates and neoprene seals for transport. They shall be thoroughly dried before shipment.

**EW-2.4.7.4.8 Hardware**

All energized hardware, i.e., bolts, nuts and washers shall be made of tinned copper alloy material such as silicon bronze or equivalent. All other hardware shall be hot-dip galvanized.

**EW-2.4.7.5 Fittings and Accessories**

The following transformer accessories shall be included:

- a) HV Bushing
- b) Oil Level Indicator
- c) Oil Sampling Plug
- d) Oil Drain Valve
- e) Oil Temperature Indicator
- f) Pressure Relief Valve
- g) Lifting Lugs
- h) Anchor Bolts
- i) Earthing Terminals
- j) HV/LV Insulating Shroud

**EW-2.4.7.6 Equipment and Marking**

The transformer shall be provided with a stainless steel nameplate in accordance with the latest standard of IEC60076-1, fitted in a visible position showing the information indicated below. The entries on the plate shall be indelibly marked.

- a) Kind of transformer
- b) Number of this standard
- c) Manufacturer's name
- d) Manufacturer's serial number
- e) Year of manufacture
- f) Number of phases
- g) Rated power (in kVA or MVA)
- h) Rated frequency (in Hz)
- i) Rated voltages (in V or kV) and tapping range
- j) Rated currents (in A or kA)
- k) Connection symbol
- l) Short circuit impedance (in %Z)
- m) Type of cooling (i.e. OA, ONAN, etc.)
- n) Insulation voltage (withstand voltages)
- o) Insulating liquid
- p) Temperature rise (in °C)
- q) Total mass, kg
- r) Mass of insulating oil

The minimum recommended dielectric strength of oil filling the transformer shall also be engraved on this plate. The rating plate and any other instructions or designations shall be in the English language.



**EW-2.4.7.7 Standard and Common Tools**

The Manufacturer of transformer shall provide standard/common tools for use in the installation/maintenance of transformer.

**EW-2.4.7.8 Tests**

All tests shall be performed as per latest revision of ANSI C57.12.90 Factory Test shall include, but not limited to the following:

**EW-2.4.7.8.1 Routine Test**

1. Ratio, Polarity and Phase Relation Test
2. No Load Losses and Excitation Current at rated Voltage and Frequency
3. Induced Potential Test (Low-frequency Dielectric Test)
4. Mechanical (Leak Test)

**EW-2.4.7.8.2 Design Test**

1. Winding Resistance Measurement Test
2. Impedance Voltage and Load Loss Measurement
3. Temperature Rise
4. Lightning Impulse
5. Audible Sound Level
6. Mechanical (Lifting & Moving Devices, Pressure Test)

**EW-2.4.7.8.3 Miscellaneous Test**

1. Insulation Power Factor
2. Insulation Resistance
3. Short Circuit Capability

**EW-2.4.7.8.4 Site Test**

The Supplier shall perform all tests specified by the equipment Manufacturer, applicable standards and as necessary to verify the proper operation of the equipment in the presence of NPC representatives.

1. Check level and alignment of the installed transformer;
2. Check tightness of connections and fastenings;
3. Check proper grounding;
4. Check oil level monitors, nameplate, vent plugs;
5. Check wire and cable connections;
6. Check cable glands and entrance; and
7. Check on the proper installation of transformer accessories.
8. Winding resistance
9. Insulation Resistance
10. Transformer Turns Ratio
11. Dielectric Test

**EW-2.4.7.9 Failure to Meet Guarantees**

Depending on the requirement stated in the Technical Data Sheets, the transformer will be tested for compliance with the Manufacturer's guaranteed losses. If the transformer losses, as determined by test, at rated voltage, frequency and 100% rated kVA exceed the guaranteed total losses, the excess in losses shall be evaluated at the following rated cost and the resulting amount shall be deducted from the contract price.

$$S = 2 [(N_{L-L}) (N_{LM} - N_{LG}) + (L_L) (L_{LM} - L_{LG})]$$

Where:

- S = Amount to be deducted from the Contract Price
- $N_{L-L}$  = Price in Php/Watt for the no-load losses as stated in the Technical Data Sheets
- $N_{LM}$  = Measured no-load losses expressed in Watt
- $N_{LG}$  = Guaranteed no-load losses as stated on the Technical Data Sheets
- $L_L$  = Price in Php/Watt for the load losses as stated in the Technical Data Sheets
- $L_{LM}$  = Measured load losses expressed in Watt
- $L_{LG}$  = Guaranteed load losses as stated on the Technical Data Sheets

When the excess of the total losses reaches five percent (5%), NPC shall have the right to reject the transformer for which such excess is verified during the factory acceptance test.

Successful Bidder shall promptly provide NPC one (1) original and three (3) certified copies of all test data and reports on the transformer.

**EW-2.4.7.10 Data and Documentation Requirements**

The following documents shall be submitted after award of contract for NPC's review and approval prior to procurement and installation of the supplied equipment and materials:

1. Outline drawings of transformer and accessories showing the following:
  - a) General Dimensional Drawing
  - b) Sectional Drawing
  - c) Nameplate Drawing
  - d) Marshaling box with connection diagram
2. Description and instructions covering the installation, operation and maintenance of the transformer and accessories;
3. Duly signed Routine Test Results; and

4. Field Test to be Performed and Certified Test and Inspection Reports duly signed and witnessed by NPC representative

**EW-2.5 Warranty**

The ESS including but not limited to the Battery Management System, Battery Modules/Batteries, Power Conversion System(s)/Battery Inverter, ESS Control System/ESS controller, and ESS transformer shall have a minimum warranty of five (5) years. This warranty shall be covered by a back-to-back warranty arrangement with the manufacturer. The supplier shall submit its warranty agreement with the manufacturer that stipulates the scope and responsibilities of each party. Both parties (bidder and manufacturer) shall be equally and severally liable for failure of either party to perform warranty obligations.

Batteries shall be tested at least once a year (or as the need arises) to ascertain the usable energy of the ESS within the warranty period. If at any time during the warranty period the ESS fails to deliver the required usable energy, the supplier/manufacturer shall repair or replace the defective components to ensure the required performance standards are met. All costs associated with the warranty shall be to the account of the supplier/manufacturer.

**EW-2.6 Track Record****EW-2.6.1 ESS Manufacturer**

Manufacturer of the ESS should have current (working) install base of more than 1MW. Bidder shall provide a list of reference project(s) with contact details for verification purposes. (fill-out form in Section VI – Technical Specifications – Part II Technical Data Sheet – Annex C).

**EW-2.6.2 Battery Manufacturer**

Manufacturer of the batteries should be ISO 9001/14001 certified and have at least five years of experience in production of Li-ion cells as given by EW-2.4.2 (c). Offered battery model must have a current (working) install base of at least 1MWh. Bidder shall provide a list of reference project(s) with contact details for verification purposes. (fill-out form in Section VI – Technical Specifications – Part II Technical Data Sheet – Annex D)

**EW-2.7 Measurement of Payment**

Measurement of payment for all electrical works shall be based on the bid price of each item as shown in the Schedule of Requirements – Electrical Works, Section VII of the Bid Document. The cost of each item shall cover all works required and described in the pertinent provisions of the specifications.

| ITEM  | DESCRIPTION  | NPC REQUIREMENTS                 | SUPPLIER'S DATA |
|-------|--|----------------------------------|-----------------|
| F-7.2 | Manufacturer   | By Supplier                      |                 |
| F-7.3 | Chemistry  | NMC, LMO, Blended LMO / NMC, LFP |                 |
| F-7.4 | Gross weight of one Battery Module                           | ≤ 60 kg                          |                 |
| F-7.5 | Nominal Capacity (Ah)  | By Supplier                      |                 |
| F-7.6 | Current Operational Install Base                             | At least 1MWh                    |                 |
| F-7.7 | List of Reference Projects with contact details <sup>2</sup> | Required                         |                 |

**F-8.0 POWER AND ENERGY MANAGEMENT SYSTEM**

| ITEM                     | DESCRIPTION   | NPC REQUIREMENTS | SUPPLIER'S DATA |
|--------------------------|---|------------------|-----------------|
| F-8.1                    | Technical and Functional Requirements as stated in <b>EW-3.0 PEMS</b> | Required         |                 |
| F-8.2                    | List of Reference Projects with contact details <sup>3</sup>          | Required         |                 |
| <b>Hybrid Controller</b> |   |                  |                 |
| F-8.3                    | Manufacturer  | By Supplier      |                 |
| F-8.4                    | Model   | By Supplier      |                 |
| F-8.5                    | Place of Manufacture  | By Supplier      |                 |
| <b>Genset Controller</b> |   |                  |                 |
| F-8.6                    | Manufacturer  | By Supplier      |                 |
| F-8.7                    | Model   | By Supplier      |                 |
| F-8.8                    | Place of Manufacture  | By Supplier      |                 |

<sup>2</sup> Use Annex D

<sup>3</sup> Use Annex E

|              |                                    |             |
|--------------|------------------------------------|-------------|
|              |                                    |             |
| Name of Firm | Name & Signature of Representative | Designation |



| ITEM  | DESCRIPTION  | NPC REQUIREMENTS | SUPPLIER'S DATA |
|-------|--|------------------|-----------------|
|       | 1. Nominal Charge / Discharge Current (A)              | By Supplier      |                 |
|       | 2. Maximum Charging Current (A)                        | By Supplier      |                 |
|       | 3. Maximum Discharge Current (A)                       | By Supplier      |                 |
| G-7.7 | Number of Battery Modules                              | By Supplier      |                 |
| G-7.8 | ESS Enclosure/Cabinet                                  |                  |                 |
|       | Gross Weight, Installed with batteries (kg)            | By Supplier      |                 |
|       | Maximum Housing Dimension, Length x Width x Height (m) | By Supplier      |                 |

**G-8.0 BATTERY MODULES**

| ITEM  | DESCRIPTION                              | NPC REQUIREMENTS                 | SUPPLIER'S DATA |
|-------|--|----------------------------------|-----------------|
| G-8.1 | Manufacturer                             | By Supplier                      |                 |
| G-8.2 | Model                                    | By Supplier                      |                 |
| G-8.3 | Chemistry                                | NMC, LMO, Blended LMO / NMC, LFP |                 |
| G-8.4 | Nominal Capacity                         | By Supplier                      |                 |
| G-8.5 | No. of Cells per Module                  | By Supplier                      |                 |
| G-8.6 | Electrical Characteristics               |                                  |                 |
|       | • Nominal Terminal Voltage ( $V_{DC}$ )  | By Supplier                      |                 |
|       | • Minimum Operating Voltage ( $V_{DC}$ ) | By Supplier                      |                 |
|       | • Maximum Operating Voltage ( $V_{DC}$ ) | By Supplier                      |                 |

\_\_\_\_\_  
Name of Firm

\_\_\_\_\_  
Name & Signature of Representative

\_\_\_\_\_  
Designation



SECTION VI – TECHNICAL SPECIFICATION

LuzP22Z1425Se

| ITEM   | DESCRIPTION  | NPC REQUIREMENTS | SUPPLIER'S DATA |
|--------|--|------------------|-----------------|
|        | <ul style="list-style-type: none"> <li>Maximum Normal State of Charge (MaxNSoC)<sup>1</sup> (%)</li> </ul> | By Supplier      |                 |
|        | <ul style="list-style-type: none"> <li>Minimum Normal State of Charge (MinNSoC) (%)</li> </ul>             | By Supplier      |                 |
|        | <ul style="list-style-type: none"> <li>Nominal C-rate @ 25°C</li> </ul>                                    | 1 or higher      |                 |
|        | <ul style="list-style-type: none"> <li>Self-discharge Rate per Month (% of its capacity)</li> </ul>        | ≤ 10%            |                 |
|        | <ul style="list-style-type: none"> <li>Cycle Lifetime</li> </ul>   | At least 5000    |                 |
| G-8.7  | Physical Characteristics   |                  |                 |
|        | <ul style="list-style-type: none"> <li>Dimension, Length x Width x Height (m)</li> </ul>                   | By Supplier      |                 |
|        | <ul style="list-style-type: none"> <li>Maximum Gross Weight (Kg)</li> </ul>                                | 60               |                 |
| G-8.8  | Overcharge Protection  | Required         |                 |
| G-8.9  | Short Circuit Protection   | Required         |                 |
| G-8.10 | Thermal Runaway Protection   | Required         |                 |

**G-9.0 ENERGY STORAGE SYSTEM (ESS) TRANSFORMER**

| ITEM  | DESCRIPTION          | NPC REQUIREMENTS   | SUPPLIER'S DATA |
|-------|----------------------|--|-----------------|
| G-9.1 | Manufacturer/Brand   | By Supplier  |                 |
| G-9.2 | Model                | By Supplier  |                 |
| G-9.3 | Rated Capacity (kVA) | 150  |                 |
| G-9.4 | Number of Phase      | Three (3)  |                 |
| G-9.5 | Type of Cooling      | ONAN   |                 |
| G-9.6 | Insulation           | Mineral Oil with its electrical and chemical characteristics is compliant with IEC and |                 |

<sup>1</sup> As defined under Section VI – Technical Specifications Clause EW-2.1

\_\_\_\_\_  
 Name of Firm    Name & Signature of Representative    Designation

