Study on the Viability and Technical Impact of Renewable Energy Resources as Embedded Generators

DECEMBER 2024

This Report is prepared by the
WESM Technical Committee (TC) for the
Philippine Electricity Market Corporation (PEMC)

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EXECUTIVE SUMMARY

In support of the county's transition to renewable energy (RE), several policies and programs are already in place to achieve the national target of 35% RE share in the energy generation mix by 2030, and 50% by 2040. One way to support the energy transition is by integrating RE as embedded generators (EG) in the distribution franchise area as compared to the traditional grid-connected generators.

This report examines the existing policies and guidelines to serve as a guide for potential investors and stakeholders in developing RE-EG in the country. Based on review and documentary research, the technical and financial viability of RE-EG projects is generally influenced by the following factors:

Technical Viability

1. Policy and Regulatory Support
2. Infrastructure and Grid Integration
3. Geographic and Climatic Conditions
4. Technological Advancements
5. Environmental and Social Impact

Financial Viability

1. Government Incentives and Policies
2. Cost of Technology
3. Financing and Investment
4. Economic and Environmental Benefit

While there are existing RE resources in various distribution franchise areas, these factors together with the individual economic and technical considerations of each RE-EG project will determine the success or failure of the project. This report also highlighted some of the major issues and challenges that need to be addressed to facilitate the influx of RE-EG projects which include technical limitations, regulatory considerations, and policy inconsistency.

The TC believes that this undertaking could also serve as an initiative for a more collaborative discussion among the policymakers and stakeholders to further realize the potential of integrating renewable energy as embedded generators in the distribution franchise areas.

Contents

1.0 PURPOSE OF THE DOCUMENT

This report is prepared by the WESM Technical Committee in response to the study request from the PEMC's Office of the President (PEMC-OP) and WESM Governance Officer (WGO) through a letter dated 07 June 2024.

This study aims to undertake a holistic review of current power industry policies and regulations which impact the viability of renewable energy (RE) resources as embedded generators (EG) in the distribution franchise area. This report provides an appreciation of the interrelationships of these policies and regulations to provide potential investors with a more realistic approach towards RE-EG developments in the country. The views of the Technical Committee are based on its understanding of the documents reviewed on the subject matter and are not necessarily shared by PEMC or the PEM Board of Directors.

2.0 INTRODUCTION

Embedded generator refers to generating units that are indirectly connected to the Grid through the Distribution Utilities' lines or industrial generation facilities that are synchronized with the Grid[1]. The integration of embedded generators into the distribution system provides major change from the traditional centralized power system where the transfer of bulk power typically comes from large generators located far from the load center.

Section 4.4.1 of the Philippine Distribution Code (PDC) 2017 classifies EG according to its characteristics and installed capacity as shown in Table 1.

Table 1. Classification of Embedded Generating Plants

Category	Installed Capacity Limits	Remarks
Large	P ≥ 10 MW	Conventional or variable RE (VRE) EG plant with an aggregated installed capacity of 10 MW or more
Medium	1 MW < P < 10 MW	Conventional or VRE EG plant with installed capacity larger than 1 MW which does not qualify as large EG plant
Intermediate	(i) 100 kW < P ≤ 1 MW and (ii) P ≤ 100 KW	(i) Conventional or VRE EG plant with installed capacity larger than 100 kW and equal to or less than 1 MW; and (ii) Conventional EG plant with installed capacity lower or equal to 100 kW connected to medium voltage networks (1 kV up to 34.5 kV)
Small	10 kW < P ≤ 100 kW	Connected to low voltage (LV) networks (not exceeding 1000 volts)
Micro	P ≤ 10 kW	Connected to LV networks

[1] Philippine Distribution Code (PDC) 2017 Edition

EGs can have many applications such as augmenting power supply, reducing line congestion and losses, providing ancillary services (AS), and serving as emergency backup power, which provide benefits to the power system.

EG's Installed Capacity

Statistically, EG shares about 6.5% of the total installed capacity in the main grids equivalent to 1,872 MW (i.e., excluding off-grid generators and battery energy storage systems). Figure 1 shows the capacity mix by connection type (i.e., grid-connected or embedded) per grid level.

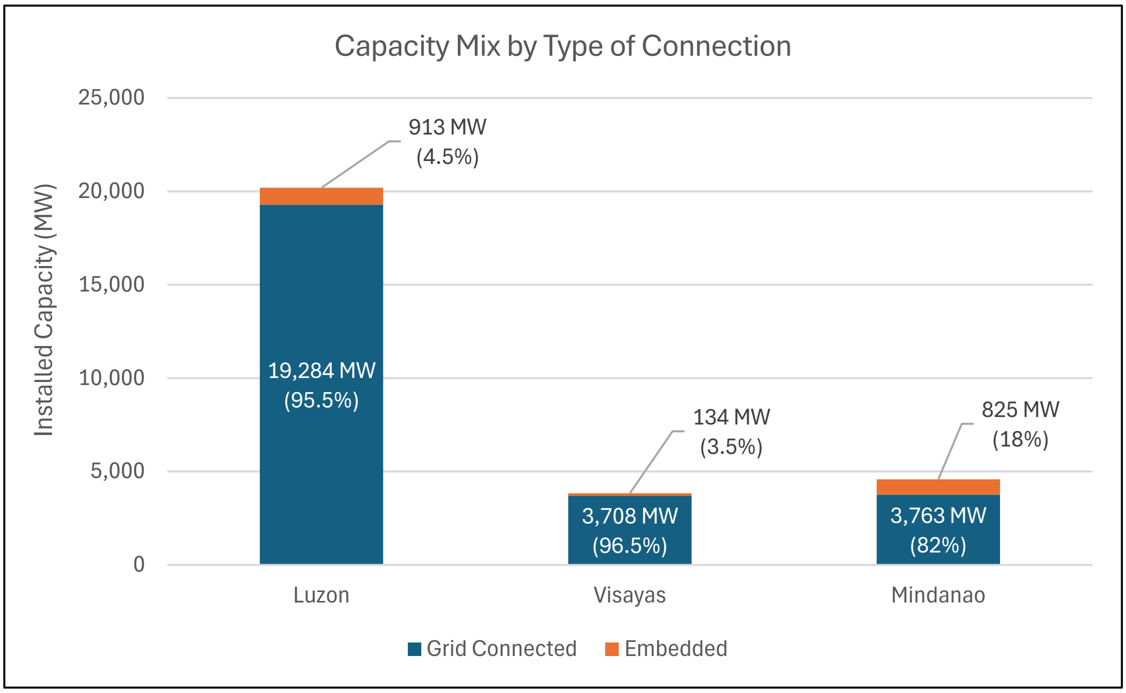

Figure 1. Capacity Mix by Type of Connection per Grid Level[2]

It can be observed that the Mindanao region currently has the largest percentage share (18%) of EG installation per grid level mainly dominated by coal and oil-based resources. On the other hand, the Luzon region has the largest share of EG installation in terms of installed capacity (913 MW). See **Annex A** for the list of embedded generators.

Renewable Energy (RE) Resources as EG

The state policy primarily promotes renewable energy resources such as biomass, solar, wind, hydro, geothermal, and ocean energy sources, including hybrid systems, but also acknowledges other emerging RE technologies. In support of the country's energy transition to RE, the proliferation of RE system is expected for both grid-connected and embedded generators.

Figure 2 shows the current percentage share of RE in the EG's capacity mix per regional grid.

[2] Department of Energy. "List of Existing Power Plants as of May 2024." August 7, 2024. https://doe.gov.ph/list-existing-power-plants.

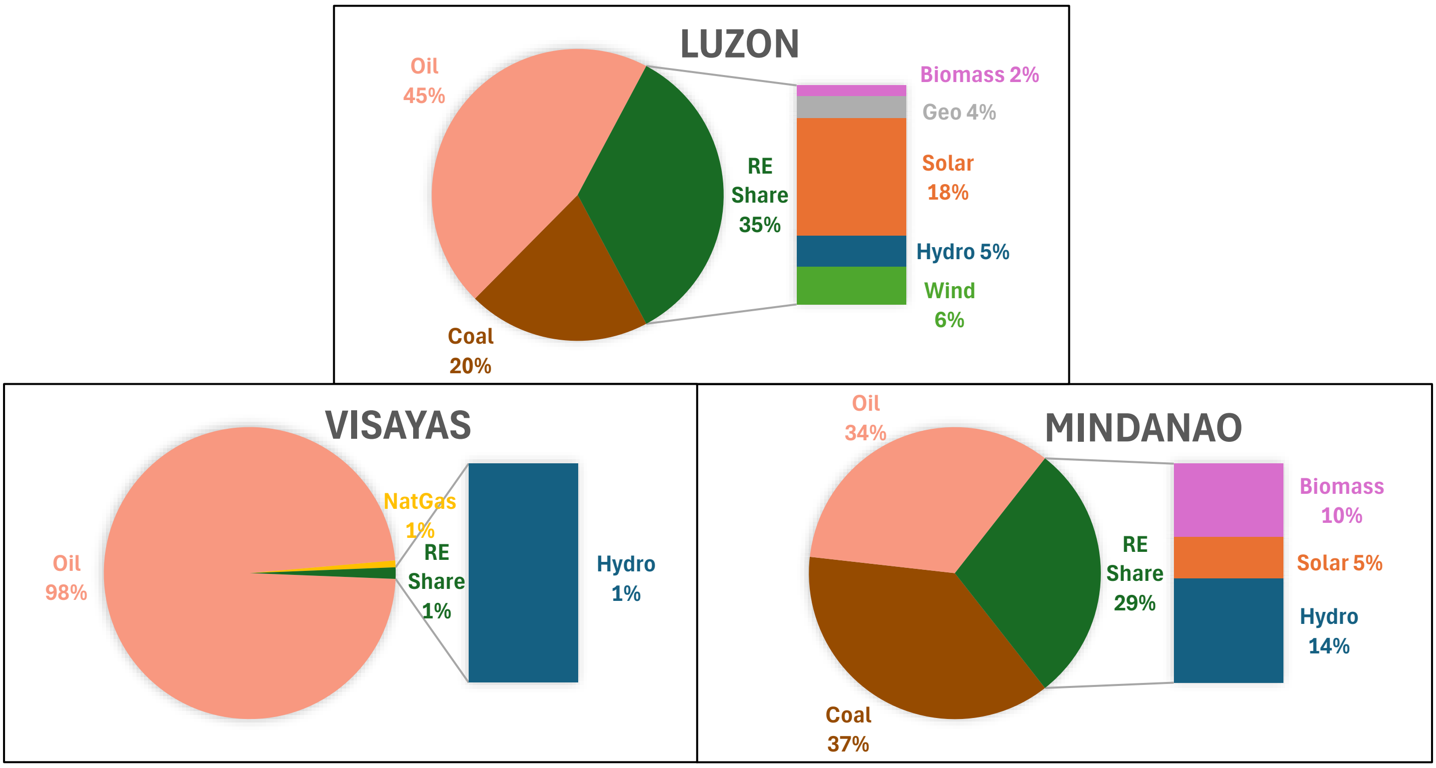

Figure 2. RE Percentage Share in the EG Capacity Mix[3]

About 30% of the country's total EG installed capacity is utilizing RE resources. In terms of regional capacity mix, the Luzon region has a total EG installed capacity of 912.6 MW with approximately 35% share of RE equivalent to 314.2 MW, wherein the majority of the RE-EG capacity in the region comes from solar technology. In the Visayas region, the RE-EG share is at 1.3% equivalent to 1.7 MW out of 133.9 MW. For Mindanao, the RE-EG share is at 29% equivalent to 237.8 MW out of 825.3 MW. Hydro technology dominates the RE-EG share in the capacity mix both for the Visayas and Mindanao region.

Given the statistics and the expected increase in RE systems particularly as EG, this study aims to establish the general technical limits and conditions by doing the following approach:

1. Review of existing policies related to EG and RE resources.
2. Assess the technical and/or financial impact of interconnecting RE as EG at the distribution level.
3. Provide recommendations on the challenges/issues that are related to the entry of various RE technologies in the DU franchise area.

3.0 REVIEW OF RELEVANT POLICIES AND GUIDELINES

This report acknowledges that there are many existing policies and guidelines relevant to this study. This section aims to consolidate the relevant documents to make it more reader-friendly to possible investors, and to provide recommendations on where the policies can be improved.

Specifically, the following documents were reviewed and considered in the preparation of this report:

[3] Ibid.

1. DOE Department Circular No. DC2024-06-0018, titled "Revised Omnibus Guidelines Governing the Award and Administration of Renewable Energy Contracts and the Registration of Renewable Energy Developers"
2. DOE Department Circular No. DC2021-06-0013, titled "Adopting A General Framework Governing the Test and Commissioning of Generation Facilities for Ensuring Readiness to Deliver Energy to the Grid or Distribution Network" and supplementing DC2022-05-0015.
3. DOE Department Circular No. DC2019-02-0003, titled "Providing for the Framework Governing the Operations of Embedded Generators"
4. DOE 2023-2032 Distribution Development Plan
5. ERC Resolution No. 17, Series of 2023, titled "A Resolution Adopting the 2023 Revised Rules for the Issuance of Certificates of Compliance for Generation Facilities (2023 Revised COC Rules)"
6. NEA Memorandum No. 2022-51, titled "Advisory on the Electric Cooperatives' Renewable Energy Project Investment with Private Sector Participation consistent with its Distribution Development Plan, Power Supply Procurement Plan (PSPP), and Renewable Portfolio Standard (RPS) Compliance"
7. Republic Act No. 9513, titled "An Act Promoting the Development, Utilization and Commercialization of Renewable Energy Resources and for Other Purposes" aka RE Act of 2008
8. Philippine Grid Code (PGC) 2016
9. Philippine Distribution Code (PDC) 2017
10. WESM Rules and Relevant Manuals

<u>Transition to Renewable Energy</u>

With the enactment of the RE Act of 2008 (RE Act), several programs are already in place to facilitate the country's transition to RE and to achieve the national target of 35% RE share in the energy generation mix by 2030, and 50% by 2040. These programs include, but are not limited to, the following:

- **Feed-in-Tariff (FIT)** – participating developers of RE projects are assured fixed payments from each type of RE
- **Net-Metering (NM)** – allows electricity end-users to build an RE facility up to 100kW primarily for own-use
- **Green Energy Option Program (GEOP)** – allows electricity end-users to choose RE as their source of energy
- **Green Energy Auction Program (GEAP)** – competitive bidding process of procuring RE supply
- **Renewable Portfolio Standards (RPS)** – mandates electricity suppliers to source an agreed portion of their energy supply from eligible RE resources
- **Renewable Energy Market (REM)** – venue for the trading of RE certificates (REC) to comply with RPS obligations

In addition, the issuance of DOE Department Circular No. DC2022-11-0034 allows full foreign ownership of RE projects to attract foreign investments. Investing in RE also comes with numerous tax incentives (i.e., income tax holiday, 0% value-added tax rate, etc.) and preferential treatment in the wholesale electricity spot market (WESM).

The issuance of National Electrification Administration (NEA) Memorandum No. 2022-51 also directed ECs, among others, to encourage private sector investments and promote development of embedded indigenous and RE resources.

Consistent with the policy direction on RE, it is expected that RE plants, particularly RE-EG, will continue to increase in number. RE as EG is also becoming popular with technological advancements particularly in inverter-based resources (IBR) technologies.

3.1 Guide for Developing a RE-EG Project

This section aims to consolidate some of the major requirements and processes when putting up an embedded RE generator. Figure 3 shows a simplified process guide with corresponding estimate timeline of completion:

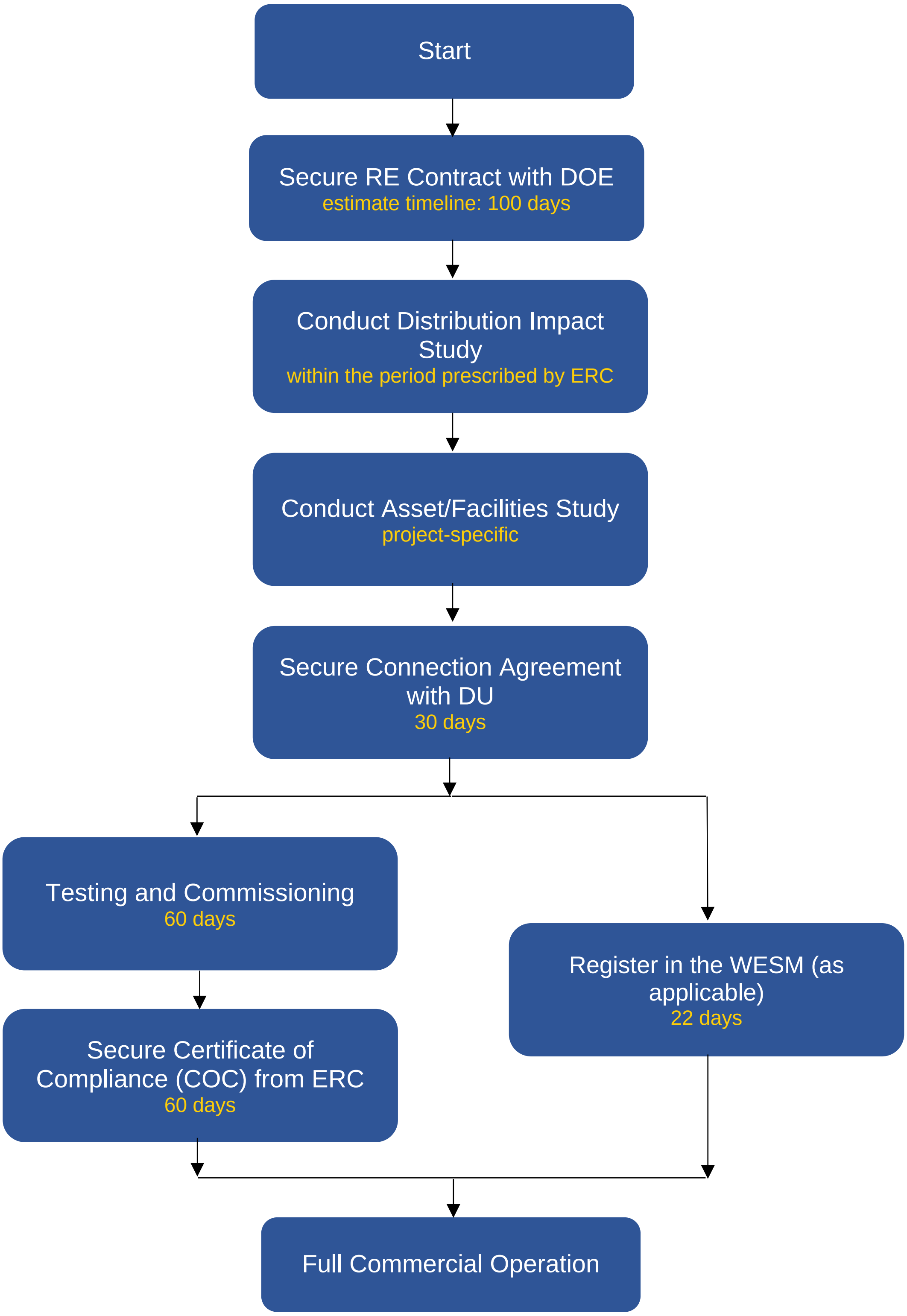

Figure 3. Simplified Process Guide for Developing a RE-EG Project

This process guide should only serve as a reference for the major processes and should not serve as a complete guide. The timeline indicated refers to the prescribed timeline consistent with the existing rules and policies governing each of the processes. Additional information is provided in the succeeding sections.

Securing a Renewable Energy Contract

To avail the incentives under the RE Act, an RE developer must secure a Certificate of Registration (COR) from the DOE. To secure a COR, an RE project for commercial operations is required to enter into an RE contract while RE projects for own-use and/or non-commercial operations are not required.

RE contract refers to the service agreement between the Government, through the DOE, and an RE developer, which grants the RE developer the exclusive right to explore, develop, or utilize the RE resource within a particular area.

The processing of application and other permitting are streamlined through the use of the Energy Virtual One-Stop Shop (EVOSS) system, hence, all RE developers are required to register with the EVOSS system. In reference to DOE Department Circular No. DC2024-06-0018, there are two modes to secure an RE contract, via (i) open and competitive selection process (OCSP) or (ii) direct application.

(i) Open and Competitive Selection Process

OCSP refers to a bidding process wherein the DOE offers a list of pre-determined areas (PDA) to potential RE developers. The specific guidelines for the conduct of each round of OCSP are being issued through DOE Department Circulars. In the latest OCSP (round 4), the DOE offered 20 PDA for potential RE development which includes 14 hydropower, 3 geothermal, and 3 wind study areas with a total potential capacity of at least 250 MW.

For reference purposes, Table 2 shows the summary of activities and timeline for the conduct of the 4^{th} OCSP by the DOE.

Table 2. Timeline for OCSP4 and Awarding of Service Contract

No.	Activity	Timeline
1	Publication of OCSP4	Day 1
2	Launching and pre-submission conference	Day 1 + 20 calendar days (CD)
3	Submission of bid documents	Day 1 + 60 CD on or before 1200H
4	Opening of bid documents	Day 1 + 60 CD at 1300H
5	Complete legal, technical, and financial evaluation	Day 61 + 10 working days (WD)
6	Endorsement of results for concurrence of ASec and USec	Day 71 + 5 WD
7	Approval by the Secretary of the results of OCSP4	Day 76 + 5 WD
8	Pre-signing of RE Contract and endorsement to the Secretary	Day 81 + 19 WD
9	Signature of the Secretary/Awarding of RE Contract	Day 99

In the case of a failed OCSP pursuant to relevant guidelines, PDAs that were offered will be open for direct application.

(ii) Direct Application

Direct application refers to the mode of RE application wherein the applicant identifies an area it wishes to explore and develop or, as applicable, pursues the application of a PDA following a failed OCSP. The guidelines and procedures on the pre-application, application, and awarding of RE contracts for each type of RE technology are detailed in the DOE Department Circular No. DC2024-06-0018.

Table 3 attempts to summarize the process for direct application of RE contract, applicable to all types of RE technology.

Table 3. Summary of Process for Direct RE Contract Application

No.	Process	Timeline
Pre-Application		
1	Registration in the EVOSS system	N/A
2	Submission of letter of intent (LOI)	
3	Pre-application orientation of interested participants (optional)	
Area Verification		
4	From receipt of the LOI with complete documents, DOE shall complete the area verification	within 18 CD
5	If the area of interest is still free for development, DOE will issue a notice to apply	within 5 CD
Filing and Evaluation of RE Contract		
6	Mandatory orientation by DOE for the applicant	schedule indicated in the notice to apply
7	Applicant to submit the complete set of documentary requirements through the EVOSS system	after the scheduled orientation
8	DOE evaluates the submission	within 3 WD
9	If complete submission, applicant pays the application and processing fees	official start of D1
10	After the payment, DOE conducts the simultaneous technical, legal, and financial evaluations	D1 + 5 WD
Awarding of RE Contract		
11	If application passes the evaluation, DOE informs the applicant to pre-sign the contract	D6 + 30 CD
12	Upon endorsement of the pre-signed contract and accompanying documents, the Office of the DOE Secretary shall act on the documents	D36 + 7 CD
13	If successful, EVOSS notifies the applicant to pay the signing fee	D43 + 15 CD
14	If payment is made, DOE uploads in the EVOSS system the signed and notarized copy of the contract and certificate of registration, as applicable	D59

Regardless of the mode of RE contract application, the DOE shall issue a Certificate of Registration (COR) to an RE developer holding a valid RE contract for purposes of entitlement to the incentives under the RE Act. Meanwhile, RE projects for own use and/or non-commercial purposes are not required to enter into an RE contract but they must still comply with the relevant registration requirements to acquire COR.

These RE service contracts also have a common term of 25 years from the date of execution applicable to biomass/waste-to-energy (WTE), geothermal, solar, hydro/ocean, and onshore/offshore wind.

<u>Conduct of Distribution Impact Study</u>

Consistent with the PDC 2017, any proposed connection or modification to the distribution system shall be evaluated through the conduct of a distribution impact study (DIS). The DIS refers to a set of technical studies which is used as technical basis in deciding whether to accept or reject the proposed connection.

As a minimum, the DIS shall cover the following:

- **Power flows,** both in normal state and in case of contingencies to ensure that the distribution system can properly accommodate the flows of both the EG plants and existing loads
- **Voltage control studies**, to ensure that voltage can be properly maintained within the prescribed limits
- **Impact of short circuit infeed to the distribution equipment,** in order to verify that the equipment limits are not exceeded
- **Definition and coordination of protection system,** to ensure that protective devices operate in a coordinated manner
- **Impact on Power Quality,** to ensure that the quality of voltage, including its frequency and the resulting current, are maintained

These studies are typically conducted using analytical tools and methods to identify the technical impact of the proposed connection. The DIS shall be performed by the DU, however the project proponent also has the option to engage the services of a third-party service provider. Nevertheless, the result of the DIS conducted by a third-party is still subject to approval by the concerned DU or EC.

Since this is a standard requirement applicable to all DU, the TC is of the opinion that the challenge lies on the distribution system to which the RE-EG will interconnect given that there are more than 150 distribution utilities (consisting of private, electric cooperatives, and others) which have varying sizes and level of technical and financial capabilities.

Conduct of Asset/Facilities Study

After the DIS, a facilities study should be conducted to determine the necessary assets and corresponding cost estimates, as well as the asset boundary conditions to accommodate the proposed connection to the distribution system.

Once the proponent and the DU/network service provider agreed on the terms, the project may now proceed with an engineering, procurement, and construction (EPC) contract.

Secure Connection Agreement with DU

Like the conduct of DIS, this process is applicable to any user seeking a new connection or modification to the distribution system. The connection agreement specifies the terms and conditions pertaining to the connection of the user system or equipment to the distribution system.

There are several options for a RE-EG to connect to the distribution system which include:

1. Tap connection along distribution feeder
2. Cut-in to a distribution feeder
3. Bus-in to a distribution substation

The tap connection method is considered the most economical, but it is also the least reliable among the three options. The cut-in connection is relatively more expensive than tap connection, but it provides better reliability. The bus-in connection is the most expensive but provides the most reliable connection to ensure continuous supply of power.

Moreover, securing a connection agreement signifies that the DIS and facilities study were already completed and approved.

Testing and Commissioning

Prior to actual connection, the RE-EG developer shall secure a provisional certificate of approval to connect (PCATC) from the DU which is a certification allowing the conduct of testing and commissioning (T&C). The general framework for the T&C of EG facilities is provided in the DOE Department Circular No. DC2021-06-0013.

During the T&C, the proponent must comply with the pertinent requirements within the validity of the PCATC (no more than 2 months assuming no extension). The conduct of T&C shall not adversely affect the security and reliability of the grid operations as well as the accuracy, transparency, and competitiveness of the market outcomes.

After the successful conduct of T&C, the proponent shall secure final certificate of approval to connect (FCATC) from the DU which is a certification attesting that the EG is ready to deliver energy to the distribution network.

Secure Certificate of Compliance (COC)

The general guiding principle is that all entities intending to own and/or operate a generation facility (regardless of connection type) shall apply for a Certificate of Compliance (COC) from the ERC in accordance with ERC Resolution No. 17, Series of 2023, also known as the 2023 Revised COC Rules. The COC shall serve as a license to commercially operate a generation facility.

Alternatively, EG developers have the option to apply for a provisional authority to operate (PAO), which serves as an interim authority granted by ERC to operate the generation facility, pending the completion of requirements for COC issuance.

Also, in the 2023 revised COC rules, it is noteworthy to mention that COC is required only for the operation of new generation facilities. For existing generation facilities, renewal is no longer necessary but the obligation to maintain underlying permits remains.

WESM Registration of EGs

The DOE Department Circular No. DC2019-02-0003 provides for the framework governing the operations of embedded generators. In terms of market participation and registration, EG is classified as follows:

Table 4. Criteria for EG Participation in the WESM

Mandatory Registration in the WESM	Voluntary Registration in the WESM
i. EGs with Pmax ≥ the following thresholds: • 10 MW for Luzon	EGs that do not meet the criteria for mandatory registration may register

	• 5 MW for Visayas and Mindanao	in the WESM on a voluntary basis
ii.	EGs with Pmax below threshold that have contract outside its host DU, or intend to sell to the WESM	
iii.	EGs that are Feed-in-Tariff (FIT) eligible RE plants	

The TC recognizes that there should be a threshold level for the mandatory registration of EG in the WESM. However, the current thresholds may no longer represent a level in which an EG will have material impact on the grid considering the size of the regional grids (i.e. Luzon is about 13,000 MW, Visayas and Mindanao are about 2,500 MW each). It is, therefore, more important to address the impact of interconnecting EG at the DU level.

For the continuation of the process, EGs that are mandated or intend to register in the WESM shall submit their COCs to the Market Operator (MO) to reflect their WESM registration as under commercial operations and for the granting of full access to the market participant interface (MPI).

3.2 EG as Distributed Energy Systems

Aside from the existing policies and rules on EG, the country has likewise introduced the concept of distributed energy systems (DES). On a broader context, the term DES is used in other jurisdictions which encompasses a diverse array of generation, storage, energy monitoring, and control solutions. In the Philippines, the following terminologies are defined and are guided by existing rules and regulations, all of which may be classified as a subset of DES, or simply as EG in general:

- **Distributed Energy Resources (DER)** – a power source connected to the distribution system or electrical system of the end-users, that could be aggregated to meet a demand
- **Embedded Generator (EG)** – a generating unit that is indirectly connected to the grid through the distribution utility's lines or industrial generation facilities that are synchronized with the grid
- **Net-Metering (NM)** – a system, appropriate for distributed generation, in which a distribution grid user has a two-way connection to the grid and is only charged for its net electricity consumption and is credited for any overall contribution
- **Self-Generating Facility (SGF)** – a power generation facility owned and constructed by an end-user for such end-user's own consumption or internal use, excluding generation facilities for use by households, clinics, hospitals, and other medical facilities
- **Energy Storage System (ESS)** – a facility capable of absorbing energy directly from the grid or distribution system, or from an RE plant or from a conventional plant connected to the grid or distribution system and storing it for a time period, and injecting stored energy when prompted, needed to ensure reliability and balanced power system.

Except for SGF, the current policies allow all these systems to export power to the distribution system. Table 5 provides a comparative review of the relevant provisions governing each of these systems (excluding SGF):

Table 5. Comparative Review of Various Distributed Energy Systems

Subject	DER	EG	NM	Embedded ESS
Primary Policy Reference	ERC Resolution No. 11, Series of 2022	DOE Department Circular No. DC2019-02-0003	ERC Resolution No.06, Series of 2019	DOE Department Circular No. DC 2023-04-0008
Capacity	a. RE-DER for own use (OU) and/or export: (i) **100 kW < P ≤ 1 MW** in on-grid DU (ii) **P < 1 MW** in off-grid DU b. no capacity limit for DER-OU regardless of technology and grid location	Capacity limit not defined	**P ≤ 100 kW**	Capacity limit not defined
COC Licensing	DER-COC	EG-COC	Qualified end-user (QE)-COC	Pursuant to the guidelines to be issued by the ERC: a. ESS-COC for stand-alone b. separate COC and ESS-COC for gen plant + ESS
WESM Registration	DER intending solely to export or sell power to the grid will be treated as EG, regardless of capacity	Refer to Table 4	Voluntary WESM registration by their host DU	Mandatory WESM registration: i. ESS connected to the grid ii. ESS connected to the DU with capacity equal to or above the regional thresholds (10 MW for Luzon and 5 MW for Visayas and Mindanao) ESS connected to the DU with capacity less than the threshold may register in the WESM voluntarily
Distribution Impact Study	DIS is required for exporting DER	DIS is required for all EG. For EGs that are mandated or intend to register in the WESM, it shall seek endorsement from the DOE for the conduct of grid impact study	DIS is required	DIS is required for embedded ESS. For WESM-registered embedded ESS, grid impact study is also required
RE Market (REM) Registration	Voluntary REM registration for DER, EG that are not registered in the WESM, and NM by their host DU			Not required
RE Certificate (REC) Ownership for RPS	DER Owner, unless otherwise provided by the DOE in respect of rules governing RPS Program	Host DU	Host DU	Not applicable

The treatment for the specific type of DES or EG will be determined based on the issued COC. In terms of market dispatch, only EGs that are registered in the WESM will be subject to central dispatch by the SO.

In terms of market network model (MNM), each WESM-registered EG (**Annex B**) has a corresponding market trading node that is modelled at the nearest node within the network being monitored by the MO. Since each trading node has a corresponding locational marginal price (LMP) represented by the sum of system marginal price (SMP), cost of congestion, and cost of losses, one concern is on how the cost of losses is being represented given that the distribution network is currently not modelled in the MNM.

To efficiently utilize the EGs in the distribution network, the TC previously recommended having a distribution system operator (DSO) which empowers the DU to manage the responsibility of balancing supply and demand variations at the distribution level without fully extending the market to the distribution level. The DSO recommendation is further referenced in Section 5.0.

Regarding RPS, the current policy provides that the host DU carries the RPS obligations of RE facilities including EG, DER, and NM which is a motivation for the DU to register them in the RE Market. Currently, the registration of these facilities in the REM is on a voluntary basis to be facilitated by the host DU.

3.3 Review of PDC 2017 Technical Requirements

Regardless of capacity, a generating plant connected to the distribution system shall abide by the PDC 2017, specifically with the connection and operational requirements for EG. The PDC 2017 should only serve as a minimum standard and it is intended to be used along with other relevant rules and guidelines.

3.3.1 Considerations for EG Connection

The following considerations for EG connection shall be observed during the application for distribution connection and during the conduct of distribution impact study:

<u>Large EG</u> (P ≥ 10 MW)

- The DU shall inform the TNP about the application for connection
- The TNP will assess the application. Certain conditions or special requirements, if any, shall be clearly stated and justified by the TNP for compliance of the User
- The DU shall formally inform the User of the results of the DIS as well as the assessment made by the TNP, if any

<u>Medium EG connected to High Voltage (HV)/Medium Voltage (MV) through a dedicated feeder</u> (1 MW < P < 10 MW)

- The total installed capacity connected to the substation shall not exceed the Minimum Load of the HV/MV transformer. In case there are no registers of such Minimum Load, the value will be estimated as 25% of the transformer rated capacity

<u>For Medium or Intermediate EG less than 2 MW connected to an existing MV feeder</u>

- The total installed capacity connected to the same feeder, regardless of their types, shall not exceed 30% of the rated capacity of the MV feeder
- The total installed capacity connected to the substation shall not exceed the Minimum Load in a year of the HV/MV transformer. In case there are no registers of such Minimum Load, the value will be estimated as 25% of the transformer rated capacity
- The maximum voltage changes at the connection point due to the switching operation shall not exceed 2% of the nominal voltage

Small EG (10 kW < P ≤ 100 kW)

- In cases of connection to an existing low voltage (LV) feeder, the total installed capacity shall not exceed 30% of the rated capacity of the LV feeder
- The total installed capacity shall not exceed one third of the rated capacity of the MV/LV transformer
- The maximum voltage changes at the connection point due to the switching operation shall not exceed 2% of the nominal voltage

Micro EG (P ≤ 10 kW)

- The micro EG all other associated equipment to be installed have been Type Tested safe and to cause no unwanted disturbance to the distribution system. The project proponent shall submit to the DU the Type Tests report
- The total amount of small and micro EG connected to the LV feeder shall not exceed 30% of the rated capacity of distribution transformer

3.3.2 Operational Requirements for EG

The DU as well as the EG both have the responsibility to ensure that the power quality standards are complied with. To cite some of these standards, Table 6 provides a summary of the operational requirements for all EG categories.

Table 6. Summary of EG Operational Requirements

	Large	Medium	Intermediate	Small	Micro
Installed Capacity	P ≥ 10 MW	1 MW < P < 10 MW	100 kW < P ≤ 1 MW; and P ≤ 100 KW	10 kW < P ≤ 100 kW	P ≤ 10 kW
Connection Point	Connected to a voltage level agreed between the EG and the DU based on the DIS, and controlled by a circuit breaker				
Frequency Withstand	VRE > 62.4 (auto disc.) > 61.8 – 62.4 (5min) 58.2 – 61.8 Hz (cont.) 57.6 – < 58.2 (60min) <57.6 (5sec)	> 62.4 (automatic disconnection) > 61.8 – 62.4 (5min) 58.2 - 61.8 Hz (continuous operation) 57.6 – < 58.2 (5min) <57.6 (5sec)		58.2 - 61.8 Hz (continuous operation)	

<table>
<tr><th></th><th>Large</th><th>Medium</th><th>Intermediate</th><th>Small</th><th>Micro</th></tr>
<tr><td>Reactive Power Capability</td><td><u>VRE</u>
(a) ±20% of capacity if active power ≥ 58% of installed capacity
(b) 95% p.f. lagging to 95% p.f. leading if active power is within 10% and 58% of installed capacity
(c) no reactive power if active power is ≤ 10 of installed capacity</td><td colspan="2">Power factor at the connection point within the range of 0.98 leading to 0.98 lagging</td><td colspan="2">Power factor not less than 0.85 lagging</td></tr>
<tr><td>Protection Arrangements</td><td colspan="3">To be agreed and coordinated with the DU</td><td colspan="2">In accordance with PDC 4.9.5</td></tr>
<tr><td>Information Exchange</td><td>RTU is required</td><td colspan="2">RTU required will be based on the DIS conducted</td><td colspan="2">Not required</td></tr>
<tr><td>Ancillary Service Provision</td><td colspan="5">• EGs with black start capability shall comply with Section 6.7.4 of the PDC
• EGs with fast start capability shall automatically start-up in response to frequency-level relays with settings in the range of 57.6 Hz to 62.4 Hz</td></tr>
</table>

The minimum standards for RE-EG are already covered in the current version of the PDC. However, the TC further recommends the updating of the PDC 2017 as well as the PGC 2016 to include, among others, the connection and operational requirements for ESS and inverter-based resources (IBR) in general.

The TC recommends adopting relevant standards such as the IEEE Std 2800-2022 *Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems* to establish general guidelines for IBR and the IEEE Std 1547-2022 *Interconnection of Energy Storage Distributed Energy Resources with Electric Power Systems* which covers distributed generators and distributed ESS. These standards should only serve as guide while considering the appropriate applications to local conditions.

4.0 VIABILITY OF RE RESOURCES AS EG

As early as the project's planning stage, the technical and financial viability of an embedded RE generator can be determined through feasibility studies. Also, part of the considerations for developing a RE-EG are the technical and financial requirements particularly during RE contract application with DOE and during COC application with ERC. The project's viability will also depend on the individual economic and technical considerations of each RE-EG project.

<u>Technical Viability</u>

In a general sense, the technical viability of RE-EG in the Philippines is influenced by several factors:

1. **Policy and Regulatory Support**. Various programs are in place to facilitate the country's transition to RE which support investments for EG projects. Navigating the regulatory landscape can be complex, but initiatives such as the EVOSS Act (2019) helps streamline the process of obtaining permits and certifications for energy projects in the country which promotes ease of doing business in the energy sector.

2. **Infrastructure and Grid Integration.** The technical impact of interconnecting embedded RE plant in the distribution system is evaluated through the conduct of DIS. The current state of the distribution network in the country is mostly radial which poses challenges on grid stability and integration. The DUs must ensure that the entry of additional generation in the distribution level will not have material impact in their respective network.

3. **Geographic and Climatic Conditions.** The Philippines have high solar irradiance making solar photovoltaic (PV) systems highly viable, strong wind resources suitable for wind turbines, and numerous rivers and streams for hydropower projects. While the country's unique landscape with over 7,000 islands is well-suited for distributed energy systems, the transmission and distribution systems are however vulnerable to natural disturbances like typhoons.

4. **Technological Advancements.** Advances in energy storage technology can enhance the reliability of RE-EG systems by storing excess energy for later use. Also, adopting smart grid technology can improve the integration of distributed energy resources, allowing for better management and distribution of electricity. The industry should also consider the technological trend for IBR which utilizes grid-forming inverters (GFMI) that offer solutions in lieu of the grid following inverters (GFLI) currently widely in use to ensure grid stability with high RE penetration.

5. **Environmental and Social Impact.** RE projects contribute to reducing carbon emissions and reliance on fossil fuels, aligning with the country's environmental goals. Localized energy generation also provides economic benefits to communities, including job creation and improved energy access.

<u>Financial Viability</u>

Meanwhile, the financial viability of an RE plant in the country, regardless of its connection whether grid-connected or embedded, is influenced by various factors such as:

1. **Government Incentives and Policies.** The current policies on RE provide benefits such as numerous tax incentives, preferential dispatch in the WESM, and exemption in the monitoring of outage for variable RE (ERC Case No. 2023-001 RM). Allowing 100% foreign ownership for RE projects such as solar, wind, hydropower, and ocean energy also helps attract foreign investments.

2. **Cost of Technology.** The cost of RE technologies, particularly solar and wind, has been decreasing, making them more competitive with traditional energy sources. The economic viability of integrating RE systems with energy storage systems should also be carefully considered to fully realize its potential and address its variability. High upfront costs can be a barrier, although these are often offset by long-term savings and government incentives.

3. **Financing and Investment.** Public-Private Partnerships can help mobilize the necessary capital for large-scale renewable energy projects. Financial instruments like green bonds and loans are increasingly being used to fund RE projects, offering favorable terms to investors.

4. **Economic and Environmental Benefit.** Energy independence by reducing reliance on imported fossil fuels can lead to significant cost savings and enhance energy security. RE projects contribute to reducing greenhouse gas emissions, therefore attracting funding from climate-focused investors.

List of Issues and Challenges

While the viability of embedded RE generators in the Philippines is quite promising, there are more issues and challenges that need to be addressed and considered:

- **EC Stranded Contracts.** The mother policy for motivating ECs to acquire RE-EG is the RPS. However, it was observed that some ECs have stranded contracts especially with coal plants, which will effectively delay the potential development of RE in the DU level since they are already fully contracted. It is, therefore, one of the challenges for the ECs to comply with their RPS obligation, in consideration of their existing power supply agreement (PSA) contracts.

- **Retail Competition and Open Access.** DUs are regulated entities when it comes to the provision of distribution network service to contestable customers and power supply to their captive customers. These conditions coupled with their exposure to WESM price volatility may also contribute to stranding of supply contracts.

- **Adequacy of Distribution Network Access.** The capacity of the distribution network to accommodate the influx of EG particularly RE-EG should be carefully considered. While this is done through the conduct of DIS for each project, having a short- and long-term plan for the distribution network, which requires coordination among various stakeholders and supported by policies, can be beneficial. The current version of the DOE's DDP (2023-2032) does not have any mention or identification of distribution infrastructure plans which could serve as guide for potential investors.

- **Energy Curtailment.** The ability or inability of the DU to accurately forecast and plan its supply may be considered a barrier with respect to the uncertainty of the demand and supply situation within the DU. Also, the variability of RE is an inherent characteristic, which is also another factor in balancing the supply and demand within the DU's franchise.

- **Land Permitting.** Securing land permits can be a complex and lengthy process. Coordination with various agencies such as the local government unit and other stakeholders can lead to delays and increased costs. Developing a RE-EG project may also encounter community opposition, which can delay the project. The environmental and social impacts need to be carefully assessed.

- **Regulatory Barriers.** These barriers include, but are not limited to, the complex approval process for obtaining the necessary permits and environmental clearance, lack of clear and harmonized policies and guidelines, and delays in the regulatory approval for the expansion of the distribution network, which effectively hampers the development of RE projects whether on-grid or EG.

- **Failed CSP.** One of the identified reasons for the failure of CSP is that the EG is unable to meet the requirements of the DU (i.e.,100% capacity factor). Also, it is possible that there are no bidders or there is only one bidder resulting in a failed CSP.

- **Failed or Delayed T&C.** Based on available data, it was observed that some RE projects are experiencing extended test and commissioning due to various technical or mechanical issues, resource constraints, and/or other external factors, which effectively delay the RE development.

- **EG Threshold for Market Registration.** The TC recognizes that there should be a threshold level for the mandatory registration of EG in the WESM. However, a review of the current threshold is recommended since it may no longer represent a level at which an EG will have material impact on the grid considering the size of the regional grids.

- **DU Contract Portfolio.** One of the challenges for the DU or EC with existing contract with a baseload plant is that dispatching a VRE could result in a variable output of the baseload plant instead of a stable power output. In such cases, the baseload plant will still incur expenses for its fixed cost. This is a concern since this might translate into a portfolio that may be more expensive in terms of electricity price.

- **Vulnerability of Small ECs.** Some ECs, particularly small ECs, are often hit by typhoons and are easily exposed even with just a small variation in their supply and demand. Consolidation of ECs, whether physically, financially, or technically may improve their situation.

- **Market Dispatch of EGs.** The modelling of EGs in the MNM, which affects dispatch, pricing, and settlement, is a challenge since the distribution network is currently not modelled in the MNM. WESM-registered EGs are currently modelled at the nearest node within the network being monitored by the MO, while non-WESM EGs are not monitored in the market. Also, in the WESM, VRE is considered as a priority dispatch resource; however, the question is if it is also applicable at the DU level.

- **Classifying Non-EG at the Grid Level.** In the context of classifying generating plants, non-EGs are currently classified in the Philippines Grid Code (PGC) 2016 as either large or non-large generating plants. The TC believes that there should be a similar approach of classifying non-embedded generators at the grid level in terms of its characteristics and installed capacity.

<u>Sample Cases of RE-EG Projects</u>

These projects highlight the potential for renewable energy in the Philippines, demonstrating how government support, community involvement, and innovative financing can drive successful implementation.

1. **Rizal Wind Farm.** Located in Pililla, Rizal, this 54 MW wind farm was developed by Alternergy. The project overcame significant challenges, including social acceptability and financing issues, through strong local government support and community engagement. The project’s host DU is MERALCO.

2. **Tarlac Solar Power Plant.** The plant has a total installed capacity of 70 MW, with the first phase (50 MW) commissioned in 2016 and the second phase (20 MW) in 2019. The project’s output is sufficient to power around 31,700 households and likewise reduces carbon emissions saving over 47,800 tons of CO_2 annually. The first phase of the project was completed in a record time of 123 days from start construction “first pile in” to commissioning and achieving “first power out”. The project’s host DU is Tarlac Electric, Inc.

3. **DREAMS Project.** Initiated by the DOE in partnership with the Global Environment Facility (GEF) and the United Nations Development Program (UNDP), this project has successfully implemented solar-powered water systems, rooftop solar PV installations, and renewable energy-powered facilities in rural areas.

5.0 OTHER REFERENCES

The following TC studies may be related to and can be used as further reference relevant to this undertaking:

- Distribution System Operator (DSO) Managed Network – March 2022

  The TC was previously tasked to identify potential technical issues that can affect the operation of WESM in the Mindanao region and to recommend possible solutions to address such potential issues specifically on the participation of EG in the WESM. Since 2019, the TC has conducted a number of consultations and has found that there are EGs who intend to supply energy within the distribution network only and without any export to the grid and there are also host DUs that wish to manage and control their resources, such as EG.

  With the Philippine WESM operating under the gross pool concept in which all energy transactions from both supply and demand sides are centrally scheduled through the market, the TC opines that the current setup may not be the best environment for the EG resources and may impede further investments including that for EG. To efficiently utilize the EGs in the distribution network, a new protocol for the DU can be introduced to take on the responsibility of balancing supply and demand variations at the distribution level without fully extending the market to the distribution level.

  Introducing a DSO empowers the DU to host and manage energy resources, which are expected to grow in installations and capacities within its franchise area. Even though the TC has not yet quantified the benefits of the DU acting as the DSO, this new role of the DU may be beneficial to the industry in terms of wider options for dispatch, delayed network investment, optimal asset utilization, and even reduced losses when managed well.

- TC's Review on the Viability of Embedded Generators (EG) as Emergency Power Supply in Highly Urbanized Area – July 2022

  Based on the TC's assessment, the viability of EGs as emergency power supply during periods of natural calamities should consider the following factors:

  1. Relative Location – the distance between the EG from the disaster area should be close enough to allow the transport of equipment and supplies or delivery of power over a short distance. However, the distance should also consider the radius of the disaster area, which can adversely affect the generator's operation.

  2. Transportability and Logistics – if the EG is transportable, safe access to the disaster area should be determined for transport of equipment and fuel supplies, as well as a suitable site for operations.

  3. Electrical Networks – if the EG is stationary, the conditions of distribution and transmission networks intended for power delivery should be determined for safety and reliability.

4. Operational Safety – operating generating equipment and high voltage networks requires qualified technical personnel for safety and reliability.

6.0 SUMMARY AND RECOMMENDATIONS

The current policy direction is leaning towards supporting the country's transition to RE to achieve the national target of 35% RE share in the energy generation mix by 2030, and 50% by 2040. One way to accelerate the proliferation of RE is by integrating RE-EG at the distribution level. While there are already existing RE-EG in the distribution system, including existing policies and programs to encourage such investment and to ensure that the entry of RE technology in the distribution franchise area will not have material impact on the grid or distribution network, the streamlined entry of additional RE resources in the distribution level is still hindered by various barriers and challenges that may pose uncertainty to potential investors and effectively delay investments.

The circular dilemma suggests that RE generator development requires financing, but they cannot be financed until transmission/distribution access is available; however, transmission/distribution lines cannot be built without regulatory approval and cost recovery certainty, or a demonstrated need for such generation.

Based on this documentary research, the TC's views and recommendations are summarized as follows:

- The viability of an embedded RE generator can be determined through feasibility studies and will depend on the individual economic and technical considerations of each project.
- There are existing processes in determining the technical impact of integrating RE-EG in the distribution network through the conduct of a distribution impact study (DIS) to be evaluated by the concerned DU.
- The challenge lies in the distribution system to which the RE-EG will interconnect given that there are more than 150 distribution utilities (consisting of private, electric cooperatives, and others) which have varying sizes, supply requirements, and levels of technical and financial capabilities.
- Having a complete and detailed model of the distribution network in the Market Network Model is recommended since it affects the dispatch, pricing, and settlement in the WESM, provided that the RE-EG is required to register in the WESM.
- Consolidation of ECs, whether physically, financially, or technically, may improve their situation; however, if this is not yet an option, then it is suggested to have a Distribution System Operator (DSO) that will facilitate contracting and balancing of power within the DU network.
- The industry should consider the technological trend for IBR, which utilizes grid-forming inverters (GFMI) that offer solutions to ensure grid stability with high RE penetration. The United Kingdom (UK) is currently utilizing synchronous condenser, which is electromechanical that has a large flywheel. The application of synchronous condenser is similar to the capabilities of the GFMI; however, whichever is more economically feasible is still unknown.
- The policy proposal (ERC Case No. 2023-001 RM) which exempts VRE from outage monitoring does not help in assessing the operational performance of RE-EGs and the reliability risk in the grid. Objective measurement of RE-EG performance guides developers in the improvement of this technology.
- The issue on stranded contracts might be a conflicting objective wherein prioritizing RE is desirable; however, accommodating them can no longer provide financial viability in the case where the DU is already fully contracted with non-RE suppliers. The cost recovery will also be a concern for the RE developer.

- Compared with transmission planning, there are relatively less barriers in distribution planning. A distribution network can be constructed faster since it is easier to secure right-of-way within the DU area. Also, another factor is the voltage level which corresponds to lower financial investment for lower voltage systems.
- In the case of a large RE plant within a small EC, as an example, it may be better to connect to the transmission grid if the available distribution network is not capable of accommodating the large RE plant.

The foregoing observations and recommendations are based on a holistic approach of reviewing the current policies and relevant guidelines which impact the technical and financial viability of RE-EG projects in the country. The TC believes that this undertaking could also serve as an initiative for a more collaborative discussion among the policymakers and stakeholders to further realize the potential of integrating renewable energy as embedded generators in the distribution franchise areas.

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