Philippines Grid Diagnostic and Roadmap for Smart Grid Development

Final Summary Report

By

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CONTENTS

List of Tables

List of Figures

Appendices

1. EXECUTIVE SUMMARY

The Philippine grid network is perceived to be relatively weak and not resilient enough to respond to various challenges associated with power grid operations and development[1]. There is a perception but with growing evidence that transmission investments in network expansion and smart technologies since the past decades were inadequate. The events in May 2023 which put the Luzon grid into red and yellow alerts[2][3] and those in the Visayas grid in April 2023[4] indicate and support these concerns. This lack of investments is a result of the absence of investment roadmap to upgrade the grid and due to certain gaps in the grid governance structure.

This study, 'Philippines Grid Diagnostic and Roadmap for Smart Grid Development', seeks to provide a blueprint to address current issues facing the power grid. The study covers 3 main components with specific objectives:

- Component 1 Road Map for Regulatory and Investment Upgrades with the objective of providing recommendations to the Department of Energy (DOE) to promote priority investments into the grids in Luzon, Visayas, and Mindanao that pave the way for significant expansion in the share of renewable energy in the total primary energy supply and to support the national goal of modernising the Philippine power grid that ensures flexibility, security, and resiliency.
- Component 2 Review of Electricity Governance Structures with the objective developing options and alternatives for changes in grid governance, as well as short-term strategies for overcoming challenges caused by the current grid governance.
- Component 3 Communications and Workshops to ensure the information is correctly and sufficiently disseminated.

With lack of investment road map supporting the government's strategic objective of decarbonising and modernising the grid, Component 1 assessed the role of smart technologies in ensuring grid flexibility, security and resiliency while achieving the government's long-term renewable energy target of 50% of the total power generation mix by 2040. The main findings and key results of Component 1 are the following:

- The current Transmission Development Plan (TDP) prepared by the National Grid Corporation of the Philippines (NGCP), the network concessionaire, covers a chapter on competitive renewable energy zones (CREZ) but does not cover an expansion plan for network investments to interconnect potential renewable energy projects identified in those zones. Also, the TDP mainly outlined the principles for smart grid development but has not elaborated a smart grid road map as required by Department Circular DC 2020-02-0003 (Providing a National Smart Grid Policy Framework for the Philippine Electric Power Industry and Roadmap for Distribution Utilities).
- Component 1 reviewed smart technologies and elaborated a **smart solutions road map** providing basis for developing investment packages in smart solutions needed to develop a flexible, secure and resilient national grid. In addition, a **smart energy transition road map** was developed as a base for preparing smart solution investment packages that partly address potential impacts of high renewable energy grid integration and ensure meeting the government's decarbonisation targets. Smart technology options for both road maps will be identified, prioritised, and selected through a least-cost optimisation exercise under the transmission network development planning process. As a result, smart grid investment road maps will form part of a transmission network development plan that seeks to cover a much broader strategic objectives of the government.

Translating these road maps into investment packages and actual investments face challenges in the project implementation stage. The pathway pursued by the government in reforming and privatising the power sector is fraught with implementation difficulties. There remain several gaps in policies and regulations that hinder the preparation and implementation of these investment packages. Component 2 reviewed the grid

[1] : These challenges include i) balancing supply and demand, b) increasing demand, c) support of the connection of VRE generation, d) reverse power operation, e) safety and stability of the power system, f) replacement of aging plants.

[2] Luzon grid placed on red alert after 5-plant outage.

[3] A red alert is raised when the power supply is insufficient to meet consumer demand, causing power outages. Meanwhile, a yellow alert is issued when the operating margin is not enough to meet the transmission grid's regulatory and contingency requirements.

[4] Panay island still facing power outages.

governance structures, identified key gaps and recommended policy regulations for the Department of Energy (DOE), Energy Regulatory Commission (ERC) and National Transmission Corporation (TRANSCO):

- The Electric Power Industry Reform Act of 2001 (EPIRA) designates TRANSCO to be responsible for preparing the TDP but this role has been transferred to NGCP during the management transfer under the concession agreement. The lack of coordination between NGCP and DOE in transmission planning results a ***sub-optimal*** TDP that responds mainly to the corporate objectives of NGCP but not the strategic objectives of the government. With this, Component 2 recommends to recapacitate TRANSCO to be the country's Strategic Transmission Network Development Planner and ensures that the strategic objectives of the government are covered in the **Strategic Transmission Network Development Plan** (STNDP). NGCP will continue to carry out its planning process and its TDP will be the main input to TRANSCOs STNDP. The STNDP will be the reference document for ERC to approve NGCPs investment plan.
- The Smart Grid Circular (DC 2020-02-0003) needs strong enforcement and NGCP has yet to comply with this policy regulation and to elaborate an investment plan of its **smart solutions road map** in the next update of its **TDP**. On the other hand, TRANSCO's **STDNP** must expound an investment plan of the country's **smart energy transition road map**.
- ERC needs to update and issue new regulations and standards related to smart technologies. In the past, the grid management committee (GMC) and distribution management committee (DMC) established under the Philippine Grid Code facilitates monitoring of compliance with these technical codes, oversees the developments of the technical codes, and provide technical assistance to the ERC. GMC and DMC were dissolved by ERC on the grounds of its nature of funding. As a result, the industry did not have a forum to discuss grid and distribution issues. ERC was likewise deprived of its technical arm that had previously conducted studies and proposed enhancement of grid and distribution standards. Consequently, ERC is becoming dependent on ad-hoc technical support from international donor organisations. Component 2 recommends the Technical Committee of the Philippine Electricity Market Corporation to house the GMC and DMC.
- The Philippine Grid Code specifies that the grid operator (NGCP) to be the sole entity undertaking the grid impact studies for power generation applicants. With high volume of applications, NGCP takes almost a year to complete a system impact study. Component 2 recommends reinforcing NGCP and to designate TRANSCO as another entity to carry out system impact studies.
- NGCP as the whole-of-grid concessionaire is responsible for grid operation and for investments in network expansion. The existing weak and less resilient grid could be partly attributed to the absence of performance indicator in NGCP's concession agreement, unlike those of other utilities such water and toll roads. Component 2 recommends preparing key performance indicators that could be used in gauging NGCP's performance as TRANCO's concessionaire.

As a summary, Component 1's smart solutions road map and smart energy transition road map are the basis for preparing the investment packages for smart technologies. The selection and prioritisation of smart technologies are to be undertaken through the optimisation analysis in the transmission development planning process. The preparation and implementation of the investment road map faces organisational and regulatory challenges but could be addressed through specific intervention measures as identified and specified in Component 2 analysis.

The Philippine whole-of-grid concession model could potentially evolve into the following: NGCP may continue to be the system operator and concessionaire of the existing transmission network. Transmission expansion investments however could be opened to third-party investors through competitive bidding. In this case, third party investors would be allowed to finance and build a new transmission line under long-term contracts (at the end of the contract, the investor will transfer the asset to TRANSCO). This scheme however will require an amendment of the EPIRA and other laws.

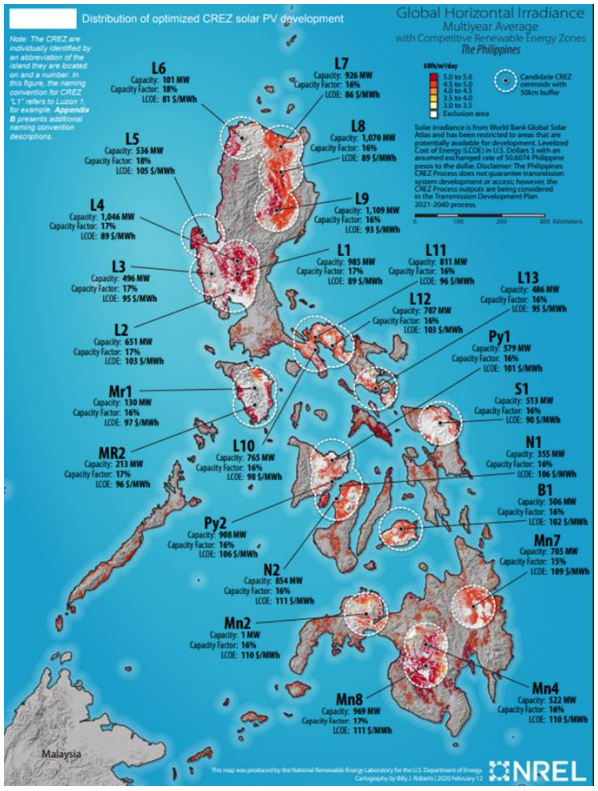
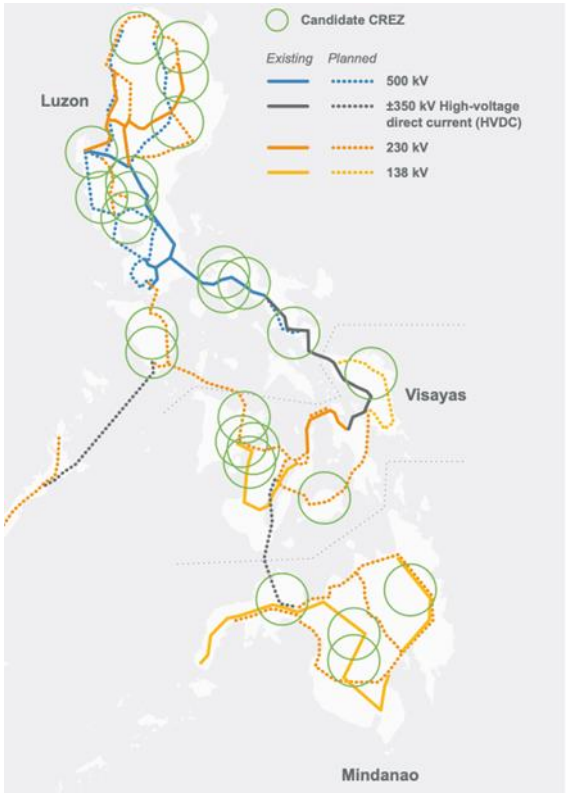
2. COMPONENT 1: ROAD MAP FOR REGULATORY AND INVESTMENT UPGRADES

This study aims to provide recommendations to the Department of Energy (DOE) to enable priority investments into the grids in Luzon, Visayas, and Mindanao that pave the way for significant expansion in the share of renewable energy in the total primary energy supply and to support the national goal of modernising the Philippine power grid that ensures flexibility, security, and resiliency. This report is the Component 1 of the study which focuses on the development of a smart technology road map that facilitates the integration of variable renewable energy (VRE) in the Philippine national grid.

2.1 VARIABLE RENEWABLE ENERGY IN THE PHILIPPINES

The Philippine Government set an aspirational target of increasing the share of renewable energy to 50% of the power generation mix in 2040. This target corresponds to a total additional cumulative installed capacity of 73,183 MW from renewable energies which consists of 44,863 MW solar, 16,315 MW hydro, 11,255 MW wind, 480 MW geothermal, and 270 MW biomass throughout the country between 2025 and 2040. These capacities can be developed in geographic areas designated as Competitive Renewable Energy Zones (CREZ) where renewable energy resource potential is high and cost effective while at the same time within proximity to the transmission network (Figure 1). The government identified 25 zones across the country with the highest commercial interest for inclusion in transmission scenario development. These CREZ have an estimated gross capacity of 152 GW of new wind and solar photovoltaics (PV). The zones also include an estimated 365 MW of geothermal, 375 MW of biomass, and over 650 MW of hydropower capacity distributed across the Luzon, Visayas, and Mindanao systems.

Figure 1. CREZ locations and Transmission Network Proximity

CREZ Locations	CREZ and Transmission Network
	

Source: NREL 2020. Ready for Renewables: Grid Planning and Competitive Renewable Energy Zones in the Philippines

2.2 SMART GRID AS A POLICY VISION

At the outset, this study would like to highlight that smart grid is not a technical solution but a policy vision. Smart technologies are elements of a toolbox that can help solve defined problems and leverage opportunities. Key enabling technologies such as high-quality data, communications and SCADA/EMS are the foundation for smart networks.

The Philippine smart grid policy aspirations were clearly defined in the Department Circular DC 2020-02-0003 (Providing a National Smart Grid Policy Framework for the Philippine Electric Power Industry and Roadmap for Distribution Utilities). The government aims to achieve a smart grid with guiding principles of safety, reliability, efficiency, flexibility/sustainability, resiliency, and consumer empowerment, and envisaging a system that is capable of i) self-healing and ii) providing full customer choice, iii) full implementation of the retail competition and open access (RCOA), Renewable Portfolio Standards (RPS), Green Energy Option (GEOP), and net metering; iv) optimised energy storage systems (ESSs), Energy Management Systems, and Distributed Energy Resources (DERs) Management Systems; virtual power plant integration; v) islanding; vi) demand response, demand-side and Peak Load Management, and; vii) smart homes and cities.

2.3 KEY TECHNICAL CHALLENGES AND TECHNOLOGY RESPONSES

The primary and long-term focus for power grid development is to upgrade them to accommodate electricity generation powered by VRE and to accommodate Low Carbon Technologies (LCTs) being adopted by society. However, there are significant challenges in meeting these objectives which include the following: i) balancing supply and demand, b) increasing demand, c) support of the connection of VRE generation, d) reverse power operation, e) safety and stability of the power system, f) replacement of aging plants.

Five main potential impacts of VRE integration on transmission networks have been identified by the study. These are the following: i) voltage management issues, ii) uncertainty of VRE outputs, iii) congestion, iv) loss of fault current, and v) reduction in system inertia.

- **Voltage Management Issues:** The implementation of new and clustered VRE within the existing network will alter the voltage profiles across the network, including voltage rise when the generation is in operation, and significant voltage swings between peaks and troughs of operation. This might include periods where some transmission lines or whole distribution networks may be at zero or negative load overall in the daytime and draw load at night. This creates a challenge in managing the voltages across the system to ensure they are stable and within required limits.
- **Uncertainty/reduced flexibility of VRE Outputs:** In a traditional power system, the large, centralised generation is dispatchable, in that it can be controlled and varied in order to match the demand of the loads connected to the grid. However, VRE generation such as wind and solar can only produce energy at certain times, and while they can be constrained down when there is more generation than needed, it cannot be ramped up at will. Therefore, the methods by which supply and demand are balanced on the grid in real time need to be carefully considered.
- **Network Congestion:** Additional VRE generation, along with the decarbonisation of sectors such as transport, heat and industry will have significant impacts on the demand profile experienced on the grid, including requiring significantly more network capacity in constrained areas. It is the responsibility of the transmission and distribution network to enable this transition by providing the required capacity effectively, quickly and affordably. In particular for the purposes of this report, congestion can occur in areas with high capacity of conventional generation sources or renewable energy flowing from other CREZ sources, including the possibility that the power flows around these areas could reverse at times of peak generation. The suitability of the network infrastructure to support reverse power needs to be considered.
- **Reduction of Fault Current:** In a traditional power system, protection systems are operated on the basis of fault current – the current that flows in the event of a fault, which is much higher than the current flowing under BAU operation. This is important as it means that protection settings can be set to reflect a level above BAU current flows, but below the expected fault levels, and the protection will operate in the event of a fault. While fossil fuelled generation contributes to fault current, VRE, which is connected though power electronic interface, typically only contributes between 1- and 1.2-times normal load current to a fault. Therefore, new approaches to protection are needed in areas of significant levels of renewable generation. This requirement might change dynamically over time, as

the contribution from VRE changes with the time of day and the weather. In the longer term, different approaches are needed to manage grid protection across the whole grid.

- **Reduction in System Inertia:** In a traditional power system, the fossil fuelled generation, with heavy and rotating synchronous machinery, contributes to the stability of the power system it feeds through the physical inertia of the machinery. This acts to dampen any sudden disruptions in system frequency due to imbalance between supply and demand, allowing ride through of short-term issues, and giving time for corrective actions if needed. The control of the system is designed around this characteristic. VRE generation is connected to the grid via inverters that change direct current in to alternating current and do not provide the same inertia characteristics. Therefore, new approaches to grid stability are needed to support in periods of time where there are significant levels of renewable generation and comparatively little spinning generation.

Table 1 presents the descriptions of these impacts as well as the potential technology responses. There are smart technologies that can help with the challenges of the adoption VRE or can enable more economic operation of the grid. The selection of the technologies and solutions to use should be based on the nature of the problem the solution is trying to solve, and options (traditional and smart) should be based on an assessment of the technical and commercial merits, while recognising the risks, and environmental and social impacts.

Table 1. Potential Technology Responses

Potential Impact of VRE on Transmission Network	Potential Technology Responses
Voltage Management Issues Renewable generation causing voltage rise and swings within the network, including periods where distribution networks may be at zero or negative load overall in the daytime and draw load at night.	SCADA/EMS studies and optimisation Controllable reactive power technologies Demand side response Connection requirements and flexible connections
Uncertainty/Reduced Flexibility of VRE Outputs Renewable generation is not dispatchable, with the generation dependent on the natural energy source – this introduces challenges in planning and balancing the system	SCADA/EMS studies and optimisation Improved forecasting of connected VRE Energy storage Flexible connections and demand side response Reserve policy
Network Congestion Additional generation capacity using up network equipment capacity, preventing additional connections. This may be particularly relevant in CREZ areas where VRE will be clustered.	SCADA/EMS studies and optimisation Dynamic asset rating Demand side response Strategic reinforcement
Loss of Fault Current Issues include dynamically changing network conditions and lower fault levels without contribution from VRE. In the longer term, different approaches are needed to manage grid protection across the whole grid.	Network studies to review static protection settings Dynamic protection settings New fault detection sensing / protective devices not reliant on fault current
Reduction in System Inertia Inertia is integral to grid stability, and is created by large, synchronous spinning generation. Periods where the proportion of VRE generation is high will have significantly reduced inertia, risking the stability of the grid.	Wide Area Monitoring Synthetic inertia

2.4 CREZ VRE INTEGRATION IMPACTS ON TRANSMISSION NETWORK

This study carried out a review of current plans for grid expansion, modernisation and upgrades as basis for assessing the impacts of variable renewable energy integration on transmission network in each CREZ. As a

diagnostic study, the potential impacts of VRE integration on the transmission network were based on expert's assessment and could be further investigated through a load flow analysis.

For the North Luzon grid:

- Voltage management issues could be potentially high in CREZ the north-eastern part of the grid (group L7, L8 and L9). Wide variation of voltage may occur due to the high VRE capacity with relatively low local demand and long EHV transmission line that connects the group to the rest of the network.
- Impact to grid due to output uncertainty could be high in CREZ groups that have large VRE capacity (L1, L2, L3, and L4, and group L7, L8 and L9), the variability of which affects the operation of the grid due to their large RE capacity.
- Congestion could occur in locations with numerous conventional generation sources and where output from the local and remote VREs converge (be high in group L1, L2, L3, and L4).
- Issues related to reduction loss of fault current/protection could also be high in locations where conventional sources of generation are not dispatched during some times of the day or when the power source is mostly VREs (CREZ group L1, L2, L3, and L4, and group L7, L8 and L9). These will affect how the grid protection will behave.
- Similarly, reduction is system inertia is high due to CREZ groups that have high VRE capacity as these displaces many conventional generation sources that contribute inertia to the grid (CREZ group L1, L2, L3, and L4, and group L7, L8 and L9). Higher inertia provides better stability to the grid.

In Southern Luzon grid:

- Voltage management issues could be potentially high in Mindoro Island (CREZ group Mr 1 and Mr 2) due to its AC interconnection to the main island of Luzon and the relatively low local demand.
- Output uncertainty, congestion, reduction of fault current/protection issues and reduction in system inertia could also be high due to high capacity VREs in in areas where CREZ group L10, L11 and L122 are located and numerous conventional generation sources near this group that may be displaced during certain times of the day.

For the Visayas region:

- Voltage management issues could be potentially high in the islands of Bohol and Samar (CREZ group B1 and S1) due to low local demand compared to the VRE capacities in these islands.
- VRE output uncertainty, reduction of fault current/protection issues and reduction in system inertia could also be high in Panay and Negros islands (CREZ groups Py1 and Py2, and N1 and N2) due to displacement of conventional generation sources in the islands during certain times of the day or have large capacity VREs.

For the Mindanao grid:

- Impacts are within low to medium except in the central part of Mindanao Island (CREZ Mn4 and Mn8) where the VREs in this group have relatively large capacity that also displaces some conventional generation sources resulting in uncertainty of VRE output and reduction in system inertia are high.

Table 2 summarises the study's assessment of the VRE impacts for the three main grids in the Philippines (Luzon, Visayas and Mindanao). In assessing the impacts of VRE integration on transmission network, the study grouped the CREZ zones based on their geographic alignment with the individual transmission operating districts.

Table 2. CREZ Potential Impact of VRE Integration on Transmission Network

	North Luzon CREZ				South Luzon CREZ			Visayas CREZ				Mindanao CREZ		
	L1, 2, 3, 4	**L5**	**L6**	**L7,8,9**	**L10, 11, 12**	**L13**	**MR1, 2**	**Py1, 2**	**N1, 2**	**B1**	**S1**	**Mn2**	**Mn4, 8**	**Mn7**
Voltage Management Issues	L	L	L	**H**	M	L	**H**	M	M	**H**	**H**	L	M	M
Uncertainty of VRE output	**H**	M	L	**H**	**H**	L	L	**H**	**H**	L	L	L	**H**	M
Congestion	**H**	M	L	L	**H**	L	L	M	M	L	L	L	M	L
Loss of fault current	**H**	M	M	**H**	**H**	L	M	**H**	**H**	M	M	L	M	M
Reduction in System Inertia	**H**	M	L	**H**	**H**	L	L	**H**	**H**	L	L	L	**H**	M

Note: H – high; M – medium; L – low. The CREZ zones are based on Figure 1. The CREZ are individually identified by an abbreviation of the island they are located on and a number. The naming convention for CREZ "L1" refers to Luzon 1, for example. Additionally, "N" refers to Negros, "Py" to Panay, "B" to Bohol, "Mn" to Mindanao, "S" to Samar, "Ms" to Masbate, "Mr" to Mindoro, "C" to Cebu, and "Pw" to Palawan.

2.5 SMART GRID ROAD MAPS

Addressing the above impacts and to ensure flexible, secure and resilient grid require investments related to grid expansion and smart technologies. Grid expansion investments are covered in the current Transmission Development Plan (TDP). This study focuses on developing a road map for developing smart grid solutions.

The study prepared two road maps.

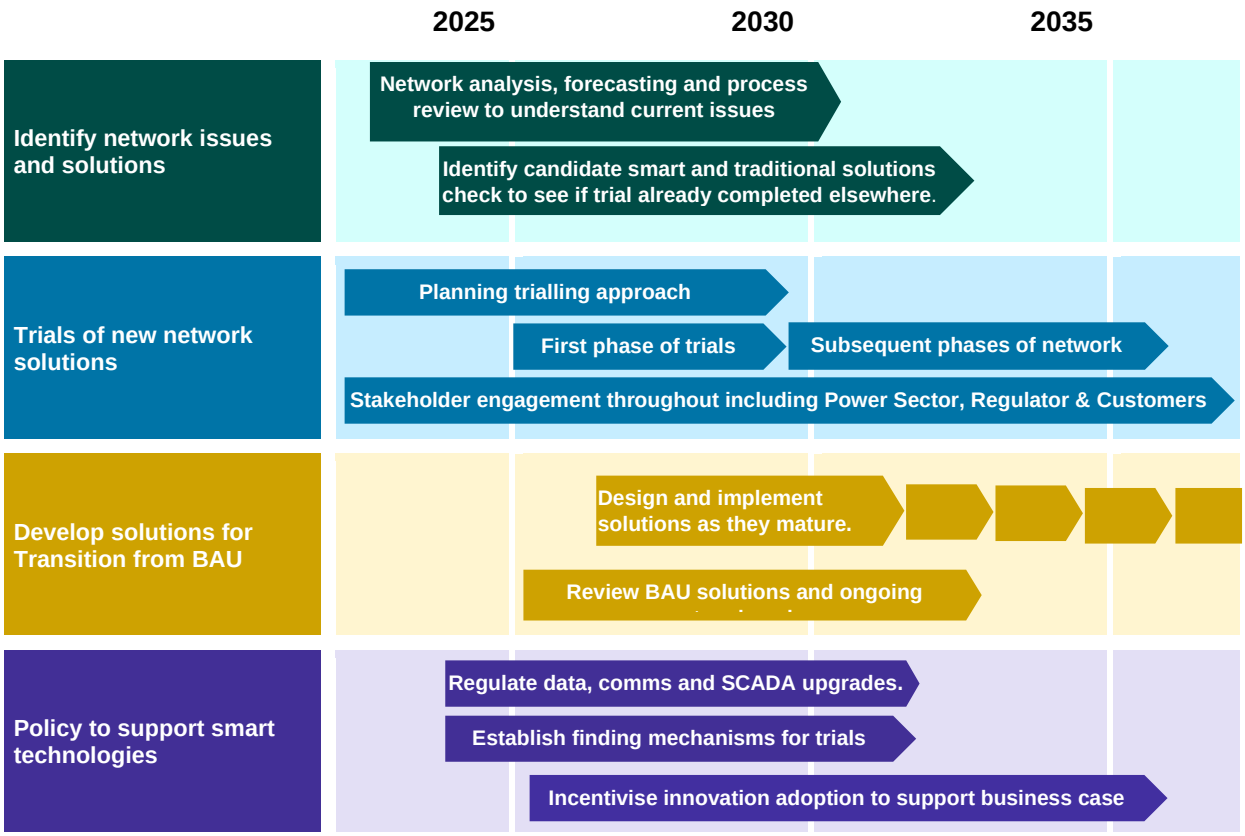
- **Smart Solutions Road Map**. This roadmap relates to the general process for developing innovative ideas for addressing the on-going challenges of improving transmission network resilience, reliability, asset utilisation, and safety.
- **Smart Energy Transition Road Map**. The road map for Philippine energy transition looks at the process of addressing specific challenges anticipated with respect to the energy transition and the increasing capacity of inverter connected variable renewable energy powered electricity generating plant connected to the transmission network.

The **Smart Solutions Road Map** shown in Figure 2 sets out a process by which innovation projects can be developed, tested, and where the benefits show sufficient value incorporated into the network operation as business as usual. Key activities under this road map includes:

- Identification of network issues and solutions,
- Pilot demonstration of new network solutions,
- Development of solutions for transition from business-as-usual scenario, and
- Introduction of policies to support smart grid technologies.

It should be noted that a very large number of innovation projects have been undertaken across the USA the EU and the UK in recent years and have been implementing some technologies into business as usual. This has developed a lot of learning on the topic, including on the projects and technologies that have not proven valuable enough to be implemented. It is also noted that ideas that at first did not look promising become more so over time as technology and business conditions develop. In some cases, benefits look sufficiently attractive for the idea or concept to be revisited.

Figure 2. Smart Solutions Road Map



The **Smart Energy Transition Road Map**, designed for the Philippine energy transition, provides an approach to addressing the issues that are anticipated to arise as a consequence of the increasing capacity of inverter based VRE connected to the transmission network. The assumption being that the VRE will displace traditional fossil fuelled rotating plant.

As shown in Figure 3, the enabling technologies are communications, supervisory control and data acquisition (SCADA) and energy management systems (EMS). These systems include applications software including functions for network analysis and secondary control of generation for automated frequency management and economic dispatch, reserve monitoring, and load forecasting functions. The existing communications, SCADA and EMS need to be upgraded since most of these installed technologies in the country are already becoming obsolete. A gradual transition approach would be beneficial to give the network operator time to understand and assess the performance and functionality of the newer technology.

The road map identified required responses to address network challenges: i) voltage management issues; ii) uncertainty/reduced flexibility of VRE output; iii) network congestion; iv) reduction in fault current; v) reduction in system inertia. These are summarised in Table 3.

Figure 3. Road Map for Addressing Philippine Energy Transition

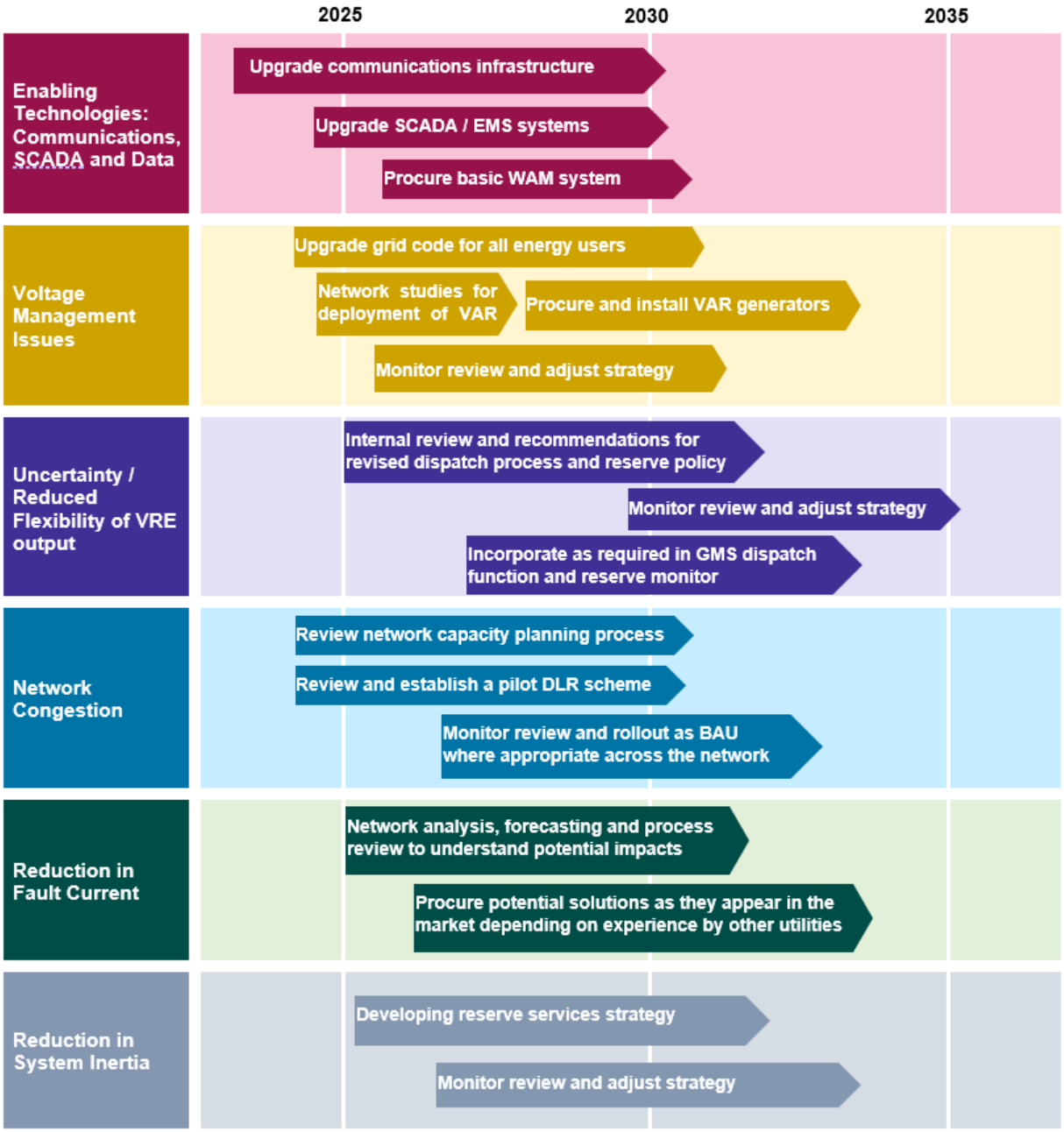


Table 3. Specific Challenges and Required Responses Identified in Road Map 2

Item	Challenge	Response
1	Upgrade foundational tools for operational management	• Upgrade network wide optical fibre-based communications infrastructure • Upgrade integrated SCADA/EMS/GMS central processing platform • Procure and implement wide area monitoring system (WAMs)
2	Voltage & VAR management	• Review requirement for new VRE to have VAR capability • Conduct studies to identify programme for introducing additional sources of reactive power on the network

Item	Challenge	Response
3	VRE and the dispatch challenge	• Develop improved output forecasting for VRE generation • Develop a reserve policy that will track the changing generation mix and accommodate worst case contingency scenarios • Identify how the reserve policy can be packaged as auxiliary services • Coordinate development of demand side management (DSR) with distribution companies to realise benefits for the operation of the transmission network
4	Network congestion	• Identify an overhead line for trialling dynamic ratings (DLR) • Transition DLR to business as usual where this will be beneficial • Incorporate strategic reinforcement into network planning where congestion is on an upward trend.
5	Reduction in fault current	• Review protection setting and the changes in the levels of fault current as the generation mix evolves of time. • Track new developments in fault identification
6	Reduction in system inertia	• Ensure reserve policy can accommodate worst case contingencies relating to loss of generation • Conduct studies to investigate relevant contingency scenarios • Track developments in synthetic inertia, grid forming inverters and fast frequency response capability to understand when it is realistic to include such requirements in the connection regulations/codes.

3. COMPONENT 2: REVIEW OF ELECTRICITY GOVERNANCE STRUCTURES

The terms of reference (TOR) specifies that the review of the current regulatory governance structure for the Luzon, Visayas, and Mindanao grids aims to identify current challenges and bottlenecks, and short-and medium-term strategies that can be implemented to ensure that adequate amounts of maintenance and forward-looking investment are made to modernize and upgrade the grid infrastructure.

At present there is lack of investment in the expansion of transmission infrastructure, and with the current governance arrangement one can expect that there will be insufficient investments for smart grid upgrades.

As a background, we carried out a review on the power sector reforms and business models for private sector participation in transmission investments.

- The Republic Act No. 9136 also known as the Electric Power Industry Reform Act of 2001 (EPIRA) unbundled the electric power industry into 4 main sectors: generation, supply, transmission, and distribution. EPIRA established the Power Sector Assets and Liabilities Management Corporation (PSALM) to privatize the generation assets and the National Transmission Company (TRANSCO) as a wholly owned subsidiary of PSALM to assume the planning, construction, centralized operation and maintenance of the transmission assets and business of the National Power Corporation (NPC). The Act also provided guidance for the privatisation of TRANSCO through either outright sale or a concession contract. The Government opted for a concession contract and signed a concession agreement with the National Grid Corporation of the Philippines (NGCP) on 28 February 2008.
- To put into global context, the report also reviewed the best practice models for private sector participation in transmission investments. These models are i) privatization, ii) whole-of-grid concession, iii) independent power transmission, vi) merchant investment and v) dedicated line for independent power producers. The Philippines is the only country that pursued the whole-of-grid concession while most of the countries that introduced reforms adopted mainly either privatisation or independent power transmission. The whole-of-grid concession model requires strong regulatory capabilities from the Government while the private concessionaire needs to trust the regulatory environment. The Philippines has a unique experience and the lessons learned from other countries may not be fully relevant to the Philippine context.

The following subsections present our findings and recommendations on the regulatory governance:

3.1 TRANSMISSION PLANNING

- **Existing rules and regulations require strong interaction and cooperation between DOE, TRANSCO and NGCP in transmission planning.**
  - *Key policy documents*. Electric Power Industry Reform Act of 2001 (EPIRA), and Concession Agreement.
  - *Key challenge*. NGCP considers the transmission planning exercise as an internal process, and only involves TRANSCO and the DOE after the plan is prepared. As a result, DOE is unable to fully reflect its policies and priority projects within the Transmission Development Plan (TDP). This resulted in a sub-optimal TDP that mainly responds to the corporate objectives of NGCP and not the strategic objectives of the government.
  - *Proposed intervention*. The current circumstances are not conducive for cooperation and does not facilitate meaningful consultation between DOE and NGCP in the preparation of the TDP. The study proposes TRANSCO to be re-capacitated to fulfil its mandates under in the EPIRA and the Concession Agreement, and to act as *Strategic Transmission Network Development Planner*.
- **The smart grid regulatory policy requires the Transmission Network Provider to prepare a smart grid roadmap.**
  - *Key policy documents*. Department Circular No. DC2020-02-0003 (Providing a National Policy Framework for the Philippine Electric Power Industry and Road Map for Distribution Utilities).
  - *Key challenge*. NGCP has yet to develop its smart grid roadmap, though the Transmission Development Plan 2022-2040 defines the company's smart grid strategies. With suboptimal

TDP, NGCP's smart grid road map will only cover the smart solutions road map but will not capture the smart energy transition road map.

- *Proposed intervention*. The smart solutions roadmap will form part of the NGCP's Transmission Development Plan. On the other hand, TRANSCO's Strategic Transmission Network Development Plan will cover the smart energy transition roadmap. This will be developed in consultation with key stakeholders including NGCP. Once approved by the DOE this will be the basis for ERC's tariff approval.

- **The smart grid regulatory policy also requires the Energy Regulatory Commission (ERC) to issue smart grid standards while the Philippine Grid Code established a technical support mechanism for ERC to formulate technical standards.**
  - *Key policy documents*. Department Circular No. DC2020-02-0003 (Providing a National Policy Framework for the Philippine Electric Power Industry and Road Map for Distribution Utilities) and Philippine Grid Code.
  - *Key challenge*. ERC has yet to issue the smart grid standards for distribution utilities and transmission network provider. Due to issues on the nature of the funding, ERC also dissolved the grid management committee (GMC) and the distribution management committee (DMC) established under the Philippine Grid Code (PGC) and Philippine Distribution Code (PDC) respectively to facilitate monitoring of compliance with these technical codes, oversee the developments of the technical codes, and provide technical assistance to the ERC. As a result, the industry did not have a forum to discuss grid and distribution issues. ERC was likewise deprived of its technical arm that had previously conducted studies and proposed enhancement of grid and distribution standards. Consequently, ERC is becoming dependent on ad-hoc technical support from international donor organisations.
  - *Proposed intervention*. The study proposes the Technical Committee of the Philippine Electricity Market Corporation (PEMC) to fill the vacuum with measures to ensure independence of the recommendations.

3.2 FINANCING

- **Incentives to NGCP are sufficient to recover investments.**
  - *Key findings*. Philippine Congress granted preferential tax treatment in NGCP's franchise, providing for franchise tax with a rate of 3% of all gross receipts derived from operations of the franchise while ERC Resolution No. 7, series of 2011 further provides that the franchise tax can be recovered through tariffs. By comparison, distribution utilities are subject to income taxes which are not pass-through costs. As to the past rates applied to NGCP by the ERC, the weighted average cost of capital (WACC) applied to NGCP has been no lower than 15%. This implies that NGCP was provided sufficient incentives to recover its investments and should have optimised investments in network expansion and smart technology solutions.

3.3 APPROVALS

- **The Energy Virtual Online One Stop Shop Law (EVOSS Act) requires streamlining of the system impact study.**
  - *Key policy documents*. The Energy Virtual Online One Stop Shop Law (EVOSS Act) and the Philippine Grid Code.
  - *Key Challenge*. The Philippine Grid Code prescribes that the system operator conducts system impact studies for power generation applicants. The EVOSS Act requires that the process be streamlined, transparent and deliver efficient and effective service to the public. Based on the assessment of the DOE Investment Promotion Office (IPO), the applications for System Impact Study (SIS) and Generation Impact Study (GIS) are numerous, and it normally takes more than a year to release one complete study.
  - *Proposed Intervention*. One entity that can conduct the said studies is TRANSCO with the assistance from the Market Operator since the Market Operator currently has data related to the market network model used in the WESM as well as access to data on congestion.

3.4 CONCESSION AGREEMENT

The whole-of-grid approach requires strong controls to ensure quality of service, transparency, and accountability. Since details in the law are not sufficient, these controls would have to be reflected in the terms of the Concession Agreement.

The Concession Agreement has been in effect for 14 years already, more than half of the 25-year term. Given the lapse of time and the issues raised by various stakeholders, it is necessary to make a systematic evaluation of the performance of the concessionaire and the terms of the Concession Agreement for the purpose of renegotiating the same.

- **Arrangements must be made in relation to possible non-extension of PSALM's corporate life**
  - PSALM was created by the EPIRA to primarily manage the privatization of NPC's assets. The 25-year Concession Agreement will terminate in 2034 while the corporate life of PSALM will expire in 2026, unless extended by law. Moreover, the Concession Agreement provides that the transmission assets will be turned over to PSALM or its nominee at the end of the term (TRANSCO however is liable for recovery payment).
- **Introduction of a Performance Scorecard for the grid operator**
  - While NGCP is responsible for the final implementation of the strategic transmission network plan, the Concession Agreement does not provide key performance indicators (KPI) to evaluate NGCP's performance, which is unlike some of the concession arrangements for water utility concessions and toll roads. The Concession Agreement does not provide for performance standards where NGCP can be gauged for the possible decision on the extension or termination of the agreement.

3.5 STRATEGIC TRANSMISSION PLANNING

The study proposes to re-establish TRANSCO as a Strategic Transmission Network Development Planner as envisioned under the EPIRA. Our concept of strategic transmission network planning are summarised below.

- The main finding of our review is that the current objectives of transmission planning is narrow in scope and that the whole planning process is reactive rather than proactive. Investment options may have been missed and clear signals may have not been sent to project developers, DOE and ERC of the need for critical, strategic investments that should be prioritised and taken forward immediately.
- The study proposes to broaden the scope of transmission planning and to reflect strategic goals of the Government such as Nationally Determined Contributions (NDC) goals and decarbonisation targets.
- The study outlines 7 stages of strategic planning process to be i) demand-supply simulation analysis, ii) identification of system needs, iii) identification of investment options, iv) cost benefit analysis, v) development of strategic transmission network development plan, vi) strategic transmission network development plan finalisation and handover to delivery bodies, and vii) detailed solution design.
- Benefits of having a strategic transmission development network planner identified in the study include the following: i) greater coordination of transmission network investments, ii) identify clear and transparent strategic investments, iii) provide the Department of Energy greater confidence in network development, iv) send clear earlier signals to users of the system, v) potentially provide confidence to planning permitting bodies and local communities, and vi) potentially reduce costs due to coordinated designs and more efficient utilisation of assets.
- Key risks identified include i) lack of capacity/manpower in TRANSCO, ii) risks associated with interoperability, and iii) duplication of resources between TRANSCO and NGCP. The capacity of TRANSCO could be strengthened, allocation of risks between NGCP and TRANSCO could be clearly assigned, and that the benefits of having a strategic transmission network planner outweighs any additional costs.

3.6 POTENTIAL EVOLUTION OF WHOLE-OF-GRID CONCESSION MODEL

Once TRANSCO is designated by the government as the Strategic Transmission Planner (which prepares priority and strategic transmission network investment packages), the current whole-of-grid concession model could potentially evolve into the following:

- NGCP may continue to be the system operator and concessionaire of the existing transmission network.
- Transmission expansion investments however could be opened up to third-party investors through competitive bidding. In this case, third party investors would be allowed to finance and build a new transmission line under long-term contracts (at the end of the contract, the investor will transfer the asset to TRANSCO).
    - In this case, NGCP will also be allowed to participate in bidding for expansion projects.
- This new arrangement is also compatible with our earlier recommendation to review and strengthen the rules for generators to invest and operate dedicated point-to-point limited transmission facilities.

The legal implications of this evolution could be summarized as follows:

- a scheme that would provide for additional transmission providers will entail amendments to law/s;
- a scheme involving building and leasing transmission facilities will require cooperation of the transmission provider. Without such consent, additional investment in transmission facilities is limited to the last paragraph of section 9 of the EPIRA, where compensation for the facilities built is at fair market value.

It must be noted that House Bill No. 7742 pending before the Committee on Energy proposes among others, an amendment to the EPIRA allowing assignment of ERC approved projects in the TDP that were not completed to qualified third parties. An amendment such as this would allow third-party investment in the grid. This would likely require renegotiating the Concession Agreement. Further, this might also require a review of the rates, as the ERC may have authorized NGCP to collect the CAPEX in their tariff already, with respect to certain projects.

4. CONCLUSION AND NEXT STEPS

With lack of investment road map supporting the government's strategic objective of decarbonising and modernising the grid, Component 1 assessed the role of smart technologies in ensuring grid flexibility, security and resiliency while achieving the government's long-term renewable energy target of 50% of the total power generation mix by 2040. The main findings and key results of Component 1 are the following:

- The current Transmission Development Plan (TDP) prepared by the National Grid Corporation of the Philippines (NGCP), the network concessionaire, covers a chapter on competitive renewable energy zones (CREZ) but does not cover an expansion plan for network investments to interconnect potential renewable energy projects identified in those zones. Also, the TDP mainly outlined the principles for smart grid development but has not elaborated a smart grid road map as required by Department Circular DC 2020-02-0003 (Providing a National Smart Grid Policy Framework for the Philippine Electric Power Industry and Roadmap for Distribution Utilities).
- Component 1 reviewed smart technologies and elaborated a smart solutions road map providing basis for developing investment packages in smart solutions needed to develop a flexible, secure and resilient national grid. In addition, a smart energy transition road map was developed as a base for preparing smart solution investment packages that partly address potential impacts of high renewable energy grid integration and ensure meeting the government's decarbonisation targets. Smart technology options for both road maps will be identified, prioritised, and selected through a least-cost optimisation exercise under the transmission network development planning process. As a result, smart grid investment road maps will form part of a transmission network development plan that seeks to cover a much broader strategic objectives of the government.

Translating these road maps into investment packages and actual investments face challenges in the project implementation stage. The pathway pursued by the government in reforming and privatising the power sector is fraught with implementation difficulties. There remain several gaps in policies and regulations that hinder the preparation and implementation of these investment packages. Component 2 reviewed the grid governance structures, identified key gaps and recommended policy regulations for the Department of Energy (DOE), Energy Regulatory Commission (ERC) and National Transmission Corporation (TRANSCO):

- The Electric Power Industry Reform Act of 2001 (EPIRA) designates TRANSCO to be responsible for preparing the TDP but this role has been transferred to NGCP during the management transfer under the concession agreement. The lack of coordination between NGCP and DOE in transmission planning results a *sub-optimal* TDP that responds mainly to the corporate objectives of NGCP but not the strategic objectives of the government. With this, Component 2 recommends to recapacitate TRANSCO to be the country's Strategic Transmission Network Development Planner and ensures that the strategic objectives of the government are covered in the Strategic Transmission Network Development Plan (STNDP). NGCP will continue to carry out its planning process and its TDP will be the main input to TRANSCOs STNDP. The STNDP will be the reference document for ERC to approve NGCPs investment plan.
- The Smart Grid Circular (DC 2020-02-0003) needs strong enforcement and NGCP has yet to comply with this policy regulation and to elaborate an investment plan of its smart solutions road map in the next update of its TDP. On the other hand, TRANSCO's STDNP must expound an investment plan of the country's smart energy transition road map.
- ERC needs to update and issue new regulations and standards related to smart technologies. In the past, the grid management committee (GMC) and distribution management committee (DMC) established under the Philippine Grid Code facilitates monitoring of compliance with these technical codes, oversees the developments of the technical codes, and provide technical assistance to the ERC. GMC and DMC were dissolved by ERC on the grounds of its nature of funding. As a result, the industry did not have a forum to discuss grid and distribution issues. ERC was likewise deprived of its technical arm that had previously conducted studies and proposed enhancement of grid and distribution standards. Consequently, ERC is becoming dependent on ad-hoc technical support from international donor organisations. Component 2 recommends the Technical Committee of the Philippine Electricity Market Corporation to house the GMC and DMC.
- The Philippine Grid Code specifies that the grid operator (NGCP) to be the sole entity undertaking the grid impact studies for power generation applicants. With high volume of applications, NGCP takes

almost a year to complete a system impact study. Component 2 recommends reinforcing NGCP and to designate TRANSCO as another entity to carry out system impact studies.

- NGCP as the whole-of-grid concessionaire is responsible for grid operation and for investments in network expansion. The existing weak and less resilient grid could be partly attributed to the absence of performance indicator in NGCP's concession agreement, unlike those of other utilities such water and toll roads. Component 2 recommends preparing key performance indicators that could be used in gauging NGCP's performance as TRANCO's concessionaire.

As a summary, Component 1's smart solutions road map and smart energy transition road map are the basis for preparing the investment packages for smart technologies. The selection and prioritisation of smart technologies are to be undertaken through the optimisation analysis in the transmission development planning process. The preparation and implementation of the investment road map faces organisational and regulatory challenges but could be addressed through specific intervention measures as identified and specified in Component 2 analysis.

The findings and recommendations of Component 1 and Component 2 studies were discussed during the interagency workshops. Overall, the DOE and its key stakeholders have expressed appreciation and accepted Ricardo's analysis and recommendations during these workshops. The ways forward were also presented during these gatherings.

i. Component 1. One of the smart technologies identified in the study is battery energy storage system (BESS). The DOE requested Ricardo to further carry out technical analysis supporting its study on Energy Storage System Road Map. The DOE shared the terms of reference (TOR), Ricardo submitted its methodology and was subsequently accepted by the DOE.

ii. Component 2. The DOE has given its approval for Ricardo to carry out the actions specified in its study recommendations. These are summarised in the Table below.

Table 4. Next Steps

Measures	Outputs and Outcomes
Development of the roadmap for the build-up of capacity of TRANSCO for strategic planning of the Philippine transmission network expansion including the smart grid.	Provide assistance in the development of a blueprint for TRANSCO's build-up as Strategic Network Development Planner, which can be the basis and reference for follow up activities. **Outputs:** • Report on gaps, organizational and technical requirements, estimated budgetary requirements, and legal and regulatory review • Internal workshop for TRANSCO • Drafting of department order/circular for role as Strategic Network Development Planner **Outcome:** • TRANSCO will have the mandate to prepare the Strategic Transmission Network Development Plan covering the smart energy transition roadmap and responding to the government's strategic objectives of decarbonising the grid.
Reconstitution of the Grid and Distribution Management Committees	To transition from the interim arrangements designating the WESM Technical Committee (TC) as the Grid Management Committee under Resolution No. 4 series of 2023, to a more permanent status by: • Drafting an amendment to the WESM Rules and WESM Manual on the Guidelines Governing the Constitution of the WESM Governance Committees to (i) reflect the desired composition, nomination and appointment procedure of the members and observers of the TC for purposes of acting as

Measures	Outputs and Outcomes
	the GMC/DMC, or as subcommittees of the TC and (ii) to reflect their expanded obligations. ○ **Outputs:** ▪ WESM Rules and WESM Manual ▪ Support for DOE public consultation on the amendments • Drafting the supplemental ERC resolution "accrediting" the TC to undertake the functions of the Grid Management and/or Distribution Management Committee and prescribing clear procedures and protocols on reporting as between the TC and the ERC. ○ **Outputs:** ▪ Supplemental Resolution ▪ Support for ERC public consultation on supplemental resolution **Outcome:** • ERC will be able to issue and update technical regulations related to smart technologies with sustained technical support from the new independent grid management committee.
Further development of the rules for generators advancing the cost of connection to the Grid	To facilitate the interconnection of the new RE projects, the following may be undertaken: • Review of the OATS Rules and related issuances to determine whether improvements may be made in terms of process, valuation, and payment as regards investment on generator interconnection assets. Based on the review proposed amendments will be made to the rules providing detailed guidelines and methods on determination of fair market value, and the treatment of the segregated asset. ○ **Outputs** ▪ Amended OATS Rules ▪ 1 stakeholder workshop/FGD • Review the rules related to SIS, particularly on when necessary and enforcement of timetable ○ **Outputs** ▪ Amended OATS Rules and PGC • Review of ERC Resolution No. 23, Series of 2016 captioned "A Resolution Adopting Amended Rules on the Definition and Boundaries of Connection Assets for Customers of Transmission Providers" to determine whether changes may be made to support greater connected generation sources and to reduce reliance on the transmission operator for their interconnection. ○ **Outputs** ▪ Amended ERC Resolution ▪ 1 stakeholder workshop/FGD **Outcome:** • Accelerate the deployment of VRE by reducing the bottleneck in VRE grid interconnection through provision of incentives to VRE generators to invest in power evacuation infrastructure.

Measures	Outputs and Outcomes
Develop performance scorecard for the Grid Operator/Concessionaire in its function in operation, maintenance and development of the Philippine transmission system including island interconnection as well as the procurement of ancillary capacities for the reliability of the power system.	In order to complement the ongoing audit of NGCP, an independent study may be made with a view of developing KPIs in relation to the functions of NGCP which may be used for renegotiation of the Concession Agreement. ○ **Outputs** ▪ Report on KPIs recommendation ▪ 1 Internal workshop (DOE, ERC, TRANSCO, PSALM and possibly COA on what standards should be adopted in terms of valuation of assets and performance a concessionaire) **Outcome:** • To stimulate NGCP optimise its investments and to strengthen and transform the grid into a resilient network.

Appendix 1. Communication Plan

The study results were presented to government stakeholders during the interagency workshops held last 12 July 2023 (Component 1) and 19 July 2023 (Component 2) with both events organised at the Department of Energy (DOE). The study reports (including the interagency workshop reports) will be uploaded at ETP's website.

In addition to these reports, some knowledge products (a 5-page document) will be developed from the study results. These are: smart grid as a policy vision and business models on private sector investments in transmission networks. Additional knowledge products may be however identified during the extension of this project. These knowledge products will be uploaded to ETP website.

The diagnostic study reports do not need public consultations since they are not translated yet into specific government policies and regulations.

Some activities specified in the proposed project extensions will however require public consultations. As described in the Executive Summary of this report, activities that require public consultations are the following:

- DOE circular designating TRANSCO as strategic planner (DOE)
- Amended WESM Rules and WESM Manual (DOE)
- ERC supplemental resolution on TC of GMC (ERC)
- Amended OATS Rules (ERC)
- Amended ERC Resolution No. 23, Series of 2016 captioned "A Resolution Adopting Amended Rules on the Definition and Boundaries of Connection Assets for Customers of Transmission Providers" (ERC)

It must be noted that some these regulatory policies are under DOE while some under ERC. Communication plans and strategies of policy regulations under DOE will follow the DOE procedures, while those under ERC will follow ERC procedures.

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