Distribution System Operator (DSO) Managed Network

MARCH 2022

This Report is prepared by the
WESM Technical Committee

EXECUTIVE SUMMARY

The Wholesale Electricity Spot Market (WESM) Technical Committee (TC) was tasked to identify potential technical issues that may affect the operation of WESM in the Mindanao region and to recommend possible solutions to address such potential issues specifically on the participation of embedded generators (EG) in the WESM. Since 2019, the TC conducted a number of consultations and 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 Distribution Utilities (DU) 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[1]. This is when the DU will act as a System Operator of its franchise area or what we call as Distribution System Operator (DSO).

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 for the industry in terms of wider options for dispatch, delayed network investment, optimal asset utilization, and even reduced losses when managed well.

In addition, the TC is in the opinion that greater participation in various existing programs such as the Interruptible Load Program (ILP) and Demand-side Bidding (DSB) are beneficial. These programs will also prepare the DUs in taking new roles to efficiently manage their distribution networks.

[1] Gharehpetian, G.B., Mohammad Mousavi Agah, S., Distributed Generation System (Elsevier Inc., 2017)

Contents

1.0 BACKGROUND

The Philippine Electricity Market Corporation acknowledges the importance of the gross pool concept of the WESM operation in which all energy transactions from both supply and demand sides are centrally scheduled through the market. This includes the scheduling and dispatch of WESM-registered embedded generators (EG) that are connected to the distribution network.

For EG operations and participation in the WESM, the TC found that there are EGs that intend to supply energy within the distribution network without any export to the grid and there are also host DUs that wish to manage and control their resources especially EG. Hence, the TC opines that the current protocol of Central Dispatch for all resources may not be the best environment for these existing resources and may impede further investments in EGs.

With this, the TC conducted various consultations, meetings, and survey to further determine and appreciate EG-related issues and provide recommendations to address them. During the TC consultations, the TC acknowledged the critical role of the Distribution Utility (DU) in the participation of EGs in the WESM. Since EGs are connected to the Distribution System and indirectly connected to the Transmission System, the TC proposes the role of a Distribution System Operator (DSO).

Some of the various activities such as consultations, focus group discussions, and survey that the TC organized were as follows:

Date	Activity/ Entities	Purpose
March 2019	National Grid Corporation of the Philippines – System Operator (NGCP-SO)	Mindanao System Operator presented the challenges in the Mindanao grid.
14 August 2019 in Cagayan de Oro (CDO) City	Consultation on Embedded Generation in Mindanao 1. Embedded Generators 2. Distribution Utilities 3. Electric Cooperatives 4. NGCP-SO 5. Independent Electricity Market Operator of the Philippines (IEMOP)	Mindanao stakeholders raised technical and commercial concerns regarding the impending WESM operation in the region.
04 October 2019	Meeting with Distribution Utilities: 1. Cagayan Electric Power and Light Company, Inc. 2. Davao Light and Power Electric Company 3. South Cotabato Electric Cooperative II (SOCOTECOII)	Discussed issues that were raised in the CDO consultation, specifically on: • Market Network Modelling, • Asset reclassification (ERC Resolution No. 23 Series of 2016), and • Distribution Network Protocol (MO-SO-DU Interface).
February 2020	Distribution Utilities and Embedded Generators	Conducted a survey on the proposed conceptual diagram for the coordination of concerned

Date	Activity/ Entities	Purpose
		stakeholders in relation to the EGs' participation in the WESM.
24 March 2021 – 22nd WESM Mindanao Readiness Assessment (WMRA) Meeting	1. Department of Energy (DOE) 2. Energy Regulatory Commission (ERC) 3. IEMOP 4. NGCP-SO 5. National Electrification Administration (NEA) 6. Power Sector Assets and Liabilities Management (PSALM) Corporation 7. Mindanao Development Authority (MinDA)	Presented the proposed TC Coordination Protocol and gathered comments on the proposed DSO-managed network.
October 2021	Survey for Embedded Generators in Mindanao – All EGs in Mindanao	Solicit information on the status of registration and the intent of EGs regarding their participation in WESM Mindanao

2.0 EMBEDDED GENERATION AND DISTRIBUTION UTILITIES IN THE WESM

As defined in the WESM Rules, a DU is an Electric Cooperative, private corporation, government-owned utility or existing local government unit, that has an exclusive franchise to operate a distribution system in accordance with its franchise and the Electric Power Industry Reform Act of 2001 (EPIRA), and registered with the Market Operator as a Network Service Provider under Clause 2.3.4. Also, as specified in the Philippine Distribution Code (PDC), the following are the operational responsibilities of the Distribution Utilities that may be directly affected by connected embedded generators[2]:

1. The Distribution Utility shall be responsible for operating and maintaining power quality in the Distribution System during normal conditions, in accordance with the provision of Article 3.2, and in proposing solutions to power quality problems.
2. The Distribution Utility is responsible for designing, installing, and maintaining a distribution protection system that will ensure the timely disconnection of faulted facilities and Equipment.
3. The Distribution Utility is responsible for ensuring that safe and economic distribution operating procedures are complied with.
4. The Distribution Utility is responsible for maintaining an Automatic Load Dropping scheme, as necessary, to meet the targets agreed upon with the System Operator.

Basically, the DUs are responsible for the conveyance of electricity from high-voltage transmission network to End-users. In the WESM, the DU acts as a customer which engages in the activity of purchasing electricity supplied through a transmission system. It does not participate in the WESM to offer generation. However, if an EG will export to the grid, the power flows via distribution network which technically makes the DU a supplier to the grid at the Grid Exit Point (GXP).

[2] Energy Regulatory Commission, Philippine Distribution Code, Section 6.2.1, 91-92 (2017)

The participation of EGs in the WESM can be restricted by network constraints. For the MO to produce an economic dispatch schedule, all generation (both grid-connected and embedded generation regardless of contractual obligations) are offered in the Market[3] and detailed transmission network model, together with any constraints therein, are taken into account. Extending this to include EGs, detailed distribution network model together with any constraints therein should be similarly considered for the economic dispatch solution. Unfortunately, many distribution networks have not provided the network models that are useful for the MO (and the SO). The absence of a distribution network model in the Market Dispatch Optimization Model (MDOM) may significantly impair the economic dispatch solution.

Going forward, the MO may either convince the DU to provide the distribution network models or concede that DU will not fully disclose network models -- in which case, the MO may waive economic dispatch over EG as well. If there is any perceived adverse effect on economic dispatch with a smaller generation pool, this is countered with a depressed net demand at GXP.

With regard to EG registration in the WESM, the DOE has issued a Department Circular No. 2019-02-003 which provides the threshold for the mandatory registration of EGs in the WESM – 5 MW for Mindanao[4]. As of January 2022, 11 out of the 28 EGs in Mindanao are registered in the WESM. Also, based on the results[5] of the survey for EG in WESM Mindanao, thirteen (13) out of the twenty (20) respondents to the survey intends to supply only to the host DU and to customers within the host DU network. There are also suggestions from the respondents that EGs that are fully contracted with the host DU be registered as indirect WESM members, while the host DU as their direct WESM member counterparty. This suggestion will transfer the responsibility for the EG's participation in the WESM to the host DU.

3.0 DISTRIBUTION SYSTEM OPERATOR (DSO)

There are two possible ways for an EG to effectively participate in the electricity market. It is either to extend the market to the distribution network where the EG is located, or virtually connect the EG at the GXP. Since EGs are connected to the distribution network, extending the market to the distribution level will be difficult for most electricity markets[6].

To efficiently utilize the EGs in the distribution network, a new regulatory entity who will act as the system operator at the distribution level – the DSO has to be introduced. Likewise, a new protocol can be introduced as the DSO takes on the primary responsibility of balancing supply and demand variations without fully extending the market to the distribution level[7].

3.1 Role of Distribution System Operator (DSO)

[3] Gross Pool - All energy transactions, like the demand and supply of electricity, are scheduled through the market. This allows for all the power produced, supplied and used to be accounted in the market. This is favorable industry-wide to maximize the pool of offers, hence maximizing competition.
[4] Department of Energy, Department Circular, DC No. 2019-02-003, Section 6.1.1 (2019)
[5] The TC received responses from twenty (20) EGs out of the twenty-eight (28) expected respondents
[6] Gharehpetian, G.B., Mohammad Mousavi Agah, S., Distributed Generation System (Elsevier Inc., 2017)
[7] Ibid.

In a study conducted by the International Renewable Energy Agency (IRENA) in 2019, they described DSO as a key player in utilizing the increased volume of distributed energy resources or DER in electrical distribution networks[8]. DERs are small or medium-sized resources that are directly connected to the distribution network such as behind-the-meter batteries, smart charging electric vehicles, demand response, and distributed generation including EG.

Currently, the roles of the DUs include planning, maintenance and management of their distribution networks which covers connection and disconnection of EG, management of supply outages and energy billing among others. In addition, IRENA identified new roles for the DU as DSO in relation to the increasing DER deployment[9]:

1. Peak load management through DERs
2. Network congestion management
3. Provide reactive power support to TSOs
4. Procure voltage support
5. Technical validation for power market

The integration of DSO in the power system will result to a positive change in the way the power system is operated. One of the key advantages of having a DSO is the increased flexibility in distribution networks[10]. DSO could utilize the increased penetration of DERs by procuring various services such as peak shaving, voltage support and congestion management among others. To achieve the flexibility in distribution networks, IRENA determined the following the regulatory mechanisms[11]:

1. Non-firm connection agreements for end-consumers
   These are connection agreements wherein the customer agrees to have constrained power supply during peak hours, and the network fee is reduced as compared to firm connection agreements

2. Bilateral flexibility contracts
   This refers to contractual agreements between DSO and DERs to provide local system services to the DSO.

3. Local markets
   This refers to local flexibility markets for distribution system services in which DER could participate to support the distribution grid. The output of these markets could be technically validated by the DSO in cooperation with the TSO.

3.2 DSO in other jurisdictions

In the United Kingdom, the Electricity Networks Association (ENA) launched the Open Network Project[12] which is expected to lay the foundation for transitioning the role of DSO. This project aims to develop improved processes for the TSO and DSO which includes planning and shared services, and a needs gap assessment for customers.

[8] Anisie, A., Boshell, F., Ocenic, E., Future Role Distribution System Operators (IRENA 2019)
[9] Ibid.
[10] Ibid.
[11] Ibid.
[12] Energy Networks Australia (ENA), Open Energy Networks Project (2020)

In Australia, they also have a project called Open Energy Networks Project (OpEN) which aims to demonstrate that through a distribution market, the industry can better integrate DER into local distribution networks[13]. In 2019, OpEN published a report which provided the potential technical framework for incorporating DERs into the electricity network – one of which is the Two-Step Tier (TST) Framework

The TST framework involves Distribution Network Service Providers (DNSP) taking responsibility for optimization of DER dispatch within their own networks. This framework involves aggregators providing bids to the DNSP, representing their dispatch preferences and eventually, DNSPs would aggregate bids from all DER in their networks and provide them to Australian Energy Market Operator (AEMO)[14]. Figure 1 provides the relationships involved in TST framework in the Australia's National Electricity Market (NEM) which is operated by the AEMO.

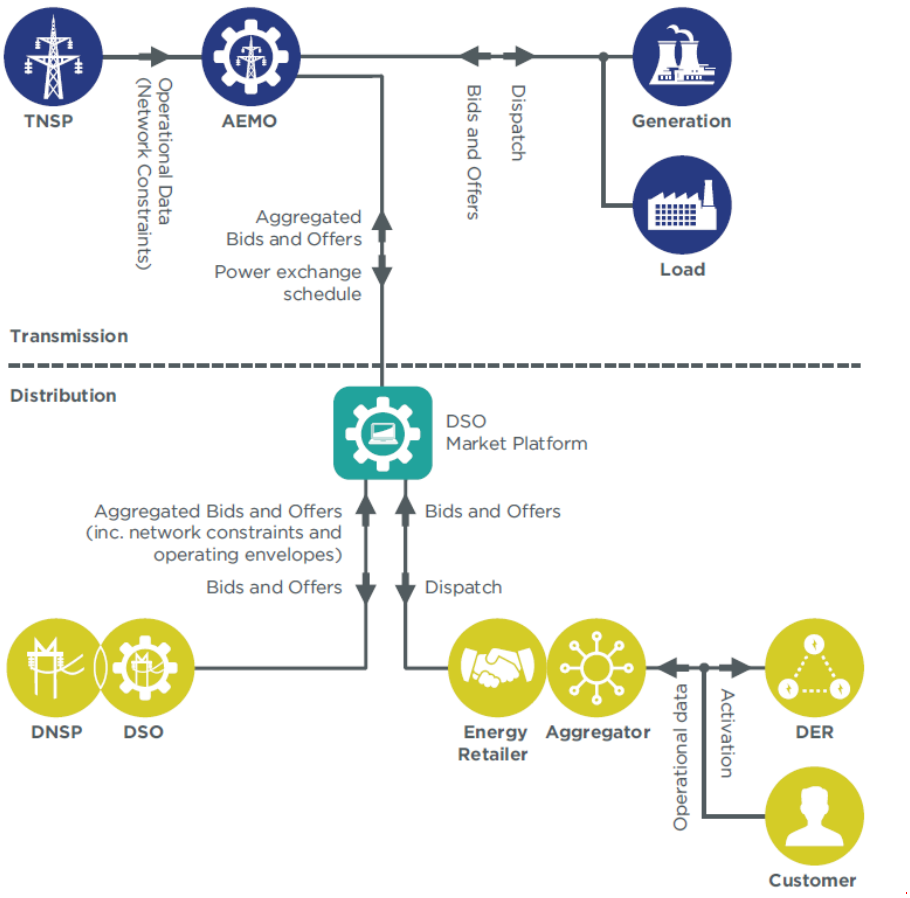

Figure 1. Relationships involved in the TST Framework[15]

[13] Energy Networks Australia (ENA), Open Energy Networks Project (2020)
[14] Ibid.
[15] Ibid.

3.3 DSO in the Electricity Market

In the NEM, the role of the DSO is to organize and operate the local market. Table 1. provides some of the key characteristics in relation to the participation of DSO[16] in Australia's NEM:

Table 1. Key Characteristics on the participation of DSO in the NEM[17] [18]

Participant	Role
AEMO	• Organizes and operates the market • Assesses all bids and offers and optimizes the dispatch of energy resources considering the transmission and distribution network constraints • Sends out dispatch instructions directly to transmission network energy resources and indirectly to distribution network schedule at the distribution network boundary
DSO	• Organizes and operates the local market • Receives DER bids and offers from the central market, prequalifies them into an aggregated bid stack per transmission connection point based on distribution network and DER operating envelopes and passes them to AEMO for whole system optimization. • Allocates the dispatch to individual DER based on the power exchange schedule. • Prequalifies, procures, dispatches and settles the DER from aggregators/retailers for distribution network constraint management via the local platform.

Currently, Australia's regulations do not allow the emergence and management of distribution level markets. In a report prepared by ENA, they highlighted the need in creating a legal foundation on this matter which will be pivotal in ensuring efficient distribution-level markets and allowing DER owners to fully realize the benefits of their investment[19].

3.4 DSO in the Philippines

As mentioned in a Department Circular (DC) released by the DOE in 2020, DC 2020-02-0003, entitled Providing a National Smart Grid Policy Framework for the Philippine Electric Power Industry and Roadmap for Distribution Utilities, a Smart Distribution Utility (SDU) shall be envisioned to be a reliable, flexible, resilient and secure automated distribution system integrated with decentralized energy resources. This modernization is expected to promote consumer empowerment and to influence consumer behavior towards efficient utilization of energy[20].

[16] Based on the Two-step Tier (TST) Framework in the NEM
[17] Energy Networks Australia (ENA), Open Energy Networks Project (2020)
[18] Based on the Two-step Tier (TST) Framework in the NEM
[19] Energy Networks Australia (ENA), Open Energy Networks Project (2020)
[20] Department of Energy, Department Circular, DC No. 2020-02-003 (2020)

Although there is no direct mention on having a DSO to achieve the foregoing vision, it is important to note that the introduction of DSO in the power system will have a huge impact in improving the flexibility, resiliency and power security in the distribution network.

With regard to the DSO's participation in the WESM, a real-time distribution level market or a Distribution Market Operator (DMO) may be introduced considering that there is a need to manage bids and offers from EG and other DERs. This setup may address the concerns raised during the TC consultations on the possible prioritization issues of the DU when acting as SO in its franchise area.

In addition, Rule 10 of the EPIRA – Implementing Rules and Regulations (EPIRA-IRR) requires each DU and other Electric Power Industry Participant to structurally and functionally unbundle their business activities in accordance with a business separation and unbundling plan prepared by the DU and approved by the ERC[21]. Based on the Business Segment Guidelines (BSG) released by the ERC, DUs have the following seven distribution and related activities business segments:

1. Distribution Services
2. Distribution Connection Services
3. Regulated Retail Services
4. Last Resort Supply
5. Wholesale Aggregation
6. Non-Regulated Retail Services
7. Related Businesses

Among these the Distribution Services and Distribution Connection Services business segments support the development of a DSO in the distribution network. Specifically, the provision of the following services contribute to the possible additional role of DU acting as the System Operator (SO) within its distribution network:

1. Control and monitoring of electricity as it is conveyed through the distribution system,
2. Provision of Ancillary Services, if any, that are provided using assets which form part a Distribution System,
3. Planning, maintenance, augmentation and operation of a Distribution System, and
4. Provision of capability at each connection to a Distribution System to deliver electricity to or take electricity from the connection point.

4.0 TC RECOMMENDATION ON THE IMPLEMENTATION OF THE PROPOSED DSO-MANAGED NETWORK

With the issue on network constraints, specifically on the DU's jurisdiction over the distribution network and EGs within its franchise area, the TC recommends that the DU should be responsible in the participation of their EGs in the WESM. The DU should act as the DSO to keep the operation of the distribution system while the Transmission System Operator (TSO) is responsible for the operation of the Grid. The EG's coordination with the MO and the TSO shall be coursed through the DSO. This may include net generation offers, dispatch schedules and dispatch instructions, among others.

Figure 2 shows the comparison between the TC proposal and the current setup of the network.

[21] Energy Regulatory Commission, Business Separation Guidelines (BSG) As Amended, Section 4.4, 29-34 (2006)

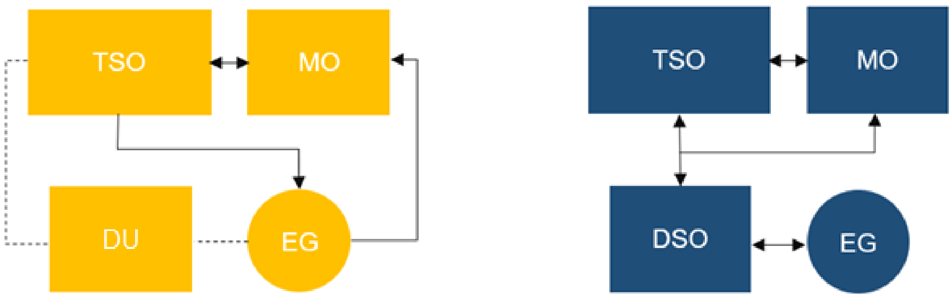

Figure 2. EG coordination with the MO and the TSO: Current setup (left) vs DSO-managed network (right)

Introducing a DSO empowers the DU to host and manage new and emerging distributed energy resources (DER) which are expected to grow in terms of number of installations and capacities. A DSO-managed network that effectively manage DER, including EG promises benefits for the industry in terms of voltage regulation[22] and accommodating voltage ancillary services[23], improved congestion management by effective utilization of flexible resources[24,25],and opportunities for new market mechanisms for distributed resources[26,27,28] even extending to peer-to-peer transactions[29]. Eventually, this translates to wider options for dispatch to include flexible resources, possible delayed network investment and reduced losses via optimal asset utilization due to an uptake in DER investments and utilization.

The TC likewise acknowledges that the proposal will entail additional costs and requirements to industry players such as operational cost, capital expenditures in terms of additional manpower and technology infrastructure (e.g. SCADA, communication systems, governing control systems, etc.). Also, the responsibility to source Ancillary Services (AS) within the DU network to maintain power quality or to address issues related to the Transmission Service Agreement (TSA) and AS charges is borne by the DU. This takes time and the time horizon varies widely across various private DUs and electric cooperatives.

[22] A. Bachoumis, C. Kaskouras, G. P. Papaioannou and M. Sousounis, TSO/DSO Coordination for Voltage Regulation on Transmission Level: A Greek Case Study (Madrid, Spain, *2021 IEEE Madrid PowerTech*, 2021), 1-7.
[23] A. O. Rousis, D. Tzelepis, Y. Pipelzadeh, G. Strbac, C. D. Booth and T. C. Green, Provision of Voltage Ancillary Services Through Enhanced TSO-DSO Interaction and Aggregated Distributed Energy Resources (*IEEE Transactions on Sustainable Energy*, vol. 12, no. 2, 2021), 897-908.
[24] H. Chang and A. Moser, Benefits of a combined flexibility utilisation between TSO and DSO for congestion management (*CIRED 2020 Berlin Workshop - CIRED 2020*, 2020), 758-760.
[25] A. Esmat and J. Usaola, DSO congestion management using demand side flexibility (Helsinki, *CIRED Workshop 2016*, 2016), 1-4.
[26] C. Salon, O. Huet and F. Blanc, How DSO could facilitate system optimization in new market mechanisms for distributed resources (Stockholm, *22nd International Conference and Exhibition on Electricity Distribution - CIRED 2013*, 2013), 1-4.
[27] A. Z. Morch, H. Sæle, D. Siface, H. Gerard and I. Kockar, Market architecture for TSO-DSO interaction in the context of European regulation (Ljubljana, Slovenia, *2019 16th International Conference on the European Energy Market - EEM,* 2019) 1-5.
[28] C. Kok, J. Kazempour and P. Pinson, A DSO-Level Contract Market for Conditional Demand Response (Milan, Italy, *2019 IEEE Milan PowerTech*, 2019), 1-6.
[29] S. Deacon, G. Taylor and I. Pisica, Peer-to-peer energy transactioning –a DSO-centric proposal (Middlesbrough, United Kingdom, *2021 56th International Universities Power Engineering Conference - UPEC*, 2021), 1-6.

Quantifying the cost-benefit ratio for such a far-reaching proposal that effectively revolutionizes the electric power system is not easy[30]. Quoting, Kristov (IEEE, 2019) on a pathway for an integrated-decentralized power system including a DSO proposal,

> *The economic case for many otherwise desirable DER-based projects, including microgrids, is hampered today by the limitations of benefit-cost analysis. A fundamental defect of the entire approach is that its outcomes depend on which benefits, and costs are included and how they are measured, things that can be highly subjective and arbitrary. Historically, benefits and costs that are too hard to measure or would lead to an inconvenient answer are left out of the analysis.*[31]

In terms of empowering the DU to manage and control resources within the franchise area, the TC is in the opinion that greater participation in the following existing programs are important and beneficial as well.

4.1 Interruptible load program (ILP)

Interruptible Load Program (ILP) or as also referred to in the PGC as Voluntary Load Curtailment (VLC) is a demand control program that allows customers to operate their generating sets and collectively reduce electricity drawn from the grid when power interruptions are imminent to ration limited power supply. This program requires the DU's management of Participating Customers (PC) in their respective franchise areas[32].

4.2 Implementation of Demand-side Bidding in the WESM

Demand-side bidding (DSB) is a demand response mechanism that enables consumers to actively participate in electricity trading, by bidding or pricing their energy demand block to match the generators' offers[33]. The integration of customer's bid price to the market optimization model aims to promote higher level of competition and provide more accurate price signals.

DSB is already embedded in the WESM, however it requires the infrastructure and support of the SO and participating DUs and Customers. This means that the DU has an important role on the successful implementation of DSB in the WESM.

Since DSB is already part of the short to medium-term plan[34] of the DOE, it will be strategic to prioritize the implementation of DSB in the WESM to further improve the DUs capability to manage their own network.

[30] L. Kristov, The Bottom-Up (R)Evolution of the Electric Power System: The Pathway to the Integrated-Decentralized System (*IEEE Power and Energy Magazine*, vol. 17, no. 2, March-April 2019), 42-49.
[31] Ibid., 47.
[32] Energy Regulatory Commission, Resolution, ERC Resolution No. 5 Series of 2015 (2015)
[33] Green, R. Hull, L., A Practical Guide to Demand-Side Bidding (International Energy Agency Demand-Side Management Programme, 2003)
[34] Department of Energy (DOE), Philippine Energy Plan 2016-2030 (2016)

Submitted by:

TECHNICAL COMMITTEE

[signed]

JORDAN REL C. ORILLAZA
Chairperson

[signed]
MARIO R. PANGILINAN
Member

[signed]
ERMELINDO R. BUGAOISAN JR.
Member

CO-AUTHORS

FORTUNATO C. LEYNES	Former TC Member
JAIME V. MENDOZA	Former TC Member