ENERGY TRANSITION PARTNERSHIP

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Development of Vietnam Smart Grid Roadmap for period up to year 2030, with a vision to 2050

DELIVERABLE 2

Report on Current Status of Smart Grid Development in Viet Nam

28 November 2023

by

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UNOPS AFD Federal Ministry for Economic Affairs and Climate Action Department for Energy Security & Net Zero Environment and Climate Change Canada / Environnement et Changement climatique Canada CIFF Children's Investment Fund Foundation SEQUOIA CLIMATE FOUNDATION Australian Government Department of Climate Change, Energy, the Environment and Water

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ACRONYMS

ADMS	Advanced Distribution Management System
AGC	Automatic Generation Control
AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
CLP	Curtailable Load Program
CPC	Central Power Corporation
DMS	Distribution Management System
DR	Demand Response
DRSM	Demand Response Management Software
DSM	Demand Side Management
DSO	Distribution System Operator
DTCR	Dynamic Thermal Circuit Rating
EE	Energy Efficiency
EMS	Energy Management Systems
ETP	Southeast Asia Energy Transition Partnership
ERAV	Electricity Regulatory Authority of Vietnam
EVN	Electricity of Vietnam
EVNCPC	Central Power Corporation
EVNHANOI	Hanoi Power Corporation
EVNHCMC	Ho Chi Minh City Power Corporation
EVNNPC	Northern Power Corporation
EVNNPT	National Power Transmission Corporation
EVNSPC	Southern Power Corporation
FLS	Fault Locator System
FMSR	Fault Management and System Restoration
HCMC	Ho Chi Minh City Power Corporation
GENCO	Generation Corporation
ICT	Information Communication Technology
IT	Information Technology
IPP	Independent Power Producer
JETP	Just Energy Transition Partnership
MAIFI	Momentary Average Interruption Frequency Index
MOIT	Ministry of Industry and Trade
NLDC	National Load Dispatch Center
NPC	Northern Power Corporation
NPT	National Power Transmission Corporation
PC	Power Corporation
PDP	Power Development Plan
RCC	Remote Control Center
RLDC	Regional Load Dispatch Center
RE	Renewable Energy

ROC	Remote Operation Center
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAS	Substation Automation System
SCADA	Supervisory Control and Data Acquisition
SPC	Southern Power Corporation
TSO	Transmission System Operator
UNOPS	United Nations Office for Project Services
VEDRP	Voluntary Emergency Demand Reduction Program
VCGM	Viet Nam Competitive Generation Market
VRE	Variable Renewable Energy
VREM	Viet Nam Retail Electricity Market
VWEM	Viet Nam Wholesale Electricity Market

EXECUTIVE SUMMARY

This Deliverable 2 - Report on Current Status of Smart Grid Development in Viet Nam has been prepared by Intelligent Energy Systems Pty Ltd (IES) and East West Energy and Climate Link JSC (EWEC) for the project titled *"Development of Vietnam Smart Grid Roadmap for period up to year 2030, with a vision to 2050"*. This project is implemented under the UNOPS Southeast Asia Energy Transition Partnership (ETP) in cooperation with the Electricity Regulatory Authority of Vietnam (ERAV). The Deliverable 2 Report provides a comprehensive review of the status of smart grid development in Viet Nam, including an evaluation of the policies and legal framework that is in place to support smart grid development.

Review of the Current Legal Framework for Smart Grid Development in Viet Nam

The two main policy documents that provide guidance for smart grids development in Viet Nam are Prime Minister's Decision No. 1208/QD-TTg (dated 8 November 2012) setting out the first Smart Grid Development Roadmap, and MOIT's Decision No. 4602/QD-BCT (dated 25 November 2016) approving the comprehensive Smart Grid Development Plan. The first roadmap has specified the objectives and targets to be achieved in each of the following three phases:

- **Phase 1** (2012-2016): focusing on development of basic regulations and improving power system efficiency. Main objectives for this period included establishment of a comprehensive data collection, monitoring, and control system (SCADA) and remote metering systems for all power plants with a capacity greater than 30 MW, substations with voltages of 110 kV and above; deployment of all functions of the Energy Management System (EMS) at the National Load Dispatch Center and regional load dispatch centers; and initial implementation of automated operations and remote control of substations in the power system.
- **Phase 2** (2017-2022): focusing on automation of transmission grid and AMI for large customers. Main activities designated for this stage were to continue the deployment and enhancement of SCADA systems for the Power Corporations, equip automation systems for 110kV substations, and install remote metering systems for large electricity consumers.
- **Phase 3** (from 2023 onwards): focusing on automation of distribution grid and AMI for all customers. One of the main goals of this phase would be to implement Smart Grid applications that allow monitoring the real-time supply-demand balance at the user level.

The Smart Grid Development Plan approved by Decision 4602/QD-BCT in the meantime, has specified the more detailed targets within the roadmap's objectives. Important targets include:

- By 2020, completion of SCADA/EMS and SCADA/DMS systems for the NLDC, Regional Load Dispatch Centers, the Power Corporation, and selected power distribution companies; all power plants with capacity over 30 MW, 500 kV and 220 kV substations are connected to the SCADA system and provide sufficient SCADA signals.
- By 2020, transition of 60% of 220 kV substations and 100% of 110 kV substations under the management of the NPT and PCs to unstaffed (fully automated) or lesser-staffed models of operation.
- By 2017, completion remote metering and data collection systems at all wholesale metering points of the NPT and PCs, and by 2020 – installation of electronic meters and remote data collection systems for approximately 50% of electricity consumers.

Progress against Roadmap Objectives

By reviewing and comparing the results of the previous programs and projects against the roadmap objectives and targets, our progress evaluation has revealed several positive outcomes in the implementation of Viet Nam's first Smart Grid Roadmap. Noticeable achievements include:

- Deployment of technology infrastructure to support power system automation and RE integration. This included the completion of SCADA/EMS systems for power plants and high voltage substations (110kV and above), automated operations of high voltage substations;
- Rollouts of electronic meters, and remote meter reading and data collection; and
- Enhancements in the reliability and quality of electricity supply, including reduction of power loss rates and improvements in SAIDI, SAIFI indexes.

There are also shortcomings and challenges. These include several areas which were set forth as targets of the roadmap but have not been fulfilled. They are summarised as follows:

- While basic applications of the EMS such as automatic generation control (AGC) and state estimator have been deployed, the other EMS and DMS functionalities are not fully utilised due to inadequate SCADA signals received from various locations at different voltage levels;
- Advance metering infrastructure (AMI) including smart meters have not been rolled out to customers due to potential increases to the electricity supply costs;
- Similarly, no commercial demand response or DSM programs have been implemented due to lack of adequate financial support mechanisms for the participants;
- No policy framework or technical regulations for energy storage systems has been adopted;
- Other technology innovations including smart grid applications, zero energy buildings, smart appliances have not been initiated.

Recommendations

Based on the review of the smart grid progress and existing status, the report proposes the following activities under four major areas to be considered in drafting the next Smart Grid Development Roadmap for Viet Nam.

Area 1. Further Modernization in Monitoring and Control of Power System Operations

- Completion of updating the SCADA/EMS/DMS systems for the NLDC and grid participants, maintaining stable connections and signal transmission to fully support EMS functioning.
- Continue to enhance the grid control and monitoring centers, achieve and maintain the 100% rate of fully automated unstaffed operations of all high voltage substations.
- Modernize the medium-voltage power grids by increasing the proportion of the distribution grids equipped with remote control devices and integration of FMSR and ADMS systems.
- Enhance communication protocols and the ability to link and exchange information between the NLDC, RLDCs and distribution grid control and monitoring centers.
- Expand the adoption of Geographic Information System (GIS) for power grid management.

Area 2: Remote Metering, Smart Metering and Data Analysis.

- Moving towards the deployment of 100% electronic meters with remote measuring capabilities across the entire power grid, with an intermediate target of 95% by 2030.
- Gradually implement AMI and smart meters (featuring two-way interactions) for customers in accordance with operational, commercial and customer service requirements while ensuring the economic efficiency.
- Rolling out smart devices / appliances capable of supporting Demand Response programs.
- Gradually apply artificial intelligence and data analytics in monitoring, energy consumption and demand forecasts, equipment condition assessment and system fault forecasting.

Area 3: Integration of Distributed Energy Sources

- Develop the Distributed Energy Resources Management System at the NLDC, RLDCs and Distribution Companies.
- Development of a TSO/DSO coordination model for managing distributed resources.
- Gradually integrate energy storage systems to optimize mobilization and operation of distributed sources. Experiment small-scale energy storage modules to balance supply and demand at the end-user level.
- Investigate the potential for implementing microgrids in important load locations, remote areas and islands; microgrid systems that integrate battery storage systems and smart electric vehicle charging stations.
- Examine new operational management models for amalgamation of many distributed energy resources, such as virtual power plants.

Area 4: Development of New Energy Sources, Renewable Energy and Energy Efficiency

- Encourage the development of new energy renewable energy sources for self-consumption to reduce the pressure of additional investments for power networks expansion.
- Implement programs for energy efficiency, demand management and demand response.
- Explore tools and solutions for managing electric vehicle charging stations and their integration into the demand management systems of the power companies.

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1 INTRODUCTION

1.1 Project Background

Intelligent Energy Systems Pty Ltd (IES) and East West Energy and Climate Link JSC (EWEC) have been selected by UNOPS to carry out the project titled *"Development of Vietnam Smart Grid Roadmap for period up to year 2030, with a vision to 2050"*. This project is implemented under the UNOPS Southeast Asia Energy Transition Partnership (ETP) in cooperation with the Electricity Regulatory Authority of Vietnam (ERAV).

Vietnam has been implementing the current Smart Grid Development Roadmap since 2012, following the Prime Minister's Decision No. 1670/QD-TTg dated 8 November 2012. However, as stated in this project TOR, the existing roadmap has not been updated to align with Vietnam's evolving policies and the significant growth in renewable energy sources. In this context, the project aims to offers insights and recommendations to the development of a new roadmap that can effectively address the current and anticipated challenges facing the Vietnamese power grid. This new roadmap is hence required to ensure the reliability and sustainability of the energy system, aligning with the objectives of Power Development Plan VIII and Vietnam's commitment to achieving net-zero emissions, as well as meeting the targets formulated under the Just Energy Transition Partnership (JETP). It will outline a strategic plan for the efficient integration of renewable energy sources into the grid, enabling it to operate in a more robust, secure, and sustainable manner.

This project is anticipated to provide substantial benefits to key stakeholders, including ERAV, Electricity of Vietnam (EVN), power generation companies, transmission and distribution entities, and electricity consumers. Its primary output will be formulation of a Smart Grid Development Roadmap, covering the period up to 2030, with an extended vision to 2050. The goals of this roadmap are to enhance the quality and reliability of electricity supply and promote the efficient utilization of energy. Additionally, the project will offer recommendations for addressing challenges in policy, legislation, economics, and technology, accompanied by proposed solutions for implementation. As such, the outcome of this project will support Vietnam in its transition towards a more dependable, environmentally friendly, and efficient energy system, contributing to one of ETP's strategic objectives focusing on the expansion of smart grids.

1.2 Scope of Work

The project aims to provide inputs and recommendations for the development of a new Smart Grid Development Roadmap that guides and accelerates the development of smart grid technologies in Vietnam with actions to year 2030, and a vision to year 2050. The new roadmap is intended to supersede the Smart Grid Development Roadmap of Viet Nam that was promulgated in Decision No. 1670/QD-TTg.

The primary outputs of this project will include:

- Research and Study reports
- Consultative Workshop
- Smart Grid Development Roadmap

1.3 Deliverable 2 – Study Report on Current Status of Smart Grid Development in Viet Nam

The objective of Deliverable 2 is to carry out a comprehensive review and assessment of the status of smart grid development in Viet Nam. This is to include an evaluation of the policies and legal framework that is in place to support smart grid development, costs, and financing schemes, as well as an assessment of the current national power system and market.

To achieve this objective, the consultant team has:

- Provided an overview of Viet Nam's electricity industry to set out a necessary context of the sector's long-term trajectory. This includes information on the current state of the power system, electricity demand and consumption patterns; Viet Nam's long-term plans for the electricity sector as outlined in the PDP VIII; the power sector governance structure and key organisations; and power market reforms;
- Reviewed existing policies and legal framework including Decision 1670/QD-TTg (the existing Smart Grid Roadmap), prior studies and prior pilot projects that were conducted in Viet Nam;
- Obtained data and information on the status of smart grid infrastructure that had been implemented;
- Carried out an evaluation of Viet Nam's development status against the objectives set out in Decision 1670/QD-TTg; and
- Identified advantages and disadvantages of the existing status and drawn opportunities for improvement.

This report is structured accordingly to cover our findings, comprising the following main sections:

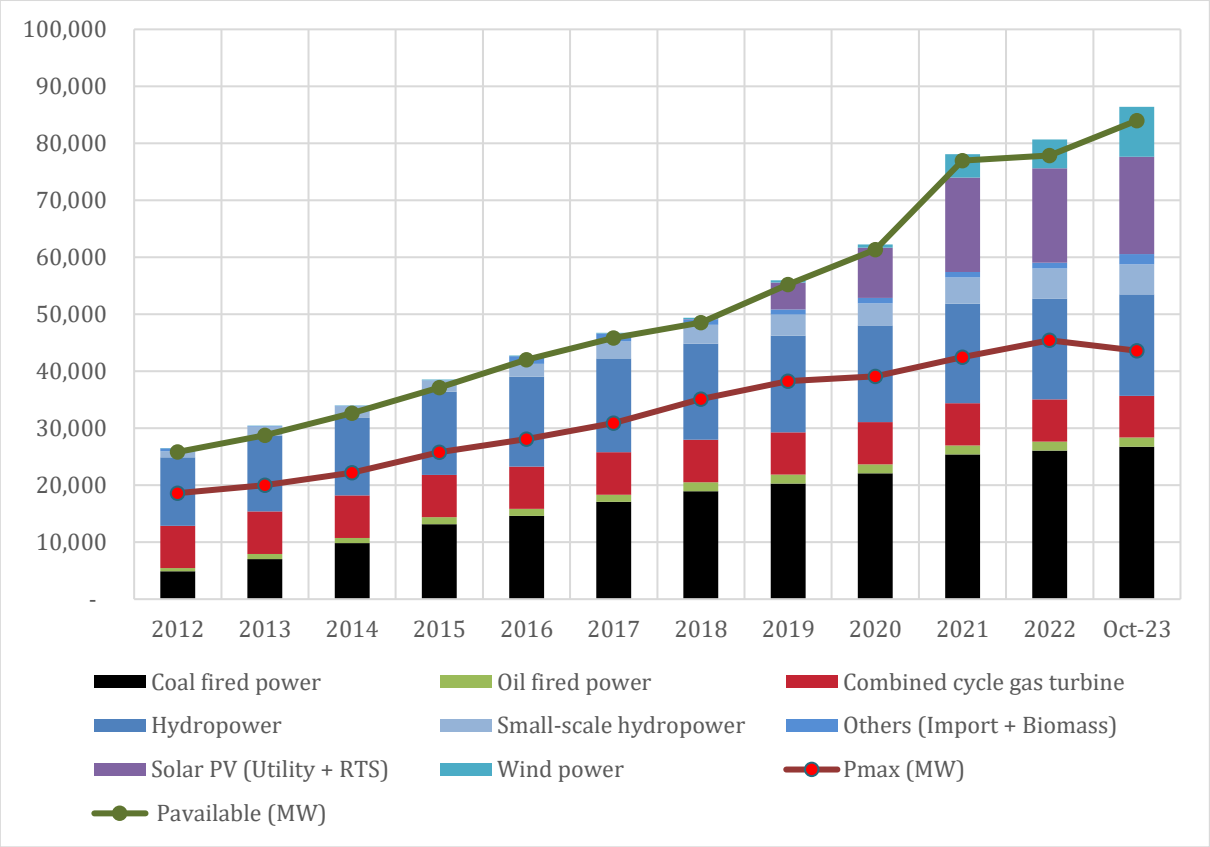
- Section 2: An overview of Viet Nam's power industry,
- Section 3: Review of the current legal framework for the smart grid development in Viet Nam,
- Section 4: Review of Smart Grid programs implemented to date,
- Section 5: Evaluation of the Smart Grid progress against the roadmap objectives,
- Section 6: Shortcomings and obstacles, and
- Section 7: Overall Recommendations.

2 OVERVIEW OF VIET NAM'S POWER INDUSTRY

2.1 Current Status of the Power System

The below chart illustrates the growth of the power system's installed capacity and peak demand from 2012 to present. Over the last decade, Viet Nam's power system has significantly expanded in terms of both its installed capacity and system peak demand (Pmax). At present, the system's total installed capacity has reached to around 84 GW, of which coal, hydro and gas contribute about 31%, 21% and 8.5% respectively. The share of renewable energy sources (mainly wind and solar) has sharply increased over the last 5 years and currently accounts for approximately 30% of the total installed capacity of the system. For the same period, the system's peak demand has more than doubled, increasing from 20 GW by 2012 to around 45 GW by 2022.

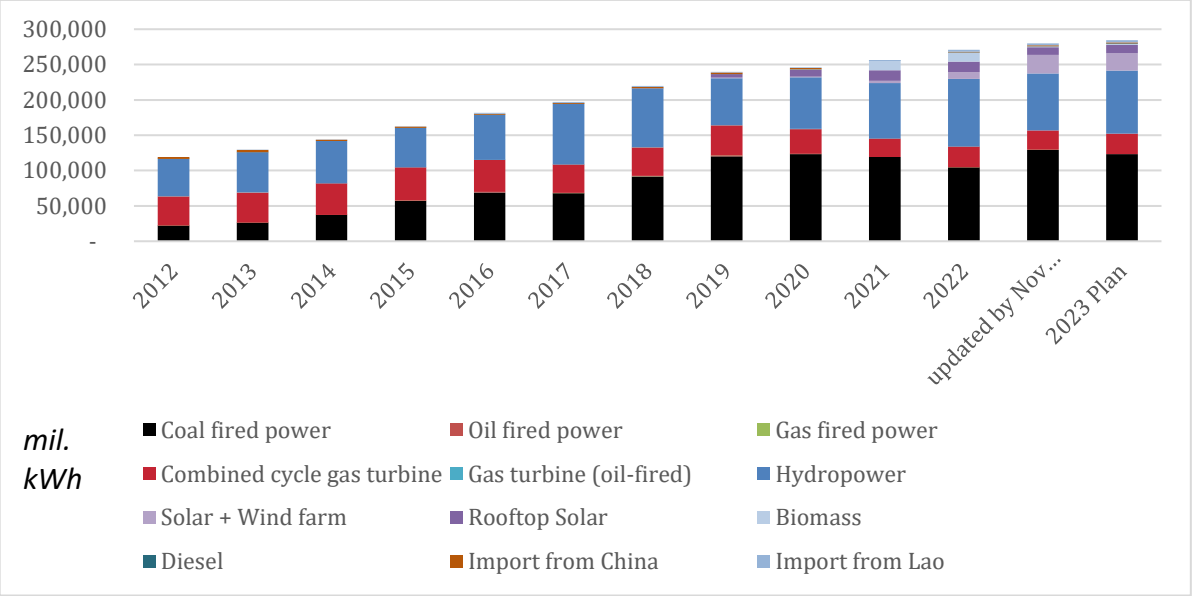
Figure 1 Growth of Power System's Installed Capacity and Pmax, 2012 – 2023



Source: MOIT & EVN, updated November 2023

Electricity generation grew to around 270 billion kWh by 2022 and is estimated to reach 280 billion kWh by 2023. Coal thermal power contributes the biggest share of the total power production, varying from 40% to 50% over the years. Hydropower is in the second largest generation source, producing around 30% to 35% of annual total electricity supply in recent years. The proportion of renewable energy generation ranges from 9% to 14% in the past two years.

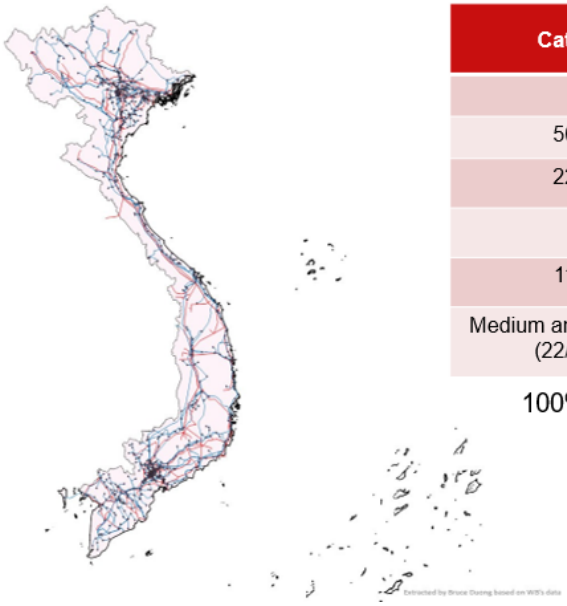
Figure 2 Power Generation Mix, 2012 – 2023



Source: MOIT & EVN, updated November 2023

The following figure shows a snapshot of the current transmission and distribution network infrastructure. In overall, the transmission network features 38 substations at the 500 kV level with a total capacity of 46,500 MVA, and 149 substations at the 220 kV level with a combined capacity of over 70,600 MVA. The accrued length of 500kV and 220 kV transmission lines are around 10,700 km and 19,000 km respectively. The distribution network comprises over 75,500 substations at the 110 kV level, around 55,000 substations of medium and low voltages, and approximately 570 thousand km of distribution grids.

Figure 3 Transmission and Distribution Network Infrastructure



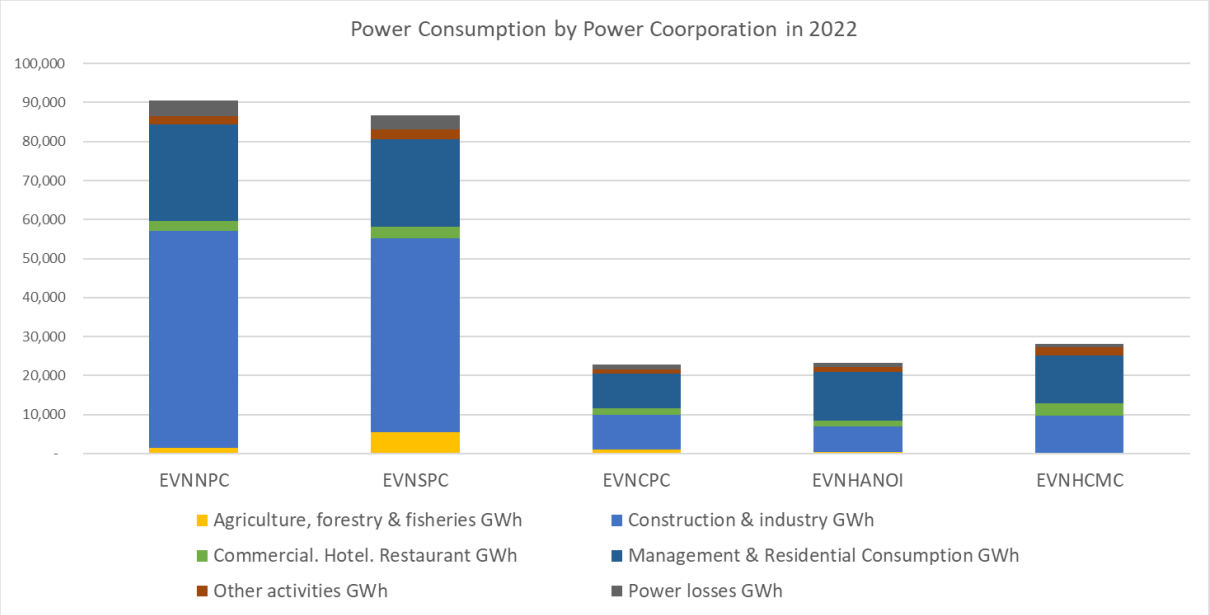
Category	Substation (Number of Substation / MVA)	Line (km)
Transmission network		
500kV	38 / 46.500	10.728
220kV	149 / 70.625	19.069
Distribution network		
110kV	75.523	21.861
Medium and Low volage (22/0.4kV)	54.675	550.746

100% of communes & 99.54% of households have access to electricity

Source: EVN & EVNNPT

By 2022, EVN's total electricity sale reached 240 TWh, of which the combined contribution of EVNNPC and EVNSPC was around 70%. The energy consumption mix is dominated by construction and industrial sectors with a share of over 54%, and the group of management and residential customers are responsible for around 34% of the total consumption.

Figure 4 Power Consumption by Power Corporations and Customer Groups, 2022



Source: EVN

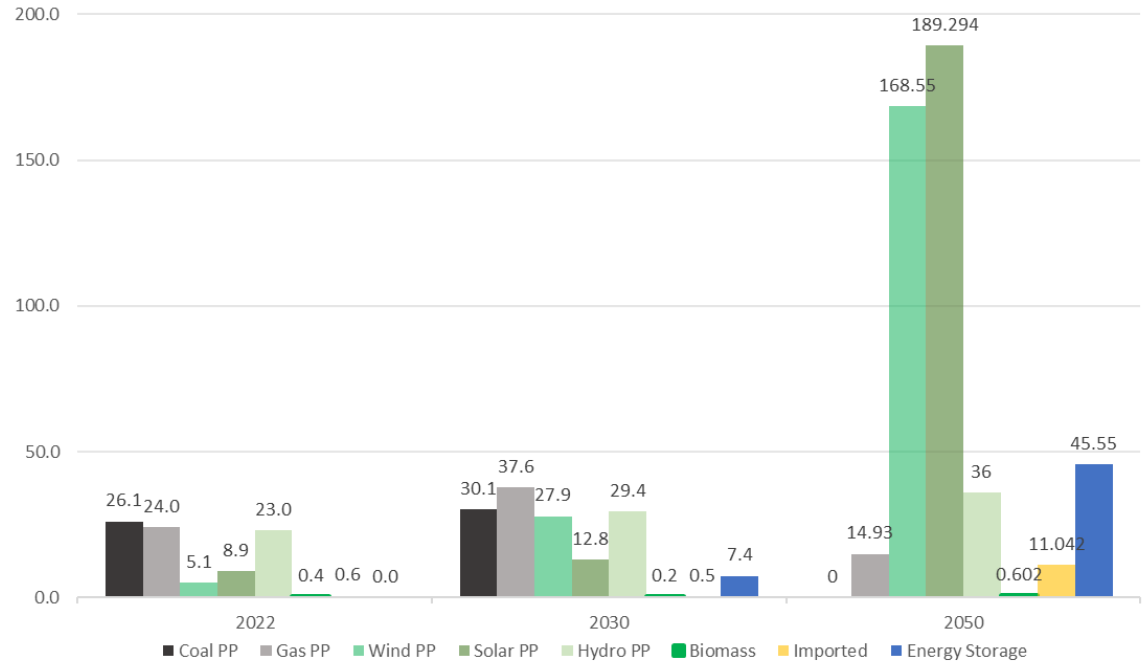
2.2 Summary of Power Development Plan 8 (PDP8)

According to the National Power Development Plan (PDP8) published in the Prime Minister's Decision No. 500/QD-TTg on 15 May 2023, Viet Nam's power system is expected to near double in size by 2030. The system's total installed capacity is projected to reach 150 GW by 2030, and between 490.5 GW – 573.1 GW by 2050. The PDP8 presents an ambitious shift in the generation mix away from coal towards renewables and new technologies such as battery storage, hydrogen, and ammonia, underpinning the Government's international commitments to reach net zero emissions by 2050. It aims at 36% to 39% of renewable energy in the electricity generation mix by 2030, followed by further renewable energy expansion towards net-zero in 2050.

Whereas the 2030 expansion targets are quite elevated for wind power (with additional 17 GW onshore wind and 6 GW offshore wind), grid-connected solar is rather backloaded to a later timeframe from 2030 to 2050. On solar expansion until 2030, the PDP8 aims at rooftop solar on 50% of all public office and residential buildings. However, mainly due to distribution grid constrains, the current focus remains on self-consumption (with no energy exports to the grid). Flexibilization of distribution grids is essential to allow further grid-connected rooftop solar, thereby enhancing the business case for investors. Accelerating the renewable energy expansion beyond the current PDP8 targets will be crucial to realize the coal power peak in 2030 and set the basis for a coal phase-out towards 2050.

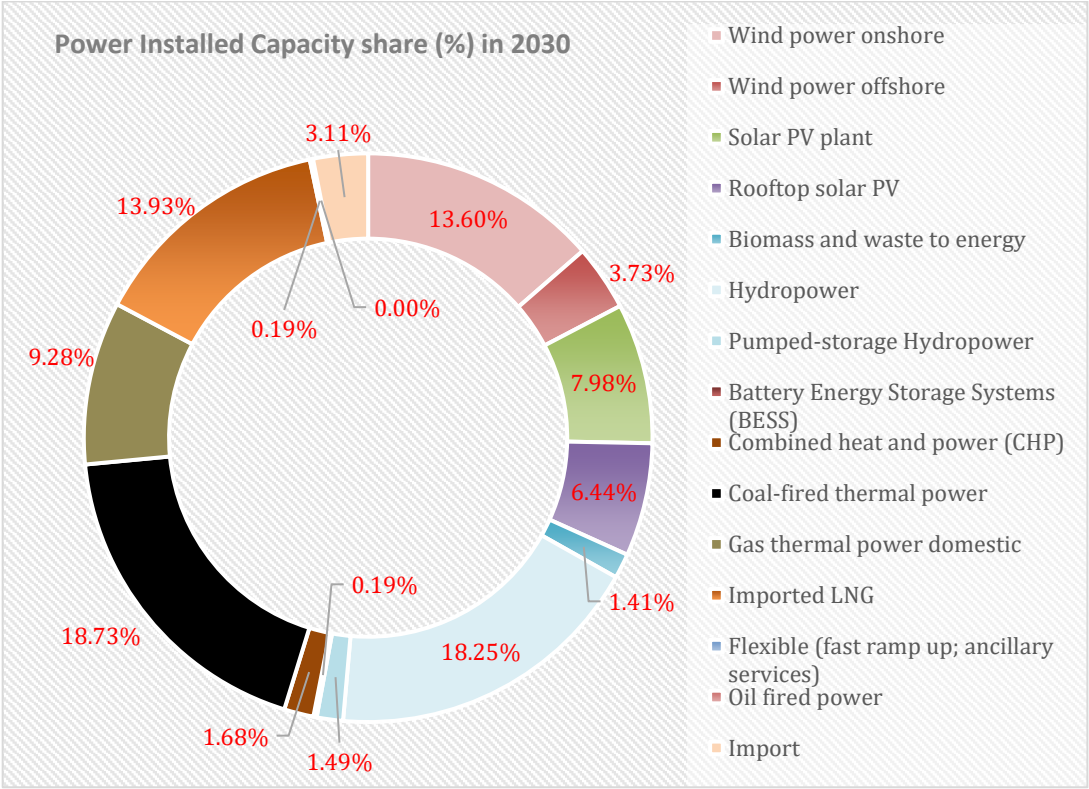
The following diagrams summarize PDP8 projected installed capacity by technology and illustrate the geographical distribution of capacity expansions over different regions in the country.

Figure 5 PDP8 Projected Installed Capacity by Technology for 2030 and 2050, GW



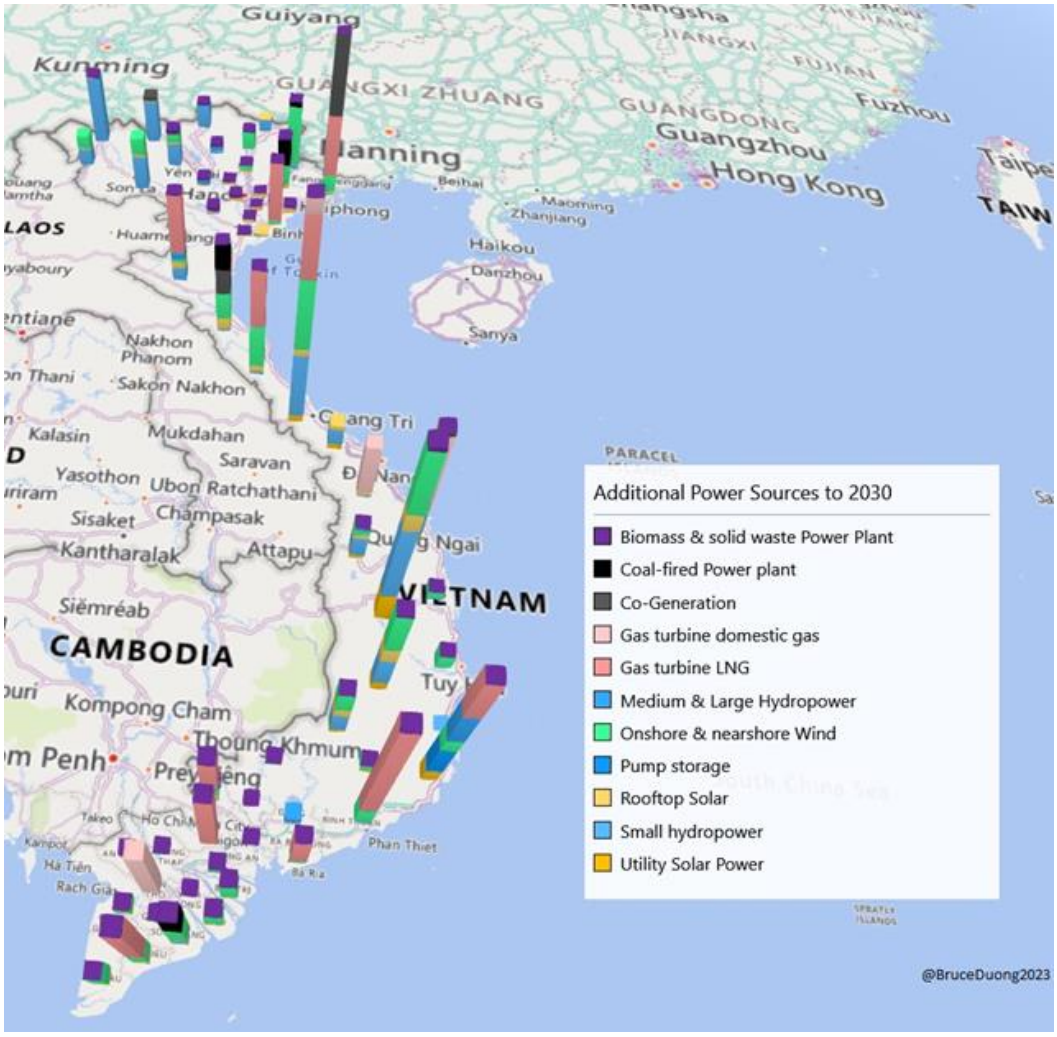
Source: PDP8 – Decision 500/QD-TTg

Figure 6 PDP8 Projected Capacity Mix by Technology for 2030 and 2050



Source: PDP8 – Decision 500/QD-TTg

Figure 7 Geographical Distribution of PDP8 Capacity Expansions by 2030



Source: Compiled by the Consultant based on PDP8 data

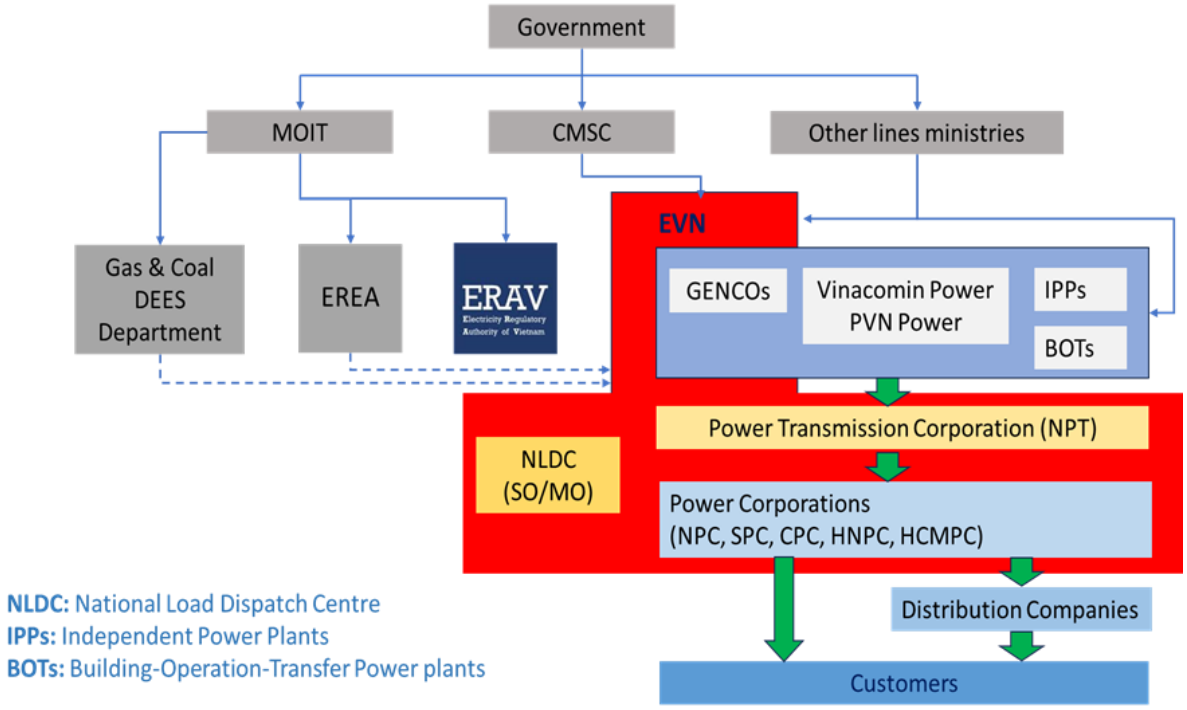
PDP 8 Smart Grid Implications

The PDP8 states "the successfully implementation of just energy transition in association with production modernization, smart grid construction, advanced power system management, in line with the trend of green transition, emission reduction, and the global technology and scientific development" as a general development target for the power sector. It also sets "developing a smart power grid system having sufficient capable of integrating and operating large-scale renewable energy sources in a safety and efficient manner" as a specific target. In addition, the PDP8 identifies "the renovation and upgrading of power transmission and distribution system, improving reliability and reducing power losses, and accelerating the roadmap to building a smart power grid" as an important solution for integrating stronger renewable energy resources. All of this is a critical basis for continued developing the smart grid in the next decade and sets out the need of reviewing and updating the national roadmap of smart grid development.

2.3 Power Sector Structure and Governance

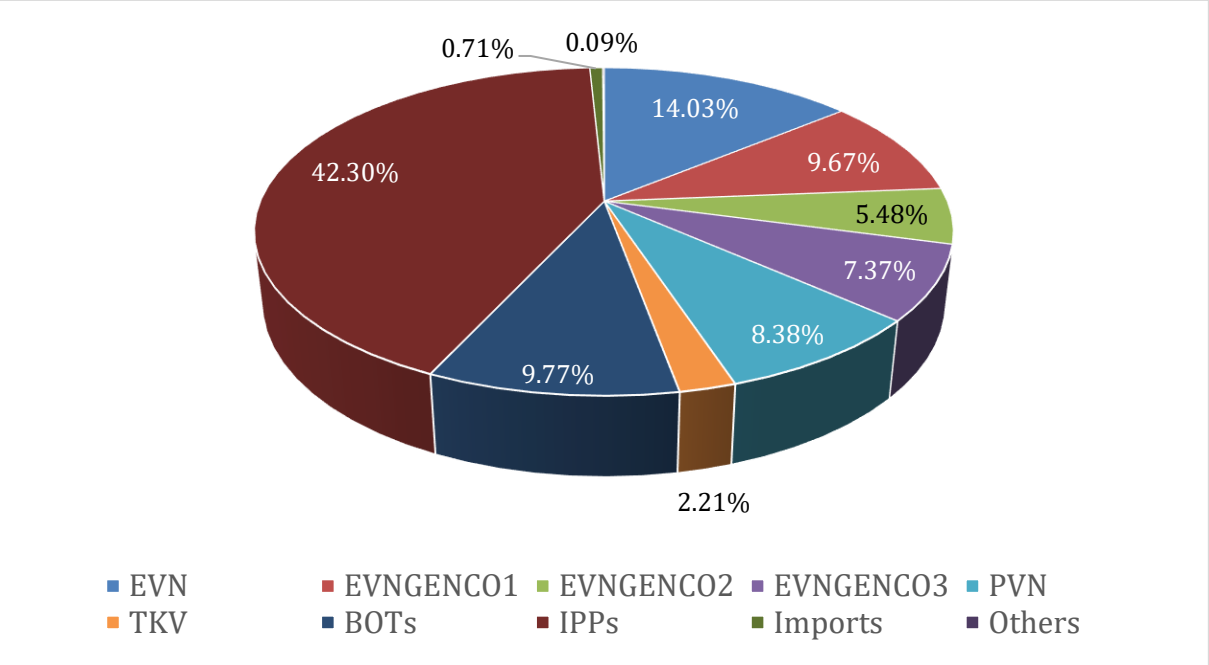
The Vietnamese power sector is managed by the Government through the Ministry of Industry and Trade (MOIT), the Commission for Management of State Capital at Enterprises (CMSC) and other lines ministries. There are four key departments and agencies under MOIT authorised with mandates to regulate the power sector. These include Electricity & Renewable Energy Authority (EREA) responsible for the national power development planning and setting investment schemes and regulations to facilitate power project development, and Electricity Regulatory Authority of Vietnam (ERAV) with the main functions in establishing and developing the electricity markets, regulating electricity prices, licensing, and monitoring the power demand and supply balance. Electricity of Vietnam (EVN) is a key state-owned enterprise (SOE) in the power sector assuming a critical role of the single buyer to purchase all electricity generated by the power plants in the system. EVN also holds a monopolistic responsibility for transmission (NPT), distribution (5 PCs) and system operation (NLDC). The power sector governance structure is illustrated in the below figure.

Figure 8 Viet Nam's Power Sector Governance Struture



Together with EVN, other State-owned enterprises (SOEs) including Petro Vietnam (PVN) and Vinacomin (TKV) also participate in the generation segment. As shown in the next chart, by 2022, these three SOEs own 47.13% of the power system total installed capacity (around 80.7 GW).

Figure 9 Generation Segment Ownership Structure, 2022

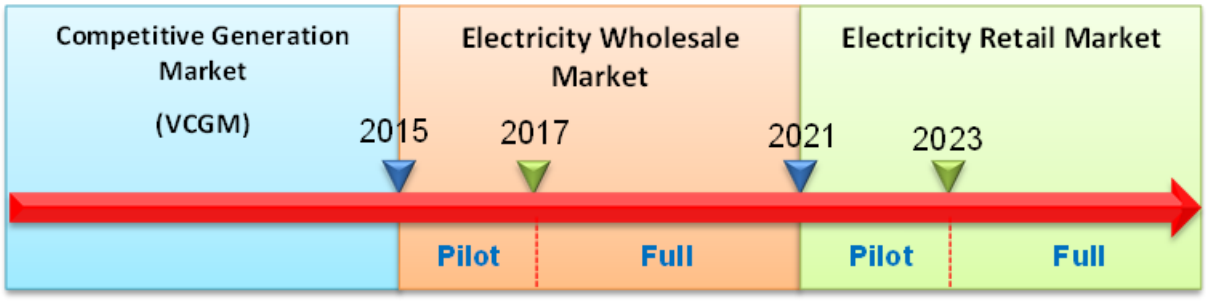


Source: EVN / NLDC

2.4 Vietnam Competitive Electricity Market

Viet Nam started to transform to a competition-based electricity market since 2005 when the Electricity Law came into effect. The electricity market development roadmap for the first time in 2006 by Prime Minister's Decision 26/2006/QĐ-TTg and updated in 2013 by Prime Minister's Decision 63/2013/QD-TTg. The roadmap outlines specific milestones of three development levels of the Vietnamese electricity competitive markets, including generation competitive market, wholesale competitive market and retail competitive market, as illustrated in the following figure.

Figure 10 Electricity competitive development roadmap by Decision 63/2013/QD-TTg



2.4.1 Viet Nam Competitive Generation Market (VCGM)

The VCGM commenced full commercial operation on 1 July 2012. In terms of trading arrangements, the key idea behind the VCGM was to facilitate competition in generation but largely retain the existing arrangements for the PCs and customers. This was done by having a single buyer, Electricity Power Trading Corporation (EPTC), purchasing all power from the generators and

providing power to the PCs under the Bulk Supply Tariff (BST) and the PCs selling power to end use customers based on the uniform retail tariffs.

In the VCGM, not all generators were competing in the market, only those that are classified as being Direct Trading Generators (DTGs). The SMO schedules the BOTs which are classified as Indirect Trading Generators (ITGs) and the SMO manages the Strategic Multipurpose Hydropower Plants (SMHPs), which are also ITGs. Around 50% of installed capacity was not traded directly in the VCGM.

The DTGs have Standardised Power Purchase Agreement (SPPA) contracts with the Single Buyer (EPTC). Even though these contracts are called Standardised Power Purchase Agreements (SPPAs) these contracts are in fact simple contracts for differences (CfDs), that is, they are financial contracts and do not involve the physical purchase or sale of power.

2.4.2 Viet Nam Wholesale Electricity Market (VWEM)

On 10 August 2015, the MOIT approved the Detailed Design of the Wholesale Electricity Market of Viet Nam (VWEM) under Decision No. 8266/QD-BCT. The decision applies to both the Pilot VWEM and the Full VWEM.

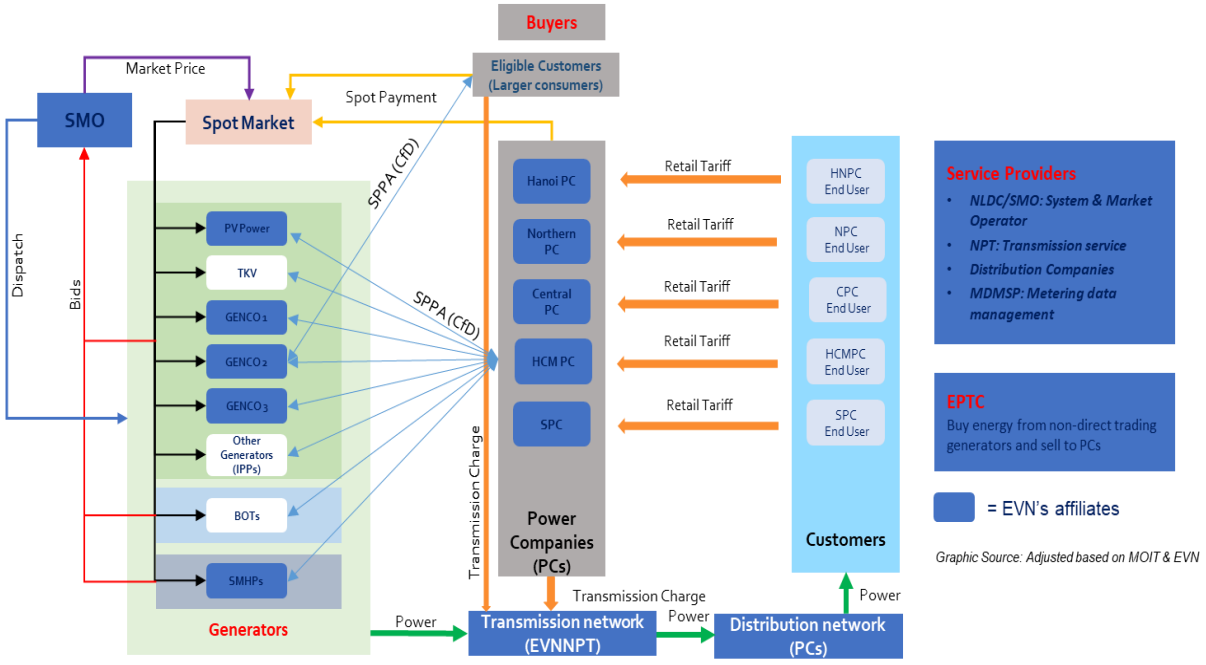
The key aspects of the MOIT decision with respect to trading arrangements are:

- Greater participation of all generating units over 30 MW in the VWEM with the aim of all BOTs and SMHPs participating directly or via a trader;
- The participation of electricity buyers including the PCs and other eligible customers in the future; and
- The PCs will contract directly with generators to buy electricity to meet their demand and will face some spot market exposure when mismatches between their contracts and actual demands occur.

The proposed trading arrangements for the VWEM were designed to have the PCs contract directly with generators and change the role of the Single Buyer (EPTC) in the market. The VWEM also allows for wholesalers to enter the market and contract with generators and then sell to PCs (contract with PCs). The MOIT's approved VWEM design allows for the possibility of having eligible customers being allowed to contract directly with generators or PCs other than their current PC. An eligible customer is either an existing or new customer that is connected (or that would connect) to the transmission network and hence needs to be considered as part of the wholesale market.

The VWEM structure is illustrated in the following figure.

Figure 11 Structure of Viet Nam Wholesale Electricity Market (VWEM)



The current VWEM that has been in operation since 1 January 2019 has allowed the PCs to participate in the market as wholesale buyers purchasing CfD PPAs from a limited number of generators. Nevertheless, compared to the VCGM the changes are incomplete and the market has not achieved the intended design features of Full VWEM, in the context that the new MMS and other required IT supporting infrastructure systems have not been procured and installed. Key observations of actual progress on the envisaged reforms and market development against what was envisaged are as follows:

- While PPA Trader arrangements have been proposed, no real progress has been made on having BOTs and SMHPs with physical PPAs participate in the VWEM as a direct trading generator,
- There has been a proliferation of participants with FITs and physical PPAs that do not require participation in the market – hence direct participation in the VWEM continues to be limited to about 40% of installed capacity,
- Customer direct participation in the VWEM has not occurred, although a pilot to trial direct PPAs (between RE developers and customers), as effectively CfDs, has commenced in 2021, which may evolve if deemed successful,
- A limited amount of contract trading directly between DTGs and PCs commenced in 2020, and it was expanded in 2021, although it accounts for no more than 10% of the total market, and
- Bilateral contracting arrangements (in addition to the current SPPAs) have not been finalised.

2.4.3 Viet Nam Retail Electricity Market (VREM)

On 7 August 2020 the MOIT approved ERAV proposal for VREM model design which includes an implementation plan of the Vietnam retail market (Decision No. 2093/QD-BCT). The proposed VREM implementation plan considers the following stages:

- First stage (up to the end of 2021) focusing on necessary preparatory works including issuance of required regulations,
- Second stage (from 2022 to 2024) allowing end users to purchase power directly from the spot market,
- Third stage (after 2024) allowing gradually end users to choose their preferred retailer.

As of December 2023, the VREM has not progressed according to this proposed plan as many prerequisites are yet to be met and no VREM legal document has been issued for implementation.

3 REVIEW OF THE CURRENT LEGAL FRAMEWORK FOR SMART GRIDS IN VIET NAM

3.1 Policy Guidance

The main legislation that provides guidance for smart grids development in the Vietnam's power sector includes the following:

- Resolution No. 13-NQ/TW dated 16 January 2012[1] which was promulgated by the Central Committee of the 11th Party Congress on building a synchronized infrastructure system to transform Viet Nam into a fundamentally modern industrial nation by the year 2020, includes the direction for developing the power infrastructure, as quoted: "research and apply smart grid and modern technologies to enhance the quality of the distribution grid, connect and synchronize Vietnam's power system with the power systems of other countries in the region".
- Prime Minister Decision No. 1208/QD-TTg dated 21 July 2011[2] on approving the National Power Development Master Plan for the 2011-2020 period, with consideration for up to 2030 (referred to as the PDP VII), which tasks the Ministry of Industry and Trade (MOIT) to develop a roadmap of Smart Grid development for the Prime Minister's approval.
- Under Resolution No.13-NQ/TW and Prime Minister Decision No. 1208/QD-TTg, MOIT has developed the first Smart Grid development Roadmap in Viet Nam, which was subsequently approved by the Prime Minister in Decision No. 1670/QD-TTg on 8 November 2012[3].
- To enhance the ongoing implementation of the programs and plans aimed at enhancing the effectiveness of the management and operation of the power system for achievement of the objectives set out in the Smart Grid Development Roadmap, on 25 November 2016, the MOIT issued Decision No. 4602/QD-BCT[4], approving the comprehensive Smart Grid development plan in Vietnam.

The main contents of Decision 1670/QD-TTg and Decision 4602/QD-BCT are summarised in the following section.

3.2 Decision 1670/QD-TTg - First Smart Grid Development Roadmap

3.2.1 General Objectives

The development of Smart Grids with modern technologies aims to:

- Enhance the power supplying quality,
- Improve the reliability of the power supply,
- Contribute to effective demand management,

[1] https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Recolution-No-13-NQ-TW-on-constructing-system-of-synchronous-infrastructure-144170.aspx?tab=1

[2] https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Decision-No-1208-QD-TTg-approving-the-national-master-plan-for-power-developmen-129981.aspx?tab=1

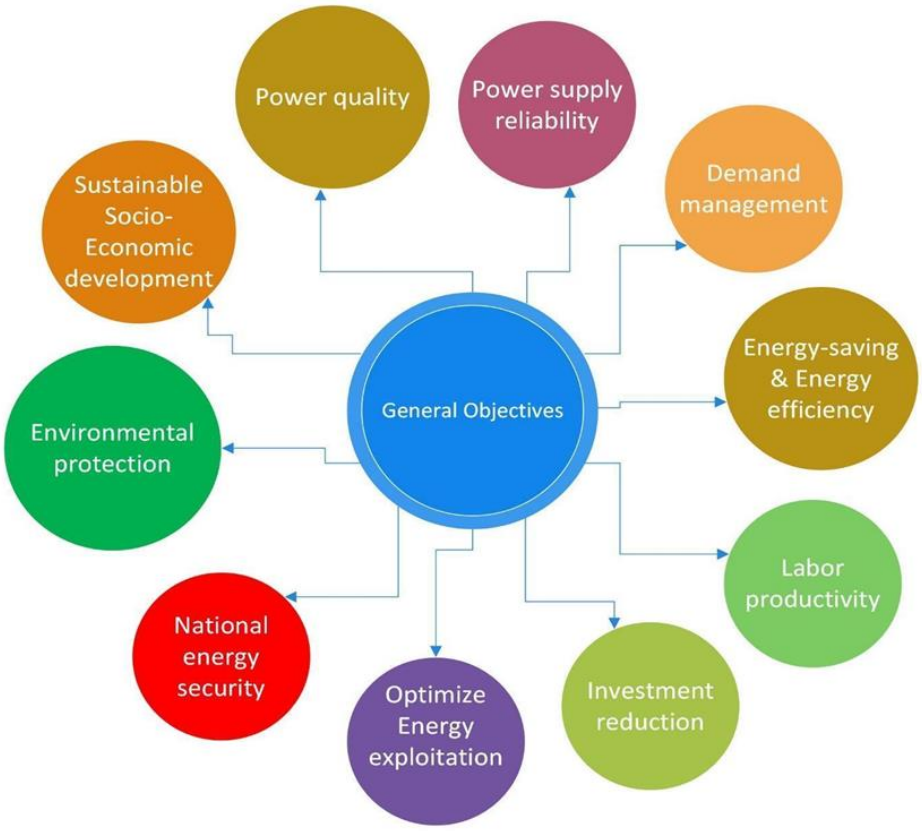
[3] https://thuvienphapluat.vn/van-ban/Xay-dung-Do-thi/Quyet-dinh-1670-QD-TTg-nam-2012-phe-duyet-de-an-phat-trien-Luoi-dien-Thong-minh-151097.aspx

[4] https://thuvienphapluat.vn/van-ban/Dau-tu/Decision-4602-QD-BCT-2016-approving-the-Master-Scheme-for-Development-of-Smart-Grids-in-Vietnam-451470.aspx?tab=1

- Encourage energy savings and efficient use of energy,
- Facilitate the increase of productivity and reduce the need of investments in power grid and generation,
- Optimize the exploitation of energy resources,
- Ensure national energy security, and
- Contribute to environmental protection and promote sustainable economic and social development.

Figure 12 illustrates these objectives of the existing Smart Grid Roadmap.

Figure 12 General Objectives of Viet Nam's Smart Grid Roadmap



3.2.2 Specific Objectives

The specific objectives of the roadmap are as follows:

- Improve the power sector's legal framework to provide a legislative basis for smart grid development.
- Develop information technology and telecommunications infrastructure and enhance automatic monitoring and control systems for the power system, including remote data collection, with the following milestones:
  - **By 2013:** establish a comprehensive data collection, monitoring, and control system (SCADA) and remote metering system for all power plants with a capacity greater than 30

MW, as well as substations with voltages of 110 kV and above within the national power system,

- **By 2016:** operate all functions of the Energy Management System (EMS) within the SCADA/EMS system at the National Load Dispatch Center and regional load dispatch centers,
- **By 2022:** implement SCADA/DMS systems for Power Corporations, and the remote metering system installed for all large electricity consumers.

- Improve the reliability of electricity supply: reduce the System Average Interruption Frequency Index (SAIFI) by 10% and reduce the System Average Interruption Duration Index (SAIDI) by 20% after every 5-years period.
- Equip automatic and control devices to enhance labour productivity in the power sector: the 110kV substations equipped with automation and remote-control devices would reduce to 3-5 persons on the duty per substation; switching operations for medium-voltage networks would be implemented remotely.
- Enhance the ability of electricity demand forecast and electricity supply planning, limit load shedding due to supply shortages through mechanisms such as peak load shifting during peak hours or emergency situations: Reduce peak load by 1 - 2% through the application of advanced metering infrastructure (AMI).
- Implement technical solutions and management measures with the aim of reducing electrical energy losses (technical and commercial losses) in the transmission and distribution systems from 9.23% in 2011 to 8% by 2015.
- Apply Smart Grid technology to connect and operate reliably new and renewable energy sources, facilitating the efficient utilization of these energy sources contributing to the encouragement of the development and increase of the new and renewable energy source share in the electricity generation mix, and contribute to the environmental protection and ensuring national energy security.
- Promote research and domestic production of intelligent electronic products for the technological needs of smart grids; to allow customers to proactively access and manage detailed information about their electricity usage and costs.

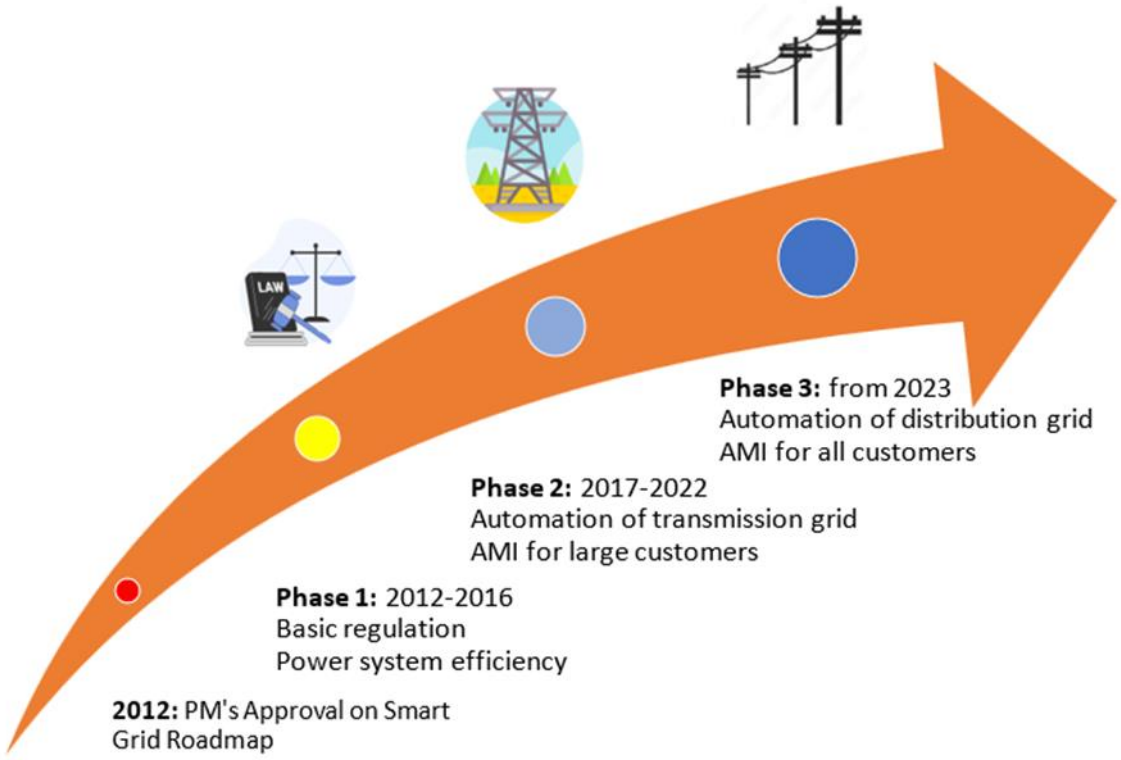
3.2.3 Detailed Roadmap

3.2.3.1 Overview of Roadmap Milestones

As shown in Figure 13, the existing Smart Grid Roadmap is composed of the 3 following phases:

- **Phase 1** (2012-2016): focusing on development of basic regulations and improving power system efficiency,
- **Phase 2** (2017-2022): focusing on automation of transmission grid and AMI for large customers, and
- **Phase 3** (from 2023 onwards): focusing on automation of distribution grid and AMI for all customers.

Figure 13 Key Milestones of Viet Nam's Smart Grid Roadmap



3.2.3.2 Phase 1 (2012-2016)

1. Activities to enhance the efficiency of the power system operation

- Complete the SCADA/EMS project for the National Load Dispatch Center (NLDC) and Regional Load Dispatch Centers. Enhance and supplement the equipment to ensure data collection for the operation of power systems at power plants and substations with voltage levels of from 110 kV upwards. Improve the automatic reading system for electronic meters at the point of supply, enabling the measurement and exchange of electricity data for all power plants and substations at 500 kV, 220 kV, and 110 kV voltage levels.
- Deploy smart grid applications to enhance the reliability, optimize the operation of the transmission and distribution grid, reduce power losses, and strengthen the fault recording system and the system for detecting and preventing wide-area power outages to ensure safe transmission on the 500 kV power system.
- Monitor and oversee the implementation of regulations regarding the mandatory data collection system in power plants and substations with voltage levels of from 110 kV onwards.
- Initially, equip SCADA systems for a number of power distribution corporations and provide software, hardware, telecommunications systems, and remote control and automation systems for selected 110kV substations.
- Provide trainings and capacity buildings of Smart Grid implementation for the National Power Transmission Corporation, the NLDC, and Power Corporations.

- Complete technical assistant projects on load research and demand response for power distribution corporations.
- Develop and implement advanced operational tools to integrate variable renewable energy sources (wind, solar power, etc.,) into the power system.

2. Implementation of pilot programs

- Pilot project on equipping the advanced metering infrastructure (AMI) for selected large customers of the Ho Chi Minh Power Corporation to implement load management programs.
- Pilot project on the integration of new and renewable energy sources in the Central Power Corporation, applied to small hydropower sources and other new and renewable energy sources.

3. Improving the legal & regulatory framework

- Complete the legislation on procedures of load research.
- Establish incentive mechanisms for customers participating in the load management programs within the pilot program at the Ho Chi Minh Power Corporation. Evaluate the effectiveness of the pilot program and improve the incentive mechanisms for customers participating in the load management program.
- Develop a legal framework to enable the application of technical standards, dispatching regulations for the automation and remote control of substations in the power system.
- Propose the financial mechanism for the Smart Grid development.
- Create a legal framework for the construction of infrastructure and the deployment of Smart Grid applications.
- Issue technical standards for Smart Grid technology, including the AMI system, technical standards for automated, remote control of substations, SCADA/EMS/DMS systems, standards for integrating distributed renewable energy sources, the configuration of the smart distribution grid, and other related technical regulations.

4. Community Outreach Program

- Develop and disseminate the Smart Grid Development Program to governmental regulatory agencies, power generation and power distribution entities, and large power consumers.
- Initiate the introduction and dissemination of the Smart Grid Development Program to residential power consumers.

3.2.3.3 Phase 2 (2017-2022)

1. Continue implementing programs to enhance the efficiency of the power system operation (with a focus on the distribution grids)

- Continue the deployment and enhancement of SCADA systems for the Power Corporations and equip automation systems for 110kV substations.
- Implement the SCADA/DMS system in large provincial and municipal power companies, connecting with selected medium-voltage distribution substations.

- Continue training and capacity building for Smart Grid implementation for power corporations and power distribution companies.
- Develop tests for optimizing the operation of the transmission grids.

2. Deploy Smart Grid applications

- Disseminate lessons learned on the AMI system; Expand the installation of the AMI system for large customers in all Power Corporations; Implement pilot projects for customers participating in competitive power markets (wholesale and retail competitive markets) at Power Corporations.
- Implement the integration of distributed power sources, new and renewable energy sources into the power system through medium and low-voltage connections.
- Implement Smart Home pilot projects.
- Develop Smart City pilot projects.

3. Further Enhancement to Legislations

- Establish mechanisms to encourage the application of Smart Grid technology in the development of new and renewable energy sources; encourage the application of Smart Grid technology in buildings that do not consume external energy (zero energy houses); encourage the application of Smart Grid technology for the exchange of power between customers and electric companies.
- Establish incentive mechanisms for residential customers to participate in demand management programs.

4. Develop technical regulations

- Establish technical standards for energy storage technology, and smart appliances used in homes that have the capability to adjust power consumption based on power supply conditions or changing electricity tariffs.

5. Community Outreach Program

- Update the Smart Grid communication program to include new changes in prices and fees.
- Widely disseminate the Smart Grid programs to residential customers.

3.2.3.4 Phase 3 (2023 onwards)

1. Continue programs to equip information technology and telecommunications infrastructure for distribution grids

- Develop the SCADA/DMS system for all provincial power companies with a reasonable number of medium-voltage distribution substations.
- Continue the deployment of optimization tools for transmission and distribution grids.
- Implement the AMI system for residential customers, facilitating customers to participate in the competitive retail power market.
- Continue to encourage the development of distributed power plants.

2. Deployment of Smart Grid applications

- Implement Smart Grid applications that allow monitoring the real-time supply-demand balance at the user level.
- Promote the use of new and renewable energy sources in the distribution grids with time-based pricing mechanisms, combined with the operation of the competitive retail power market.

3. Completion of the legal framework for Smart Grid implementation

- Develop legal documents that allow the implementation of Smart Grid applications based on optimal utilisation of existing information technology infrastructure.

3.3 Decision 4602/QD-BCT - Comprehensive Smart Grid Development Plan

The Comprehensive Smart Grid Development Plan which was approved by the MOIT in 2016 consists of three component projects as follows:

- Research and Development of the SCADA System in the Viet Nam's Power System;
- Study of the organizational model for the Remote Control and Switching Centers for the power grids of the National Power Transmission Corporation and the Power Distribution Companies; and
- Development of the Electronic Meter and Remote Data Collection System

3.3.1 Development of SCADA Systems

- Invest, build, and synchronized upgrade a comprehensive SCADA/EMS and SCADA/DMS system at the National Load Dispatch Center (NLDC), Regional Load Dispatch Centers, the Power Corporations, and provincial/city power distribution companies under the central government with the following targets:
  - By 2020, endeavour to complete SCADA/EMS and SCADA/DMS systems for the NLDC, Regional Load Dispatch Centers, the Power Corporation, and selected power distribution companies. These SCADA/EMS and SCADA/DMS systems must be interconnected and with access to shared data to ensure the safe and reliable operation of the national power system. This integration and compatibility should also extend to the establishment of control centers for power plants and substations.
  - Power plants, substations, and control centers within the power system must be equipped with complete RTU/Gateway devices and telecommunications systems to ensure connectivity of full signals with the SCADA/EMS/DSM systems as specified in the Grid Code and Distribution Code.
  - Synchronize infrastructure investment solutions, technical management, operational management, and workforce training to ensure connectivity of full SCADA signals from power plants and substations to the control centres. Ensure a stable, reliable, and continuous supply of signals to support control and the operation of SCADA/EMS, SCADA/DMS systems.

    By 2020, endeavour to achieve the following specific targets:

    - 100% of power plants with an installed capacity of over 30 MW, 500 kV and 220 kV substations connected to the SCADA system and providing sufficient SCADA signals;

    - 100% of 110 kV substations and power plants with an installed capacity from 10 MW to 30 MW should be connected to the SCADA system, and 90% of them shall provide sufficient SCADA signals for operation.
  - Gradually deploy EMS and DMS functions within the SCADA system at all control levels, particularly real-time applications for operations to ensure and enhance the stable, safe, and reliable operation of the national power system through functions such as power flow calculation, fault analysis, state assessment, power flow optimization, automatic generation control, and demand forecasting. By 2020, these functions should be fully operational to support power system operations.
- Improve the dedicated telecommunications system within EVN to ensure reliable operation, providing communication channels for production, business, and power system operation management. The goals to be achieved by 2020 are:
  - All power plants with a capacity of over 30 MW, 500 kV and 220 kV substations are connected through two independent optical fibre lines.
  - All 110 kV substations are connected by optical cables to the Control Centers or Dispatch Centers.
  - Over 90% of district-level Power Companies are connected by optical cables to the dedicated telecommunication network.

3.3.2 Organizational Models for Power Grid Remote Control and Switching Centers

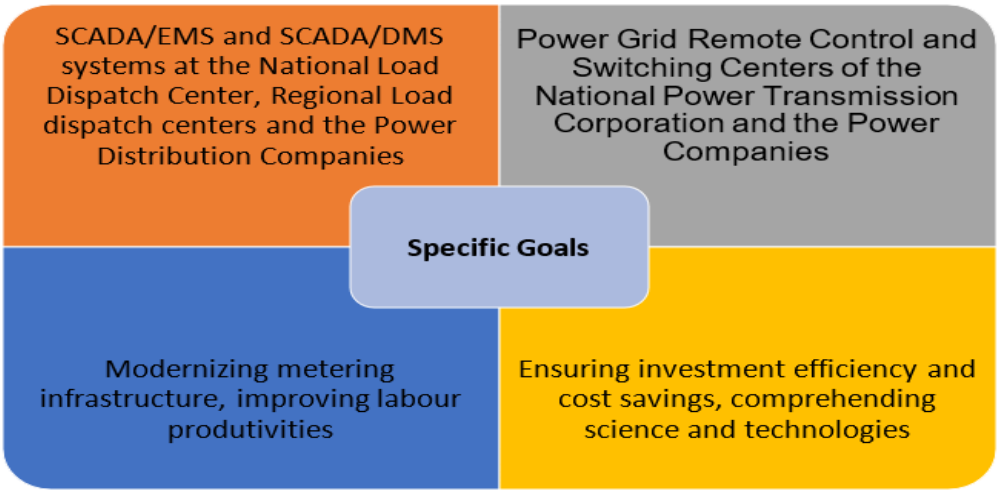
- Utilizing the existing infrastructure, gradually upgrade and implement the control center models for remote operation and switching of electrical equipment in both the transmission and distribution grids. The goal is to ensure safety in power system operation, enhance reliability and quality of power supply, and improve efficiency of production and operational management.
- Control Center Model for transmission grids: establish the control center at an existing or planned substations to remotely operate a group of substations in the area; staff at the control center shall perform operations on equipment remotely according to instructions by the authorized dispatch engineer.
- Control Center Model for distribution grids: The control center can be located at the provincial Distribution Grid Control Center or at a branch of the High-voltage Power Grid Company to remotely operate equipment following the instruction from the authorized dispatch engineer, or equipment under the self-control category.
- Apply technological advancements to synchronously transform substations from on-site staffed operation to unmanned or less staffed models of operation.
- Specific targets to achieve by the end of 2020:
  - Transition of 60% of 220 kV substations and 100% of 110 kV substations under the management of the National Power Transmission Corporation and Power Companies to unstaffed (fully automated) or lesser-staffed models of operation.
  - Implementation of safe, reliable, and efficient remote control and operations for 220 kV and 110 kV substations within the national power system.

3.3.3 Development of Electronic Meter and Remote Data Collection System

- Equip and enhance the remote electricity metering and data collection system at off-take metering points and boundaries between electricity suppliers and consumers within the national power grid. This system serves the operation of the power grid and the competitive power market.
- Equip electronic meters, and implement a remote data collection system for electricity consumers with following objectives:
  - Ensure that the cost does not increase significantly compared to mechanical meter installations, avoiding undue pressure on electricity price hikes.
  - Ensure the standards and quality of electronic meters and remote data collection systems.
  - Ensure the reliability, accuracy, and security of metering data.
  - Ensure cost-effectiveness and labour productivity improvements.
  - Improve the customer service quality.
- Specific targets:
  - By the end of 2017: Complete installations of the remote electricity metering and data collection systems at all metering points to serve the management, production, and business activities of the NPT and PCs (including metering between different entities and main meters at 0.4 kV distribution substations).
  - By the end of 2020: Install electronic meters and remote data collection systems for approximately 50% of electricity consumers.
- Investigate options of leasing electronic meters for electricity consumers, including residential consumers, to expand the adoption of time-of-use (ToU) electricity pricing.
- Develop a plan and roadmap for implementing an advanced metering infrastructure (AMI) system that aligns with the development of smart grid technology in Vietnam.

The following Figure 14 Illustrates the specifics goals of smart grid development in Viet Nam that have been summarised above.

Figure 14 Specific Goals of Smart Grid Development in Viet Nam (Decision 4602/QD-BCT)



3.4 Other Legal Documents supporting Smart Grid Development

The following are a list of legal documents issued by the MOIT with provisions and regulations supporting or related to the smart grid development in Viet Nam:

- Circular 40/2014/TT-BCT dated 5 November 2014, Circular 44/2014/TT-BCT dated 28 November 2014 and Circular 28/2014/TT-BCT dated 15 September 2014 regulating the power system dispatch procedures, equipment switching procedures and incident handling procedures respectively. These legal documents have set out a framework for the establishment of Remote Control Centers (RCC) / Remote Operation Centers (ROC) to facilitate remote control and switching of electric equipment in the power system.
- Circular 31/2019/TT-BCT dated 18 November 2019 providing amendments to the three aforementioned circulars (28/2014/TT-BCT, 40/2014/TT-BCT and 44/2014/TT-BCT): updated regulations related to dispatching, equipment switching and incident handling for control centers and unmanned power plants / substations; frequency control, and dispatching hierarchy for RE power plants.
- Circular 42/2015/TT-BCT dated 1 December 2015 – the revied Metering Code stipulating the legal framework to enable the application and implementation of remote metering and metering data collection in the national electricity system.
- Circulars 39/2015/TT-BCT dated 18 November 2015 – Distribution Code and 25/2016/TT-BCT dated 30 November 2016 – Grid Code supplementing regulations for technical and connection requirements to integrate RE sources into the national power system, and regulations relating to RCC/ROC and the operation of unmanned power plants and substations.
- Circular 30/2019/TT-BCT dated 18 November 2019 – amendments to Gird Code and Distribution Code updating regulations on electricity supply quality, frequency control, provision of ancillary services and technical requirements for renewable energy sources.
- Circular 19/2017/TT-BCT dated 29 September 2017 setting out the method and procedures for conducting research on electric load profiles.
- Circular 23/2017/TT-BCT dated 16 November 2017 specifying the procedures for implementation of electric load adjustment and demand response programs.
- Decision 1047/QD-BCT dated 21 March 2016 approving the criteria for assessment of the electricity industry development indicators including monitoring and evaluating electricity quality, electricity supply service quality, technical indicators, labour productivity and power grids modernization through performance indicators (KPI).

Figure 15 below illustrates the milestones of all policy documents that directly regulate or are related to smart grids development in Viet Nam.

3.5 Assessment of Effectiveness and Challenges in the Current Policy Landscape

The current legal framework for smart grids development has so far provided a strong basis for implementing infrastructure projects and programs to build a foundation necessary for subsequent applications of specific smart grid technologies and solutions. The systemwide infrastructure projects have mainly focused on supporting power system automation and RE integration, enhancing the reliability and quality of electricity supply, and rollouts of electronic

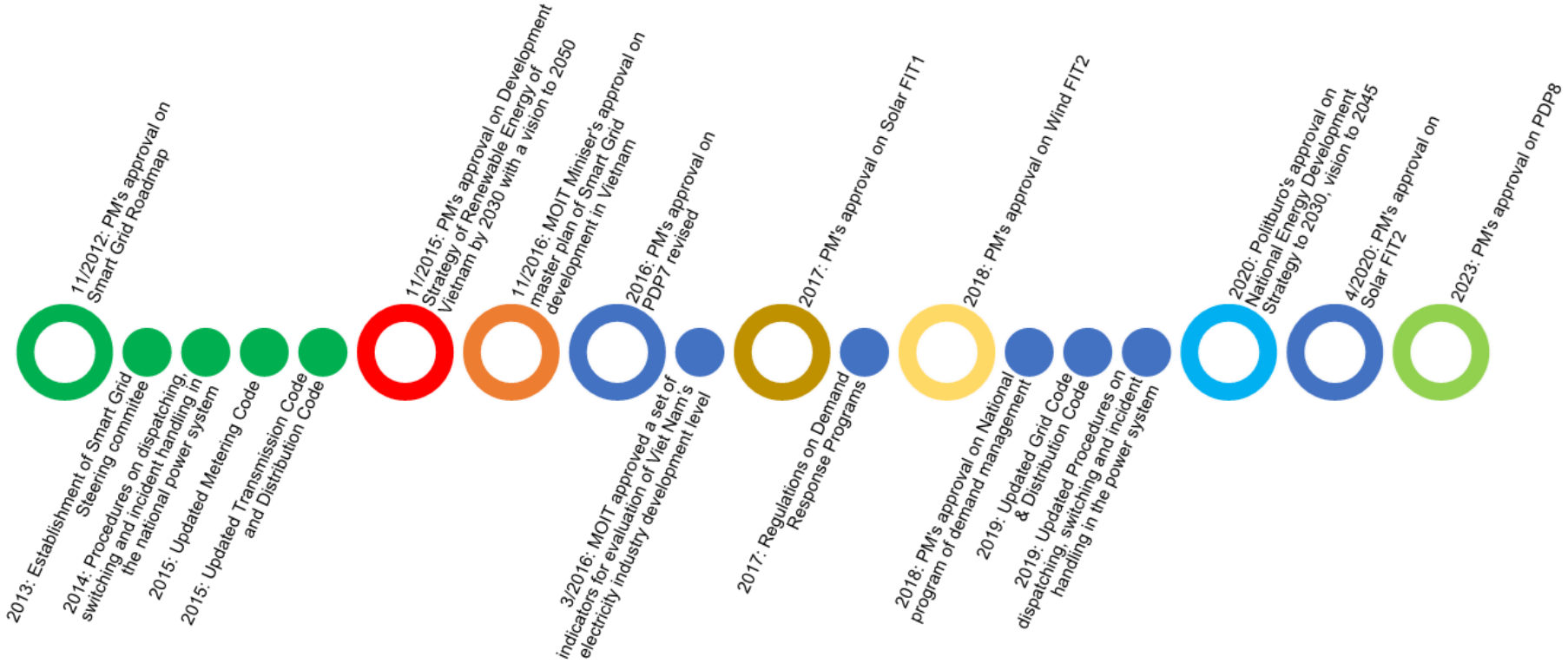
meters and remote metering. Detailed reviews of those grid infrastructure programs that were implemented to date are provided in the following Section 4 and Section 5.

On the other hand, there is still lack of policies that provide technical guidance for and promote the deployment of specific smart grid technologies and solutions, especially those focusing on demand side participation and responses in a context of more complex power grid operations with diversified modes of power supply and consumption. This has been a policy challenge for the industry to achieve more substantial progress in smart grids, making the power system not only more modern but also a smarter one for Viet Nam.

Noticeable legislations that have been planned but are yet to be developed include:

- Incentive mechanism for smart grid applications in new and renewable energy,
- Incentive mechanism for smart grid applications in zero energy buildings,
- Incentive mechanisms for smart grid applications in energy trade between customers and power companies,
- Incentive mechanisms for residential customers participation in DSM,
- Regulations for integration of energy storage systems, and
- Regulations for smart appliances capable of adjusting the demand based on supply conditions or electricity tariff.

Figure 15 Milestones of Smart Grid Related Policy Documents



4 REVIEW OF SMART GRID PROGRAMS IMPLEMENTED TO DATE

4.1 New SCADA/EMS/DMS Systems

- **Upgrade and build a new SCADA/EMS system at NLDC:** According to the MOIT's Smart Grid Annual Report (2023), the new SCADA/EMS system for the National Load Dispatch Center (NLDC) and Regional Load Dispatch Centers (RLDCs) was completed in 2016. The new system has the capability to integrate, synchronize, and exchange data between NLDC and RLDCs for enhancing the operation efficiency of the national power system. Basic applications of the EMS system, such as automatic generation control (AGC) and state estimator, have been deployed in accordance with the operational requirements.
- **SCADA/DMS, miniSCADA systems at Power Corporations, Provincial Power Companies:** 100% of Power Corporations and Provincial Power Companies have been equipped with SCADA/DMS, miniSCADA systems to monitor and control the distribution power grids.
- **SCADA systems for substations and power plants:** The status of SCADA signal connections for substations and large power plants at the end of 2022 is summarised in Table 1.

Table 1 Status of SCADA Signal Connections at Substations and Power Plants

Category	Quantity		Full Signal	Partial Signal	Lost connection	Not connected
Substations						
500 kV	Quantity	41	38	3	0	0
	%		*92.68*	*7.32*	*0*	*0*
220 kV	Quantity	157	137	19	1	0
	%		*87.90*	*12.1*	*0.63*	*0*
110 kV	Quantity	954	822	102	10	20
	%		*86.58*	*10.69*	*1.04*	*2.09*
Generators > 30 MW						
All voltage levels	Quantity	330	298	20	8	0
	%		*93.64*	*6.06*	*2.42*	*0*
Generators between 10 MW - 30 MW						
Connected to high voltage grids (110 kV or higher)	Quantity	240	170	53	15	2
	%		*70.83*	*22.08*	*6.25*	*0.83*
Connected to medium voltage grids	Quantity	2	2	0	0	0
	%		*100*	*0*	*0*	*0*
Generators < 10 MW						
Connected to 110kV or higher	Quantity	13	9	4	0	0
	%		*69.23*	*30.76*	*0*	*0*
Connected to the medium voltage grids	Quantity	1	1	0	0	0
	%		*100*	*0*	*0*	*0*

Source: The data in this and the following tables has been extracted from the MOIT's 2023 Smart Grid Annual Report.

- *Power plants with a capacity more than 30 MW:* Basically, 100% power plants have been equipped with SCADA system, compared to the rate of 92% in 2013. For these power plants, 93.64% of the SCADA connections currently provide stable signals, a significant improvement in comparison to that rate of 46% in 2013.
- *500kV substations:* 100% of 500kV substations have been connected to the SCADA system. The proportion of 500kV substations having sufficient SCADA signals has increased to 92.68%, compared to 42% in 2013.
- *220kV substations:* All 220kV substations have their SCADA systems connected, with 87.9% of them providing stable signals.
- *110kV substations:* SCADA connections have been set up at 97% substations of this voltage level, with 86.58% transmitting good signals.

Areas of Improvement:

- Despite the SCADA systems having been completely installed at the power plants and substations, the stability of SCADA connections and signal reception needs further improvement (at least 90% of stable SCADA data reception is required) for effective utilisation of all functions of the SCADA/EMS/DMS systems including the EMS application for real time calculations.
- The last major upgrade to the SCADA/EMS system was completed in 2016. To meet the VWEM long term requirements and be able to handle a much larger power system with more generators and substations, a new SCADA/EMS system is being developed, with an accomplishment target set for 2028-2030. The new system should ensure all EMS features are functional.

4.2 Remote Metering Data Collection

Table 2 and Table 3 show the proportions of remote metering set up at the power plant level and consumer levels respectively by end of 2022.

Table 2 Remote Metering at Power Plants

	Power plants with installed capacity > 30MW	Power plants with installed capacity ≤ 30MW
Total number of plants	455	488
Plants with remote metering	452	478
Proportion (%)	99.3%	98.2%

Table 3 Classification of Consumer Metering

	All consumer meters		Electronic meters with remote metering
	Mechanical meters	Electronic meters	
Number of meters	5,663,538	24,667,754	23,292,310
Proportion (%)	19.0%	81.0%	76.8%

- *For power plants:* 452 out of 455, or 99.3% power plants with capacity of over 30 MW have been equipped with remote metering. For power plants with capacity of 30 MW or less this rate is 479 out of 488 plants or approximately 98.2%.
- *For substations:* All main and backup meters at 500kV and 220kV substations have the remote metering infrastructure installed and operational within the wholesale electricity market (VWEM). For 110kV substations, the Power Corporations (PCs) completed the remote metering systems in 2020.
- *For electricity end-users:* By the end of December 2022, the 5 PCs manage a total of 30,331,292 consumer meters, of which the number of electronic meters is 24,667,754 (accounting for approximately 81%). The number of electronic meters featuring remote measuring and data collecting systems is 23,292,310 (comprising approximately 76.8% of the total number of consumer meters).

Challenges in rolling out smart metering:

- Advanced metering infrastructure (AMI) for large customers was piloted for HCMC in 2017 but has not been widely implemented afterwards; instead, only automatic meter reading (AMR) infrastructure has been deployed. The main barrier to the AMI implementation was the high costs of smart meters – rolling out many AMI meters for customers in a short time would increase supply costs hence putting pressure on electricity prices.

4.3 Remote Control Centers and Unstaffed Automated Substations

A snapshot on the numbers of Remote Control Centers (RCCs) and unstaffed, fully automated substations at various power grid management entities (PCs and NPT) by December 2022 is shown in Table 4 below.

Table 4 Numbers of Remote Control Centers and Unstaffed Automated Substations

Entities	Number of RCCs in operation	Ratio of RCCs in operation / total RCCs	Substations (220kV/110kV) operating under automated criteria	Total substations (220/110kV) in operation	Ratio of automated substations
EVNNPC	27	100%	313	313	100%
EVNCPC	13	100%	142	142	100%
EVNSPC	21	100%	243	243	100%
EVNHANOI	01	100%	56	56	100%
EVNHCMC	01	100%	61	61	100%
EVNNPT	No Control Centers		115	146	78.8%

These records show that:

- *For 110kV substations:* the Power Corporations have successfully put 100% of the RCCs into operation and achieved a 100% rate of 110kV substations operating in compliance with the fully automated criteria.

- *For 220kV substations:* EVNNPT has put 115 out of 146 of 220kV substations or 78.8% into operation in accordance with the unstaffed automated criteria.

Issues in relation to fully automated substations:

- Although the necessary infrastructure and regulations have been set up, there are currently no updated guidance regarding fire prevention and firefighting for these facilities, therefore grid entities still need to arrange 1 employee to be physically present at each substation for fire duty in accordance with current fire prevention regulations.

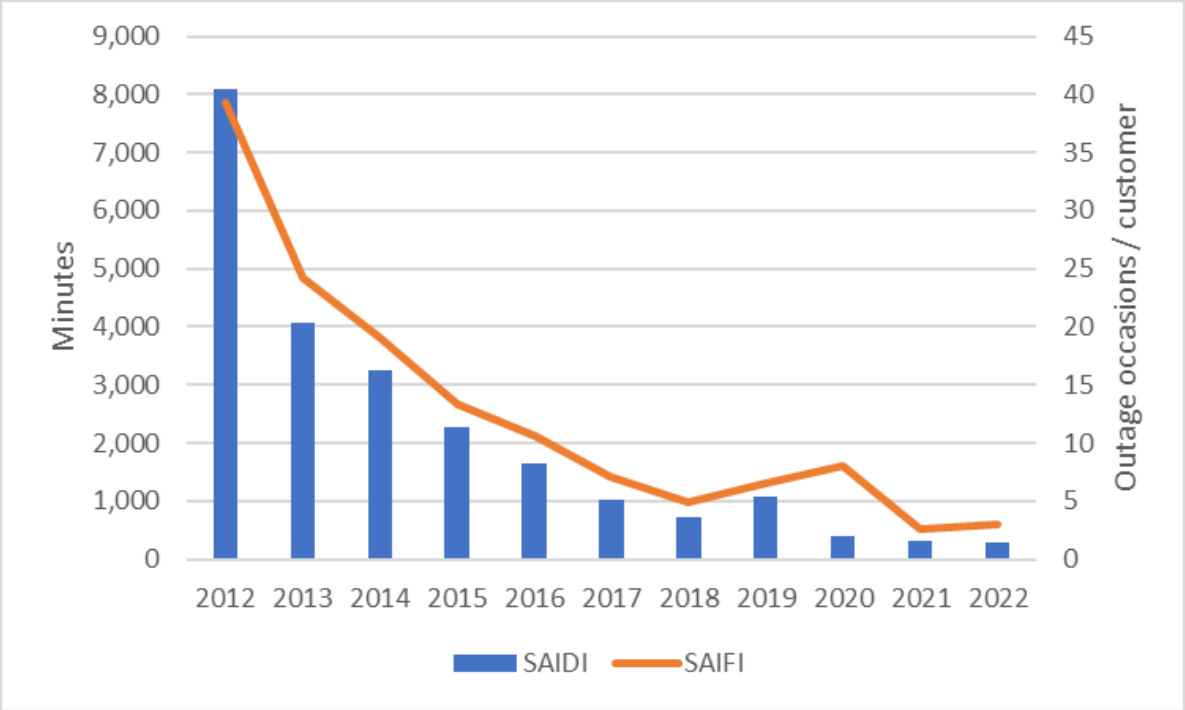
4.4 Electricity Supply Reliability Improvements

Electricity supply reliability indicators including MAIFI (Momentary Average Interruption Frequency Index), SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index) have considerably improved between 2012 -2022 as shown in the following Table 5 and Figure 16.

Table 5 MAIFI, SAIDI and SAIFI between 2012-2022

Year	MAIFI (Outage occasions / customer)	SAIDI (Minutes)	SAIFI (Outage occasions / customer)
2012	5.07	8,077	39.24
2013	3.58	4,067	24.17
2014	2.59	3,242	19.03
2015	2.03	2,281	13.36
2016	1.51	1,651	10.6
2017	0.94	1,028	7.04
2018	0.78	724	4.97
2019	0.89	1,071	6.57
2020	2	400	8
2021	1.22	319	2.64
2022	1.65	283	2.95

Figure 16 SAIDI and SAIFI Improvements between 2012-2022



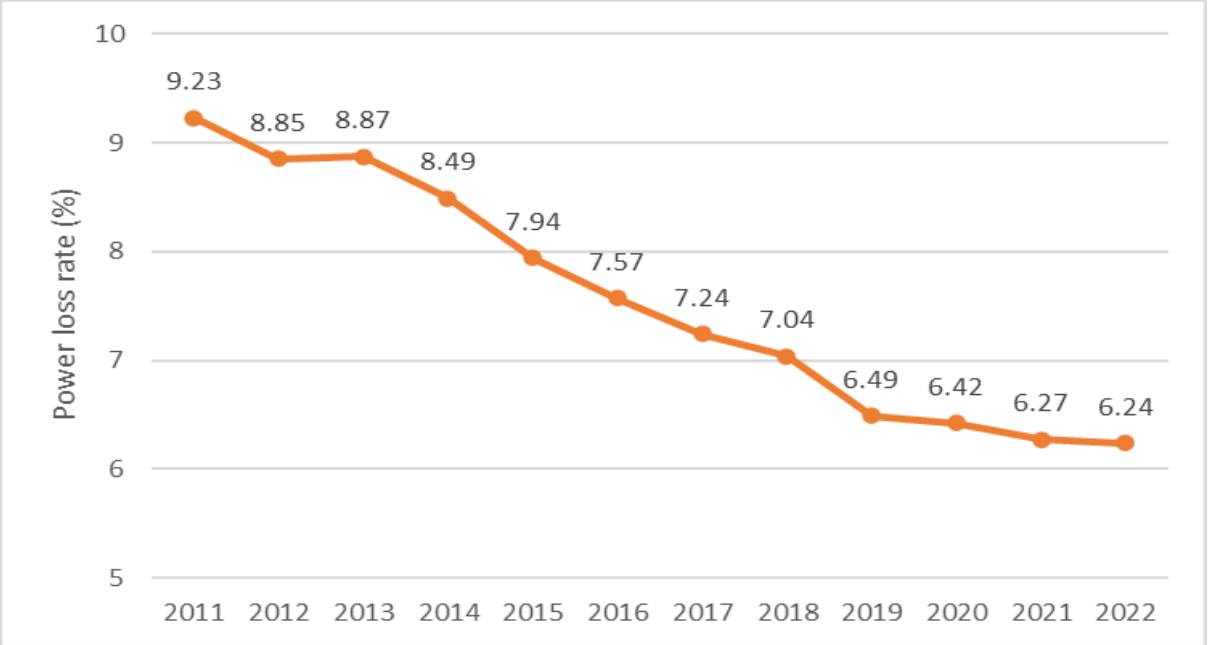
4.5 Reduction in Power Losses

As shown in Table 6 and Figure 17, EVN power loss rate has steadily decreased from 8.85% in 2012 to 6.24% in 2022. This reduction in power losses was achieved through the implementation of various solutions including investments for grid reinforcement, optimization of operational methods to reduce technical losses and management solutions to reduce commercial losses, especially addressing electricity theft in low voltage distributed grids.

Table 6 EVN Power Loss Rates between 2011-2022 (%)

Entities	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NPC	8.04	7.76	7.39	6.68	6.09	5.63	5.10	4.99	4.84	4.54	4.30
SPC	5.64	5.44	5.51	5.19	4.78	4.44	4.39	4.22	3.89	3.86	3.87
CPC	7.10	6.52	6.51	6.08	5.73	5.3	5.12	4.67	4.65	4.43	4.15
HANOI	7.08	6.65	5.83	5.71	5.22	4.57	4.37	3.73	3.67	3.55	3.55
HCMC	5.56	4.96	5.08	4.66	4.16	3.72	3.78	3.48	3.41	3.12	3.21
NPT	2.33	2.69	2.49	2.12	2.36	2.45	2.44	2.15	2.23	2.29	2.55
EVN	**8.85**	**8.87**	**8.49**	**7.94**	**7.57**	**7.24**	**7.04**	**6.49**	**6.42**	**6.27**	**6.24**

Figure 17 Reduction in EVN Power Loss Rates over 2011 - 2022



4.6 Load Adjustment and Demand Response Programs

In 2014 the Ministry of Industry and Trade (MOIT) issued Decision No. 2600/QD-BCT approving the plan to implement pilot demand response (DR) programs for the period 2014 - 2015, and assigning ERAV the following tasks:

- Develop and submit for MOIT approval a detailed design of pilot demand response programs, and
- Develop and submit to relevant authorities for approval the incentive mechanisms required to implement the pilot programs.

4.6.1 Pilot Demand Response Program at the Ho Chi Minh City Power Corporation

MOIT and ERAV in collaboration with international consultants and the Ministry of Finance developed the pilot demand response program for the Ho Chi Minh City Power Corporation (HCMC) through issuance of the following legal documents:

- Decision No. 2600/QD-BCT dated 27 March 2014 approving the implementation plan for the pilot demand response programs.
- Decision No. 4425/QD-BCT and Decision No. 4426/QD-BCT dated 8 May 2015 approving the detailed design and incentive mechanisms for implementing demand response programs at HCMC.
- ERAV Decision No. 44/QD-DTDL dated 14 July 2015 setting out the procedures and guidance for HCMC and customers in implementing the pilot demand response program.

Main features of the DR Pilot Program were:

- *Objectives:* contributing to the reduction of electricity demand during peak hours and reduction in occurrences of the distribution grid being overloaded or congested.

- *Demand response events:* the pilot program considered 2 DR events:
  - Curtailable Load Program (CLP) - Planned electricity load reduction with customers being notified at least 24 hours in advance.
  - Voluntary Emergency Demand Reduction Program (VEDRP) - Voluntary emergency load reduction with notification to customers at least 2 hours in advance.
- *Participants:* 20 large electricity consumers within the industrial or commercial segments in Ho Chi Minh City.
- *Implementation time:* 2015.
- *Incentive mechanism:* the participating customers would receive a financial incentive determined based on the actual electricity savings and the electricity price at the time of the load adjustment event, specifically:
  - For CLP participants: customers would receive an incentive payment corresponding to the existing electricity prices at the time of the demand response event (different tariffs for peak, off-peak, and normal hours).
  - For VEDRP participants: customers would receive an incentive payment corresponding to the existing tariffs multiplied by 3 times for peak hours, 2 times for normal hours, and 1 time for off-peak hours.
  - The financial incentives would be paid out to customers through utilisation of the HCMC's Science and Technology Development Fund

The **outcomes** of the pilot program is summarised in Table 7.

Table 7 Results of the HCMC Pilot Demand Response Program (2015)

Events	Time	Number of participated customers	Average demand reduction	Average reduction ratio compared to the baseline level	Total resulted incentives (VND)
First CLP	14:00 – 16:00 7/10/2015	9	647 kW	5%	2,307,056
First VEDRP	10:00 – 12:00 21/10/2015	10	653 kW	4%	10,578,765
Second CLP	8:00 – 10:00 4/11/2015	12	752 kW	6%	3,875,200
Second VEDRP	15:00 – 17:00 18/11/2015	11	461 kW	4%	3,465,392
Total			**628.25 kW**	**4.75%**	**20,226,333**

Observations:

- The incentive mechanism leveraging the HCMC's Science and Technology Development Fund was not attractive to customers and did not accurately reflect the essence of incentivising instruments for the DR programs that were being applied worldwide.

- The average demand reduction margin compared to the base load was relatively low at around 5%. The pilot implementation time of just 4 months and the small number of eventuated DR events demonstrated customers not being fully aware of the benefits of the program, and not being adequately interested in participating in it.

4.6.2 Non-Commercial DR Programs

To further facilitate demand management and demand response programs, MOIT and ERAV has issued the following policy documents:

- Circular 23/2017/TT-BCT dated 16 November 2017 guiding the process of implementing DR programs,
- Decision No. 175/QD-BCT on 28 January 2019 approving the roadmap and plan for the implementation of DR programs, and
- ERAV Decision No. 54/QD-ĐTĐL on 12 June 2019 providing guidelines for implementing DR.

Since 2018, the MOIT has directed EVN to proactively organize and implement non-commercial DR programs based on Circular 23/2017/TT-BCT. This included surveys and evaluation of DR potentials, customers signing agreements on DR implementation, and development of demand response management software (DRSM).

Table 8 shows the participation status in non-commercial demand response programs that have been initiated across the 5 EVN Power Corporations. A total of 3,035 customers with electricity consumption of 1 million kWh per year or more have signed agreements with the PCs to take part in non-commercial voluntary DR programs. The total potential reduction in demand of the participated customers is estimated at 1,552 MW.

Table 8 Participation in Non-Commercial DR Programs

Entities	Total number of critical customers	Number of consulted customers	Customers signing agreements	Participation ratio	Potential reduction in demand (MW)
NPC	1,354	1,303	990	73,1%	697.7
CPC	220	220	209	95,0%	167.8
SPC	1,758	1,758	1,319	75,0%	483.0
HANOI	225	225	197	87,6%	63.4
HCMC	365	365	320	87,7%	140.0
All EVN	**3,922**	**3,871**	**3,035**	**77,4%**	**1,552**

Some highlights of these programs include:

- 10 DR events were eventuated in 2019 which included 7 emergency DR events and 3 planned DR events.
- The maximum reduction in demand of 513.9 MW occurred on September 10, 2019.

- Total electricity savings: 6,373,361 kWh.
- Cost savings: 24.12 billion VND (due to not having to mobilize DO power plants).

5 PROGRESS EVALUATION AGAINST ROADMAP OBJECTIVES

5.1 Assessment of Roadmap Objectives and Targets

As of end of 2022, the Phase 2 milestone of the first Smart Grid Development Roadmap had been surpassed. Our review in the previous section has revealed several positive outcomes in the implementation of this roadmap. Noticeable up-to-date achievements include:

- Gradual deployment of technology infrastructure to support power system automation and RE integration,
- Enhancements in the reliability and quality of electricity supply,
- Rollouts of electronic meters and remote metering, and
- Initiating demand-side management and demand response programs.

More detailed evaluation of Viet Nam's Smart Grid roadmap progress is provided in the following Table 9 and Table 10, through comparison of the actions taken and outcomes against the specific objectives and targets set out in Decision 1670/QD-TTg and Decision 4602/QD-BCT.

Table 9 Progress of Smart Grid Roadmap General Objectives (Decision 1670/QD-TTg)

No.	Roadmap General Objectives (2012)	Results achieved (by the end of 2022)
1	Establishing a legal framework for the Smart Grid Development by reviewing, amending, and supplementing existing legal documents in the electricity sector; promulgating new documents related to development of renewable energy sources; and developing relevant technical standards and regulations.	Policy documents have been issued to provide legal frameworks for: • Frequency regulation and ancillary services operation in conjunction with the integration of a significant amount of RE sources; • Establishment of Remote Control Centres (RCC) / Remote Operation Centres (ROC) and automated substations to facilitate remote control and switching of electric equipment in the power system; • Application of remote metering and metering data collection; • Criteria or assessment of the electricity industry development; • Technical requirements and operational management of the SCADA/EMS/DMS system; • Load research and Pilot Demand Response Program. Other legislations are yet to be developed to provide: • Incentive mechanism for smart grid applications in new and renewable energy • Incentive mechanism for smart grid applications in zero energy buildings • Incentive mechanisms for smart grid applications in energy trade between customers and power companies • Incentive mechanisms for residential customers participation in DSM • Regulations for integration of energy storage systems • Regulations for smart appliances capable of adjusting the demand based on supply conditions or electricity tariff
2	By 2013, establish a comprehensive data collection, monitoring, and control system (SCADA) and remote metering system for all power plants with a capacity greater than 30 MW, as well as substations with voltages of 110 kV and above within the national power system.	• Power plants with a capacity more than 30 MW: Basically, 100% power plants have been equipped with SCADA system, compared to the rate of 92% in 2013. For these power plants, 93.64% of the SCADA connections currently provide stable signals, a significant improvement in comparison to that rate of 46% in 2013. • 500kV substations: 100% of 500kV substations have been connected to the SCADA system.

No.	Roadmap General Objectives (2012)	Results achieved (by the end of 2022)
		The proportion of 500kV substations having sufficient SCADA signals has increased to 92.68%, compared to 42% in 2013. • 220kV substations: All 220kV substations have their SCADA systems connected, with 87.9% of them providing stable signals. • 110kV substations: SCADA connections have been set up at 97% substations of this voltage level, with 86.58% transmitting good signals.
3	By 2016, all the functionalities of the Energy Management System (EMS) of the SCADA/EMS system are fully utilized at the National Load Dispatch Center and Regional Load Dispatch Centers.	• Basic applications of the EMS system, such as automatic generation control (AGC) and state estimator have been deployed in accordance with the operational requirements.
4	By 2022: SCADA/DMS system for Power Corporations; remote metering system installed for all major electricity customers.	• 100% Power Corporations and Provincial Power Companies have been equipped with SCADA/DMS, miniSCADA systems to monitor and control the distribution power grids. • 100% customers with monthly electricity consumption greater than 1 million kWh have remote metering set up.
5	Improve the reliability of electricity supply: reduce the System Average Interruption Frequency Index (SAIFI) by 10% and reduce the System Average Interruption Duration Index (SAIDI) by 20% after every 5-years period.	• Over the last 10 years, SAIFI has decreased 13 times (from 39.24 in 2012 to 2.95 in 2022), and SAIDI has decreased 28 times (from 8,077 minutes in 2012 to 283 minutes in 2022).
6	Equip automatic and control devices to enhance labour productivity in the power sector: the 110kV substations equipped with automation and remote-control devices would reduce to 3-5 persons on the duty per substation; switching operations for medium-voltage networks would be implemented remotely.	• For 110kV substations: the Power Corporations have successfully put 100% of the RCCs into operation and achieved a 100% rate of 110kV substations operating in compliance with the fully automated criteria. • For 220kV substations: EVNNPT has put 115 out of 146 of 220kV substations or 78.8% into operation in accordance with the unstaffed automated criteria. • However, there are currently no detailed regulations regarding fire prevention and firefighting for fully automated substations, therefore entities still have to arrange 01 employee to be physically present at each substation for fire duty in accordance with current regulations.

No.	Roadmap General Objectives (2012)	Results achieved (by the end of 2022)
7	Enhance the ability of electricity demand forecast and electricity supply planning, limit load shedding due to supply shortages through mechanisms such as peak load shifting during peak hours or emergency situations: Reduce peak load by 1 - 2% through the application of advanced metering infrastructure (AMI).	• Advanced metering infrastructure for large customers was piloted for HCMC in 2017 but has not been widely implemented afterwards; only Automatic meter reading (AMR) infrastructure has been deployed. • Commercial Demand Response has not been implemented; however, non-commercial Demand Response mechanisms were initiated; a reduction of 513.9 MW in peak demand was achieved in 2019, which was around 1.5% system Pmax.
8	Implement technical solutions and management measures with the aim of reducing electrical energy losses (technical and commercial losses) in the transmission and distribution systems from 9.23% in 2011 to 8% by 2015	• This objective has been achieved: system power loss factor was 7.94% in 2015 and decreased further to 6.42% in 2022.
9	Apply Smart Grid technology to connect and operate reliably new and renewable energy sources, facilitating the efficient utilization of these energy sources contributing to the encouragement of the development and increase of the new and renewable energy source share in the electricity generation mix, and contribute to the environmental protection and ensuring national energy security.	• 100% RE plants are connected to SCADA and can be monitored and controlled via AGC from the dispatch center. • Rooftop solar systems less than 1 MW do not feature monitoring systems connected to the dispatch center.
10	Promote research and domestic production of intelligent electronic products for the technological needs of smart grids; to allow customers to proactively access and manage detailed information about their electricity usage and costs.	• Some entities have proactively carried out research on product development, however, due to the lack of incentive mechanisms and supporting industries, no commercial products have been widely introduced. • Distribution entities have implemented web and mobile applications, allowing customers to monitor and manage specific information about their electricity usage and electricity purchase costs.

Table 10 Progress of Specific Smart Grid Development Targets (Decision 4602/QD-BCT)

Area	Targets	Year	Progress	Notes
SCADA and telecommunication infrastructure	National and all regional load dispatching centres, all Power corporations, selected provincial and municipal city power companies are equipped with SCADA/EMS, SCADA/DMS systems	2020	Completed by end of 2022	
	Power plants, substations and control centres are equipped with RTU/Gateway and telecommunication systems	2020	Completed by 2020	RTU/Gateway and telecommunication equipment were installed for power plants, substations and operation control centres (OCCs)
	100% of power plants capacity above 30 MW, 100% of 500kV and 220kV substations have sufficient SCADA signal transmitted	2020	Completed by 2020	
	100% of 110kV substations and power plants capacity between 10 - 30 MW have SCADA signal, 90% of them have sufficient signal transmitted	2020	Almost completed by 2020	Some substations that belong to customers are not connected
	Use DMS and EMS systems applications at all dispatching levels	2020	Not fully completed (as of 2020)	Hindered by insufficient SCADA signals
	100% of power plants capacity above 30 MW and 500kV, 220kV substations are connected to a dedicated EVN system via two independent fibre lines	2020	Completed by 2020	100% of power plants with capacity of 30 MW or above, 100% of 110/220/500kV have D2 connections
	100% of 110kV substations are connected to control centres or dispatching centres via a fibre line	2020	Completed by 2020	100% of 110kV substations and regional power companies have fibre-optic connections installed, except island

Area	Targets	Year	Progress	Notes
				district power units where microwave channels are used.
	More than 90% of district power companies are connected to a dedicated EVN system via a fibre line	2020	Completed by 2020	100% urban district power companies and 98% rural district power companies have fibre-optic connections installed (with the exception of remote island power companies).
Remote control centres for NPT and power corporations	60% of 220kV substations, 100% of 110kV substations controlled by NPT and power corporations are unstaffed (fully automated)	2020	- 220kV: Completed by 2020 - 110kV: Completed by 2022	
Electronic metering and remote metering	Complete installations of the remote electricity metering and data collection systems at all metering points to serve the management, production, and business activities of the NPT and PCs (including metering between different entities and main meters at 0.4 kV distribution substations).	2017	Completed by 2022	
	Installation of electronic metering and telemetry function (remote metering) for 50% of customers	2020	Completed by 2022	

5.2 Assessment of Deployed Smart Grid Technologies

As already pointed out in this report, the previous smart grid infrastructure projects have mainly focused on supporting power system automation and enhancing the reliability of electricity supply, whereas application of technologies promoting participation and responses from the energy end users remains limited.

According to a report titled "Smart Grids Technology Assessment for Renewable Energy and Energy Efficiency" conducted by GIZ in 2022[5], key technologies that have been widely applied in the Viet Nam's power system include:

1. SCADA/EMS system which has been upgraded and extended to all power plants with the capacity of over 30 MW, and also installed for Power Corporations;
2. Dissolved Gas-in-oil Analysis (DGA) – equipped for all 500 kV transformers and important 220 kV transformers;
3. Outage Management Systems (OMS) – set up in most Power Corporations with the DMS integration; and
4. Automatic Meter Reading (AMR) – successfully deployed for the Power Corporations' most of customers.

The GIZ report has identified other technologies which were deployed in small scales or implemented as pilot projects, such as:

- Equipping Substation Automation Systems (SAS) for 110kV substations,
- Wide Area Monitoring System (WAMS) established and connected with several 500 kV substations,
- Lightning Location System (LLS) established with 9 sensors in various regions,
- Fault Locator Systems (FLS) or Fault Location, Isolation and System Restoration (FLISR) systems are made available at some Power Corporations,
- Dynamic Thermal Circuit Rating (DTCR) as trials,
- AMI and Smart Meters conducted as a pilot project in Ho Chi Minh City Power Corporation.

The GIZ study also performed a benchmarking analysis of the smart grid progress in Viet Nam in comparison to several other countries. This assessment was implemented using the Smart Grid Index methodology that was introduced by SP Engineering Council, SP Group, Singapore. The SP Group methodology defines the seven dimensions of Smart Grids, including Monitoring and Control, Data Analytics, Supply Reliability, Distributed Energy Resources (DER) Integration, Green Energy, Cybersecurity and Customer Empowerment and Satisfaction. The GIZ study has also introduced an additional index which is "Energy Market" to provide guidance for evaluation of Viet Nam's smart grid readiness for a transition from the current wholesale energy market stage to the anticipated retail market stage. More details of these Smart Grid Indexes are shown in the following figure.

[5] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.giz.de/en/downloads_els/Smart%20Grids_ENG_25-6.pdf

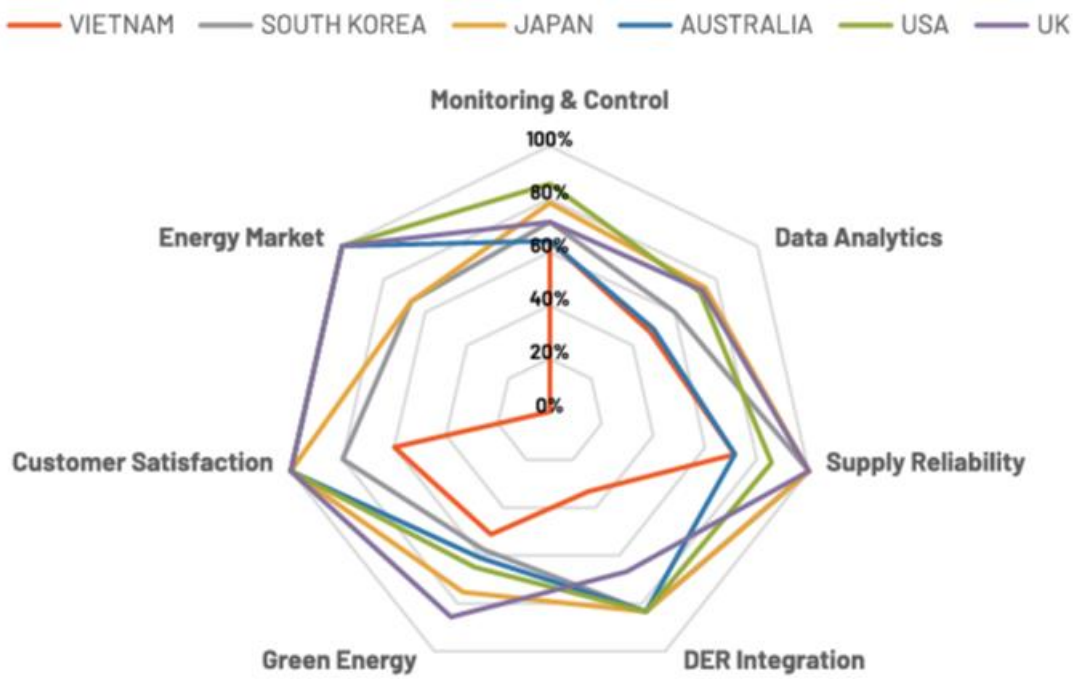
Figure 18 Smart Grid Indexes (in alignment with SP Group SGIs)

The GIZ study's outcomes in the following table show that the smart grid development indexes for Viet Nam (in percentage) remain considerably lower than those of the countries under comparison, including South Korea, Japan, Australia, USA and the UK. This implies that there are substantial venues in the Vietnamese power system for future deployment of smart grid technologies and applications. The acceleration of smart grids development in the country will require having an updated roadmap together with robust policies and regulations set in place, which will in many ways contribute to promoting energy transition through integration of more renewable energy resources.

Table 11 Smart Grid Development Indices of Viet Nam vs. Selected Countries

Index / Dimension	Viet Nam	South Korea	Japan	Australia	USA	UK
Monitoring & Control	64%	71%	79%	64%	86%	71%
Data Analytics	48%	60%	75%	50%	72%	73%
Supply Reliability	71%	100%	100%	71%	86%	100%
DER Integration	33%	83%	83%	83%	83%	67%
Green Energy	51%	57%	75%	61%	65%	86%
Customer Satisfaction	60%	80%	100%	100%	100%	100%
Energy Market	0%	67%	67%	100%	100%	100%
Final Score	***47%***	***74%***	***83%***	***76%***	***85%***	***85%***

Figure 19 Comparison of SG Development Indexes between Viet Nam and Selected Countries



6 SHORTCOMINGS AND OBSTACLES

We have previously discussed the progress that Viet Nam have achieved in those Smart Grid programs implemented over the last 10 years. Beside many accomplishments, there are numerous apparent shortcomings and obstacles that have hindered attainment of more fulfilled, pragmatic results. These impeding issues are summarised as follows:

- **Coordination among different ministries:** MOIT would need stronger support and collaboration from other relevant Ministries and agencies, such as Ministry of Finance, Ministry of Science and Technology, Ministry of Construction, Ministry of Transport. The rationale for close partnerships between different sectoral agencies is that new Smart Grid concepts and applications require careful research and expertise exchanges among the impacted parties before appropriate sectoral policy mechanisms can be made. Additionally, the level of investment required for Smart Grid development is substantial, for which supporting policies and appropriate financial mechanisms are needed but still absent or unspecified. Design of financial incentive mechanisms with any implications on electricity prices will require policy inputs and backing from agencies such as Ministry of Finance.
- **SCADA/EMS/DMS systems:** Despite the SCADA systems having been completely installed at the power plants and substations, the stability of SCADA connections and signal reception needs further improvement (at least 90% of stable SCADA data reception is required) for effective utilisation of all functions of the SCADA/EMS/DMS systems.
- **For transition to unstaffed, fully automated transformer substations:** Although the necessary infrastructure and regulations have been set up, there are currently no updated regulations regarding fire prevention and firefighting for these facilities, therefore grid entities still need to arrange 01 employee to be physically present at each substation for fire duty in accordance with current fire prevention regulations.
- **On AMI infrastructure:** Assessment of the AMI pilot project implemented at HCMC has showed that rolling out many AMI meters for customers in a short time would increase supply costs hence putting pressure on electricity prices. Therefore, the roadmap for deployment of AMI systems needs to be reconsidered and adjusted accordingly.
- **On the outcome of demand response programs:** Currently Viet Nam does not have active commercial or mandatory DR programs. The pilot DR program implemented briefly for HCMC in 2015 did not subsequently result in wider actual applications continuation due to several reasons, with the main factor being lack of supporting financial incentives for customers and a cost pass-through mechanism for the host power company (for example, end-use retailed tariffs cannot be dynamically adjusted to absorb DR related costs). The Power Corporations instead have been implementing non-commercial DR programs with voluntary subscription by large customers. The actual implementation has showed that while customers may have agreed to participate (through signing the agreement with the PC), their responses to announced DR events were limited because they remained reluctant to reduce their power consumption due to the absence of direct monetary benefits or any compensation for resultant impact on their business operations. As such, it is rather challenging for these voluntary DR initiatives to attract and maintain long-term customer engagement.

  The outcome of the demand response programs implemented to date in Viet Nam is indeed not different to many international examples where commercial DR programs have proved to

be a far more effective tool for attaining desirable consumer demand responses as compared to non-commercial participation.

- **On the policy framework to provide technical guidance for and promote the deployment of smart grid technologies and solutions:** There is lack of policies focusing on demand side participation and responses. Legislations that have been planned but are yet to be developed include technical regulations for energy storage systems, incentive mechanism for smart grid applications in zero energy buildings, incentive mechanisms for smart grid applications in energy trade between customers and power companies, and incentive mechanisms for residential customers participation in DSM.
- **On smart grid product research and development**, companies have proactively carried out research on product development, however, due to the lack of incentive mechanisms and supporting industries, no commercial products have been widely introduced.
- **On stakeholder / customer outreach:** Although ERAV, EVN and the grid companies have made diligent efforts to communicate the significance and benefits of Smart Grids in modernised electricity supply, more work shall be done so that the information on smart grid objectives and undertakings can be disseminated to and understood by wider communities including direct and indirect stakeholders (such as power generators, power companies and electricity customers).

7 OVERALL RECOMMENDATIONS

Based on our review of the existing status, this final section will present the Consultant's initial recommendations which include four (4) major areas of activities to be considered in drafting the next Smart Grid Development Roadmap for Viet Nam.

Area 1. Further Modernization in Monitoring and Control of Power System Operations

- Completion of updating the SCADA/EMS/DMS systems for the NLDC and grid participants, maintaining stable connections and signal transmission to comply with the requirements of the power system and power market operations, and capable of supporting all EMS/DMS functionalities and integrating a larger amount of diversified RE sources.
- Continue to enhance the grid control and monitoring centers, achieve and maintain the 100% rate of fully automated unstaffed operations of all high voltage substations (110kV and 220kV).
- Modernize the medium-voltage power grids by increasing the proportion of the distribution grids equipped with remote control devices, integration of Fault Management and System Restoration (FMSR) and Advanced Distribution Management System (ADMS) system into SCADA to improve power supply reliability. Set an intermediate target of 50% medium-voltage substations to be remotely monitored and operated by 2030.
- Enhance communication protocols and the ability to link and exchange information between the NLDC, RLDCs and distribution grid control and monitoring centers.
- Geographic Information System (GIS): Set a target of 50% transmission and distribution network management units by 2030 to develop and implement GIS for power grid management.

Area 2: Remote Metering, Smart Metering and Data Analysis.

- Moving towards the deployment of 100% electronic meters with remote measuring capabilities across the entire power grid, with an intermediate target of 95% by 2030. No new mechanical meters shall be installed.
- Gradually implement AMI and smart meters (featuring two-way interactions) for customers in accordance with operational, commercial and customer service requirements while ensuring the economic efficiency.
- Rolling out smart devices capable of supporting Demand Response programs.
- Gradually apply artificial intelligence and data analytics in monitoring, energy consumption and demand forecasts, equipment condition assessment and system fault forecasting.

Area 3: Integration of Distributed Energy Sources

- Develop the Distributed Energy Resources Management System at the NLDC, RLDCs and Distribution Companies.
- Development of a TSO/DSO coordination model for managing distributed resources.
- Gradually integrate energy storage systems to optimize mobilization and operation of distributed sources. Experiment small-scale energy storage modules to balance supply and demand at the end-user level.

- Investigate the potential for implementing microgrids in important load locations, remote areas and islands; microgrid systems that integrate battery storage systems and smart electric vehicle charging stations.
- Examine new operational management models for amalgamation of many distributed energy resources, such as virtual power plants.

Area 4: Development of New Energy Sources, Renewable Energy and Energy Efficiency

- Continue to encourage the development of new energy renewable energy sources for self-consumption to reduce the pressure of additional investments for power networks expansion.
- Implement programs for energy efficiency, demand management and demand response.
- Explore tools and solutions for managing electric vehicle charging stations and their integration into the demand management systems of the power companies to help achieve the overall effectiveness of the electrical system.